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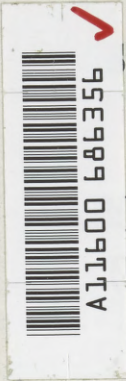
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In 8/4 INTERNATIONAL BIOLOGICAL PROGRAM

GOVERNMENT

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HEARING
BEFORE THE
SUBCOMMITTEE ON HEALTH
OF THE
COMMITTEE ON
LABOR AND PUBLIC WELFARE
UNITED STATES SENATE
NINETY-FIRST CONGRESS

SECOND SESSION

ON

S.J. RES. 89

EXPRESSING THE SUPPORT OF THE CONGRESS, AND URGING
THE SUPPORT OF FEDERAL DEPARTMENTS AND AGENCIES
AS WELL AS OTHER PERSONS AND ORGANIZATIONS, BOTH
PUBLIC AND PRIVATE FOR THE INTERNATIONAL BIOLOGICAL
PROGRAM

H.J. RES. 589

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AS WELL AS OTHER PERSONS AND ORGANIZATIONS, BOTH
PUBLIC AND PRIVATE FOR THE INTERNATIONAL BIOLOGICAL
PROGRAM

FEBRUARY 9, 1970

Printed for the use of the Committee on Labor and Public Welfare



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INTERNATIONAL BIOLOGICAL PROGRAM

MONDAY, FEBRUARY 9, 1970

U.S. SENATE,
SUBCOMMITTEE ON HEALTH OF THE COMMITTEE
ON LABOR AND PUBLIC WELFARE,
Washington, D.C.

The subcommittee met at 10 a.m., pursuant to call, in room 4232, New Senate Office Building, Senator Thomas F. Eagleton (presiding pro tempore).

Present: Senators Yarborough, Eagleton, and Javits.

Also present: Senator Muskie.

Staff members present: James Murphy, professional staff member; James Babin, professional staff member; and Jay Cutler, minority counsel to the subcommittee.

Senator EAGLETON (presiding pro tempore). Good morning. The Subcommittee on Health of the Senate Labor and Public Welfare Committee will now be in order.

This hearing is to consider Senate Joint Resolution 89, which expresses the support of Congress for the International Biological Program, IBP.

It is an appropriate time as we begin the new decade to discuss this program of ecological research. If, as many of us hope, the 1970's are to be the time when we finally turn the Nation's attention to environmental problems, it is important that we understand something about this system we call the environment and how it works.

The Congress has dealt in the past with seemingly isolated problems of pollution, food resources, conservation of wild area, water use, etc.; however, congressional support for ecology—the only scientific discipline which specializes in the total environment—has been conspicuously lacking.

The International Biological Program—which I should add has been conceived and developed largely by scientists and no government—can be of major significance in helping to make up for the inattention of the past.

The data which this program can produce about the environment, and of equal importance, about man's adaptability to a changing environment, should form the basis for the programs that we expect will be devised in the years to come.

(The text of the legislation under consideration and the departmental reports received on this legislation follow:)

91ST CONGRESS
1ST SESSION

S. J. RES. 89

IN THE SENATE OF THE UNITED STATES

APRIL 3, 1969

Mr. MUSKIE introduced the following joint resolution; which was read twice and referred to the Committee on Labor and Public Welfare

JOINT RESOLUTION

Expressing the support of the Congress, and urging the support of Federal departments and agencies as well as other persons and organizations, both public and private for the international biological program.

- 1 *Resolved by the Senate and House of Representatives*
2 *of the United States of America in Congress assembled,*
3 That (a) the Congress hereby finds and declares that the
4 international biological program, which was established
5 under the auspices of the International Council of of Scien-
6 tific Unions and the International Union of Biological Sci-
7 ences and is sponsored in the United States by the National
8 Academy of Sciences and the National Academy of Engi-
9 neering, deals with one of the most crucial situations to face

1 this or any other civilization—the immediate or near potential
2 of mankind to damage, possibly beyond repair, the earth's
3 ecological system on which all life depends. The Congress
4 further finds and declares that the international biological
5 program provides an immediate and effective means avail-
6 able of meeting this situation, through its stated objectives
7 of increased study and research related to biological pro-
8 ductivity and human welfare in a changing world environ-
9 ment.

10 (b) The Congress therefore commends and endorses
11 the international biological program and expresses its sup-
12 port of the United States National Committee and the Inter-
13 agency Coordinating Committee, which together have the
14 responsibility for planning, coordinating, and carrying out
15 the program in the United States.

16 (c) In view of the urgency of the problem, the Congress
17 finds and declares that the provision by the United States
18 of adequate financial and other support for the international
19 biological program is a matter of first priority.

20 SEC. 2. (a) The Congress calls upon all Federal depart-
21 ments and agencies and other persons and organizations, both
22 public and private, to support and cooperate fully with the
23 international biological program and the activities and goals
24 of the United States National Committee and the Interagency
25 Coordinating Committee.

1 (b) For this purpose, the Congress authorizes and re-
2 quests all Federal departments and agencies having func-
3 tions or objectives which coincide with or are related to those
4 of the international biological program to obligate or make
5 appropriate transfers of funds to the program from moneys
6 available for such functions or objectives and provide such
7 other support as may be appropriate.

91ST CONGRESS
2^D SESSION

H. J. RES. 589

IN THE SENATE OF THE UNITED STATES

NOVEMBER 13, 1969

Read twice and referred to the Committee on Foreign Relations

FEBRUARY 9, 1970

The Committee on Foreign Relations discharged, and referred to the Committee
on Labor and Public Welfare

JOINT RESOLUTION

Expressing the support of the Congress, and urging the support
of Federal departments and agencies as well as other per-
sons and organizations, both public and private, for the
international biological program.

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- 2 *of the United States of America in Congress assembled,*
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- 8 Academy of Sciences and the National Academy of Engi-
- 9 neering, deals with one of the most crucial situations to face

II

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2 tential of mankind to damage, possibly beyond repair, the
3 earth's ecological system on which all life depends. The
4 Congress further finds and declares that the international
5 biological program provides an immediate and effective
6 means available of meeting this situation, through its stated
7 objectives of increased study and research related to bio-
8 logical productivity and human welfare in a changing world
9 environment.

10 (b) The Congress therefore commends and endorses the
11 international biological program and expresses its support of
12 the United States National Committee and the Interagency
13 Coordinating Committee, which together have the respon-
14 sibility for planning, coordinating, and carrying out the pro-
15 gram in the United States.

16 (c) In view of the urgency of the problem, the Con-
17 gress finds and declares that the provision by the United
18 States of adequate financial and other support for the inter-
19 national biological program is a matter of high priority.

20 SEC. 2. (a) The Congress calls upon all Federal depart-
21 ments and agencies and other persons and organizations, both
22 public and private, to support and cooperate fully with the
23 international biological program and the activities and goals
24 of the United States National Committee and the Inter-
25 agency Coordinating Committee.

1 (b) For this purpose, the Congress authorizes and
2 requests all Federal departments and agencies having func-
3 tions or objectives which coincide with or are related to those
4 of the international biological program to obligate or make
5 appropriate transfers of funds to the program from moneys
6 available for such functions or objectives, which moneys were
7 appropriated for the fiscal year ending June 30, 1970, or
8 any prior fiscal year, and provide such other support as may
9 be appropriate.

Passed the House of Representatives November 12, 1969.

Attest:

W. PAT JENNINGS,

Clerk.

NATIONAL SCIENCE FOUNDATION,
OFFICE OF THE DIRECTOR,
Washington, D.C., May 29, 1969.

HON. RALPH YARBOROUGH,
*Chairman, Committee on Labor and Public Welfare,
U.S. Senate, Washington, D.C.*

DEAR MR. CHAIRMAN: This is in further reply to your request for the comments of the National Science Foundation on S.J. Res. 89, "Expressing the support of the Congress, and urging the support of Federal departments and agencies as well as other persons and organizations, both public and private for the international biological program."

The views of the Foundation on S.J. Res. 89 are set forth in the enclosed copy of testimony delivered by the Head of the Foundation's Biological and Medical Sciences Division, Dr. Harve J. Carlson, at hearings held on May 6, 1969 before the Subcommittee on Science, Research and Development, House Committee on Science and Astronautics.

The Foundation's interest in U.S. participation in the IBP is based upon the fact that the knowledge sought is urgently needed and the research proposed is fundamental and innovative in nature, to be undertaken through challenging multidisciplinary approaches. The Foundation is satisfied that meritorious scientific programs are evolving, and that effective management is being applied to them. We are confident that the results of IBP research will help to provide the necessary groundwork of basic understanding to enable civilization to cope with pressing ecological problems.

The Foundation is pleased with the cooperation of the agencies comprising the Interagency Coordinating Committee for IBP. The question of interagency support of IBP integrated research programs seems to be not a question of new funding mechanisms, but rather of fiscal and program flexibility to employ existing mechanisms. In this connection, it should be noted that funding is not the only limitation to large-scale agency support. The number of well-trained personnel available to work on IBP problems is also limited. One hoped-for result from the program would be an increased supply of such well-trained people.

In conclusion, the Foundation favors the objectives of S.J. Res. 89, and agrees that the major IBP research programs should be of high priority.

The Bureau of the Budget has advised us that there is no objection to the submission of this report from the standpoint of the Administration's program.

Sincerely yours,

LELAND J. HAWORTH, *Director.*

Enclosure.¹

DEPARTMENT OF STATE,
Washington, D.C., May 6, 1969.

HON. RALPH W. YARBOROUGH,
*Chairman, Committee on Labor and Public Welfare,
U.S. Senate, Washington, D.C.*

DEAR MR. CHAIRMAN: In answer to your request of April 7 there is transmitted herewith a report on Senate Joint Resolution 89 concerning the International Biological Program. S.J. Res. 89 is identical with H.J. Res. 625. The Department of State now as in the past gives its support to the International Biological Program. We endorse the Joint Resolutions as an aid to that end. It appears especially important that Federal departments and agencies concerned with the objectives of the Program should support and cooperate fully to assist the activities of the U.S. National Committee for the IBP and the Interagency Coordinating Committee.

The Bureau of the Budget advises that from the standpoint of the Administration's program there is no objection to the submission of this report.

Yours sincerely,

WILLIAM B. MACOMBER, Jr.,
*Assistant Secretary for
Congressional Relations.*

¹ The enclosure referred to may be found in the files of the subcommittee.

INTERNATIONAL BIOLOGICAL PROGRAM AND ITS RELATION TO
SENATE JOINT RESOLUTION 89

The International Biological Program (IBP) is a broad effort established on a world-wide basis. It is being conducted by more than fifty nations in order to establish an ecological base for managing the environment and for preventing its deterioration. Within the United States it is being coordinated by the National Academy of Sciences and the National Academy of Engineering, to which is attached the U.S. National Committee for the IBP, and, for the Federal Government in particular, by a special interagency coordinating committee. The National Science Foundation serves as the U.S. Government's lead agency.

In the United States the National Committee has formed a series of subcommittees which are responsible for the planning of substantive research in various fields; such research necessarily concerns a number of Federal agencies.

The Department of State welcomes the support which the joint resolution gives to U.S. efforts in behalf of IBP action. The encouragement to Federal agencies to give their support to the program should help to guarantee an important role for the United States in the IBP. Such cooperation is altogether appropriate in our continuing efforts to seek productive and peaceful ties with other countries. A strong IBP will stimulate productive exchange among world scientists and it will prepare the way for further joint efforts planned for the 70s.

DEPARTMENT OF AGRICULTURE,
OFFICE OF THE SECRETARY,
Washington, May 9, 1969.

HON. RALPH W. YARBOROUGH,
*Chairman, Committee on Labor and Public Welfare,
U.S. Senate, Washington, D.C.*

DEAR MR. CHAIRMAN: This is our report on S. J. Res. 89, "Expressing the support of the Congress, and urging the support of Federal departments and agencies as well as other persons and organizations, both public and private, for the International Biological Program."

The joint resolution would declare that the International Biological Program (IBP), established under the auspices of the International Council of Scientific Unions and the International Union of Biological Sciences and sponsored in the United States by the National Academy of Sciences and the National Academy of Engineering, deals with one of the most crucial situations to face this or any civilization. That situation is the immediate or near potential of mankind to damage, possibly beyond repair, the earth's ecological system on which all life depends. The joint resolution would also declare that the IBP provides a means of meeting this situation. The Program's stated objective is increased study and research related to biological productivity and human welfare in a changing world environment.

The joint resolution commends and endorses the IBP and expresses support of the Committees having responsibility for the Program in the United States.

The Federal departments and agencies, other persons and organizations, private and public, would be called upon to support and cooperate fully with the Program. The joint resolution authorizes and requests all Federal departments and agencies having functions or objectives coinciding or related to those of the IBP to obligate or make appropriate transfer of funds to the Program from moneys available for such functions or objectives and provide such other support as may be appropriate.

The Department of Agriculture endorses the general objectives of S.J. Res. 89.

We strongly recommend the objectives of the IBP. A large proportion of the agricultural and forestry research of the USDA is concerned with environmental management and the interaction of man with his environment. The objectives of the IBP are relevant to all the commodity production, resource conservation, rural development, and human welfare responsibilities of this Department.

The USDA feels that the IBP has a unique and important role in bringing a broad interdisciplinary and international approach to the solution of environmental problems. This approach complements the Department's mission-oriented domestic effort. It also holds promise for solution of certain environmental problems that are international in character.

USDA scientists are participating in planning and coordinating the Program through memberships in the Executive Committee, the Federal Interagency Coordinating Committee, and committees of the individual programs. This Department also contributes part of the financial support for the operation of the U.S. National Committee.

The USDA is collaborating actively in the ecosystem studies of IBP. For example, Department scientists are or will be conducting studies as an inherent part of integrated research programs such as the Grassland, Forest, and Desert Ecosystem Studies. Also, USDA is providing research resources such as experimental forest and range areas and research natural areas.

Further, many of the Department's research projects are IBP-related. More than 60 of the 266 IBP-related projects listed in IBP Report No. 3 are USDA projects. This Department also provides partial support for participation of State agricultural experiment station and forestry school scientists in several IBP-related projects:

The Department of Agriculture intends to continue its support of IBP. The USDA is mainly an in-house research organization and does not have large blocks of grant funds. However, the Department will continue to work through its research planning and budgeting procedures to support appropriate parts of IBP. USDA will likewise work with developing IBP programs that are related to its mission.

The Bureau of the Budget advises that there is no objection to the presentation of this report from the standpoint of the Administration's program.

Sincerely,

J. PHIL CAMPBELL,
Under Secretary.

Senator EAGLETON. Our first witness this morning is Dr. W. Frank Blair, Department of Zoology, University of Texas, Dr. Blair.

You may proceed at your pleasure. If you have other individuals accompanying you, they may come forward, or you may proceed by yourself.

STATEMENT OF DR. W. FRANK BLAIR, DEPARTMENT OF ZOOLOGY, UNIVERSITY OF TEXAS; ACCOMPANIED BY DR. WILLIAM S. BENNINGHOFF, DEPARTMENT OF BOTANY, UNIVERSITY OF MICHIGAN; DR. EVERETT LEE, DEPARTMENT OF SOCIOLOGY, UNIVERSITY OF MASSACHUSETTS; DR. JAMES V. NEEL, CHAIRMAN, DEPARTMENT OF HUMAN GENETICS, UNIVERSITY OF MICHIGAN MEDICAL SCHOOL; AND DR. GEORGE M. VAN DYNE, COLLEGE OF FORESTRY AND NATURAL RESOURCES, COLORADO STATE UNIVERSITY

Dr. BLAIR. Mr. Chairman, I have some of my colleagues from the International Biological Program here today. They know much more about some of the details of the program than I do. I would like to call them to come forward to the table and sit as a panel.

Mr. Chairman, ladies and gentlemen, I have a prepared statement which I would like to submit for the record and will for the purposes of this hearing today hit the high spots of the prepared statement, rather than read the entire document.

It is a pleasure and a privilege to be here today to talk about our progress and our needs in the International Biological Program. Specifically, we are speaking in support of the Senate Joint Resolution 89, which was introduced by Senator Muskie.

The parallel resolution in the House was passed on the 12th of November and I feel that it is enormously important to the Inter-

national Biological Program, as participated in by the scientists in this country, that the parallel resolution receive favorable treatment in the Senate.

I have outlined the chronology of the International Biological Program. I do not intend to go through this in detail.

It is needless to say that the first four or five pages of this document represent many false starts and much sweat, blood, and tears, and I think also the design of new kinds of ways of doing ecological research.

The International Biological Program is essentially at midpoint of its research phase, although there is high probability that it will be extended for 2 years internationally, in order to phase over the kind of major research projects that have developed under the IBP to other programs about which I will say more later.

Internationally, the International Biological Program presently has 57 participant countries and in the first of the figures at the back of this document there is a map that I think is both now interesting and rather challenging.

It is quite obvious that the technologically advanced countries have entered into enthusiastic and active participation in this international effort.

It is also quite obvious that the two continents, in which we usually refer to the countries as developing, or underdeveloped, there has been less than major participation. The situation in South America is perhaps better than in Africa, taken continentwide, but there is a challenge, for the advanced countries to look to the assistance of these countries which have had great difficulty in the mounting of their scientific program.

Internationally, the International Biological Program is under the sponsorship of the International Council of Scientific Unions, which has an international committee with headquarters in London and with reasonably good representation from various parts of the world.

There is a map showing the distribution of the membership and officers of this committee. It is evident that we have representation from the developing as well as the technologically advanced countries.

In the United States, after trial and error, and after a considerable course of evolution, the present management structure for the IBP has emerged and seems to work quite satisfactorily. The committee is a committee of the NAS-NRC and actually consists of three major committees.

The executive committee is a small seven-man committee, of which I am chairman, which really manages the program. We have a Program Coordinating Committee made up of the directors of the major projects in the U.S. IBP which coordinates among the U.S. programs, and we have an International Coordinating Committee that has as its major charge the coordination internationally with the efforts in the other participant countries.

The management of the U.S. effort in the International Biological Program is financed through contributions from several Federal agencies. Incidentally, the method of financing of the research in the IBP is such that the participant countries finance their own research programs. Some programs are worked out jointly between countries, but basically the scientists are supported by their parent country.

The international office in London is supported by dues from the various participant countries. In the United States the management of the program has been rather effectively shared between our own management organization and the National Science Foundation, in particular, with excellent support from some of the other Federal agencies, such as Agriculture, HEW, and AEC, to mention a few.

The National Science Foundation was asked in a letter from Dr. Donald Hornig when he was science adviser to President Johnson to serve as a coordinating Federal agency.

You will hear more about this later from Dr. Carlson, but in order to coordinate, the National Science Foundation did set up an Inter-agency Coordinating Committee.

The only new funds that have been earmarked specifically for the IBP have come through the National Science Foundation budget. In the current fiscal year, I believe there is \$4 million for the IBP. Last year there was \$500,000.

We anticipate some increase in this amount in the fiscal 1971 budget.

Essentially, the management of the IBP has involved the review of programs by the IBP National Committee, close coordination with Federal agencies, specially with the National Science Foundation, and a scientific review there as well as by our own committee.

Our committee looks for appropriateness to the IBP as well as scientific quality, and the National Science Foundation applies the same stringent review that they would apply to any other proposal that came to them.

In terms of an international effort, I think that the IBP is proving to be a very, very successful kind of undertaking. There are all levels of international cooperation and the projects—or programs we call them—that make up the heart of the IBP in the United States are coordinated with the international effort in various ways.

I might say a word about these integrated programs. In the beginning of the IBP and still in a good many countries, including particularly the less technologically advanced countries, the participation in the IBP has consisted mainly of an attempt to coordinate what they have already been doing with what is being done in other countries.

There is considerable amount of merit in this. One thing I have seen personally is that there has been a great deal of interchange among Latin American countries under the IBP, something that had never occurred before the IBP.

They usually knew more about who was doing what in the United States than they did of the people in their neighboring countries in Latin America. All in all, the IBP has certainly created a much better spirit of cooperation and coordination in the efforts of scientists around the world.

But I think the United States can take the credit for setting a pattern that goes far beyond this in terms of bringing scientists to work together. This has been the so called integrated research programs (IRP's) which came to be the heart of our U.S. effort. These are multidisciplinary for the most part.

They are complex efforts to understand complex ecological problems, both human ecology in the broad sense, and environmentally oriented problems.

These major multidisciplinary studies are, in my opinion, falling into two patterns. One, there is largely a national effort, as in our Grassland and other studies, that you will hear more about later, and good coordination internationally with comparable efforts in other countries.

Dr. VanDyne can correct me, if I am misstating this, but I believe there are 15 of the participant countries in the IBP where they are actually doing what we call ecosystem type studies, large systems type on Grasslands.

These are coordinated through an international coordinating group so that the generalizations that come from these projects will be interchangeable, and the whole will be greater than the sum of the parts.

Another kind of effort, of which you will hear in other presentations is one that involves scientists from this country and scientists from other participant countries working together in the same place on the same problems, or on aspects of the same major problems. I think this is an excellent type of development and it is the kind of development that should assist the developing countries to develop their science.

Thus, we have various levels of internationalism in the IBP, but I think all three of these kinds of international participation represent a big advance over the kind of research that was being done in the field of ecology up to the time of the IBP.

We have a series, some 16 or 17, of the so-called integrated research programs. These are divided into two types. One is oriented mainly toward the environment and problems of the environment, not leaving man out of the picture, but with the emphasis on the whole system.

The other type is directed toward man's adaptability to the environment and to changing conditions. We will hear more about this from Dr. Neel in a few moments.

In the U.S. program, the Analysis of Ecosystems Integrated Research Program, which really involves six major subprograms, has loomed very large. This is setting the pattern for the kind of ecological research that seems essential if we are able to manage the world's environments, turn back the tide of the pollution, restore environmental quality, and maintain the world as a decent place in which to live.

We are not saying that these are aimed at management. We are saying that these programs will give us models, predictive models, and thus give us the scientific know-how to predict the effects of any particular modification of the environment.

Most of our engineering feats of the past have been accomplished with really no serious considerations for the ecological ramifications, that is, there has been essentially no consideration of deleterious side effects on the quality of the environment.

It is only through the kind of research that is represented in these studies that we can look at and really be able to predict what a specific action will produce in the way of environmental results.

These six biome studies are aimed at six major ecological systems, or biomes, that make up most of the territory of the United States and of the American tropics.

The first of these, which get underway first and, subsequently, has acted as a prototype for the others, is the grassland study, which you will hear about shortly.

Others are directed at our deserts, eastern forests, coniferous forests of the west, the arctic tundra, which now has become a rather hot issue because of the oil strike, on the Alaskan north slope, and lastly, the tropical forest, which is a very major ecological component of the whole biosphere.

I was horrified to read a special feature story in the newspaper about 2 days ago about plans to exploit the Amazon forests. It mentioned specifically agriculture. Every agricultural effort, I think, that has been tried in the tropical rain forests so far, has been a failure. There are good ecological reasons for this. Unless ecological know-how goes into the exploitation of that forest, I think it will be a disaster that all the world will rue.

In the document which we have passed out, we have identified the integrated research programs. We have identified the funding situation with respect to fiscal year 1969 and fiscal year 1970 and we have made a projection to fiscal year 1971.

It is our understanding that the National Science Foundation will request \$7 million for the IBP in its fiscal year 1971 budget. Our own committee in careful deliberations and in very painful deliberations with the pro com committee has estimated that the program that the United States should have in fiscal 1971 would cost \$16 million.

The estimated need for fiscal 1970 was \$15 million. Actually we have only \$4 million expected in fiscal year 1970 from the NSF plus approximately one half a million dollars from other agency sources.

So, in fiscal year 1970 we have something like \$4.5 million. If you put in services that are hard to put figures on, there is perhaps \$5 million for the IBP in fiscal year 1970 as opposed to our considered estimate of \$15 million of needed funds.

For fiscal year 1971 our estimate again is far over what we can expect the NSF to be able to provide in these times of short money. So, I think that this resolution is very important to us in calling the attention of the various interested agencies—and there are many—and several of them are represented in this room today—that have missions which certainly parallel the objectives of the IBP.

It seems to me personally, and to our committee, that the way that we can mount the kind of program that the United States should have is through careful cooperation among these agencies, with these agencies respectively taking an active role in seeking funds for the IBP through their own budget processes.

Certainly where there are parallel missions, it should be in the agency interest to do this. I don't want to prolong this discussion. However, I would like to say a word about what the IBP means to me, and to many others who have been worrying about this problem, in terms of the present concern with environment and in terms of possible future programs.

Administratively, the IBP is scheduled to end in 1972. However, our U.S. committee has asked for an additional 2-year phaseover period carrying through 1974 so the momentum of the IBP will not be lost in the time in which other international programs might come into being.

There are two of these in particular that I would mention. One, the United Nations is responsible for the sponsoring of a program called "Man and the Biosphere." This UN program has been assigned to UNESCO as the lead agency among the UN family of agencies and actually, the program that UNESCO has generated has been the IBP program. There has been close liaison, and essentially, the UNESCO program is a continuation of the IBP program.

Secondly, the International Council of Scientific Unions has recently created an international committee called "Scientific Committee on Problems of the Environment." Their plans include the establishment of an international center for the environment and the sponsorship of programs like the IBP.

It is quite possible that some of the ongoing important research of the IBP will go into the Man in the Biosphere program at UNESCO. Some of it may go in under the sponsorship of the nongovernmental scientific committee on problems of the environment (SCOPE).

Another activity that has spun off from the IBP that may well be one of its major contributions has been a feasibility study for a global network for monitoring the environment.

We are not talking about just monitoring the characteristics of one physical environment, such as air pollution, but we are talking also of monitoring the organisms to see what we are doing to them genetically, to see what we are doing to the species and the composition of the plant and animal communities of the world, what levels of pesticides and heavy metals might be moving through ecological systems, and so on.

This has derived directly from the special committee for the IBP, the international committee. I have been a member now for nearly 2 years of a three-man committee involving a Russian, a Swede, and myself, each of us in our own countries doing feasibility studies through picking brains of our own scientists.

We have a preliminary report stating that it is feasible to set up a worldwide monitoring system. We would hope that the result of this committee can be made available to the UN Special Conference on Man and the Environment in 1972. Then it might well be that this could become an agenda item at that conference. This is what we are shooting for. This is one of the kinds of things that has spun off from the IBP.

Lastly, there has been much talk recently about a National Institute of Ecology. I think that of the kind of research that is represented in the IBP, most of it would fit very nicely into a National Institute of Ecology.

We would essentially have a full grown, or at least a ready made, ready to go, program for such an institute in much of the research being done under the IBP.

I do not wish to take more of the committee's time. I have identified some of the most pressing reasons why I think why we need the support of S.J. Res. 89. I really believe that passage of this resolution is essential.

We need a clear-cut identification of the interest of the Congress in this program, and I sincerely hope that it will receive favorable action by the subcommittee and by the parent committee and by the Senate.

I would like to call on some of my colleagues for brief statements about their specific areas in the IBP.

(The prepared statement of Dr. Blair follows:)

PREPARED STATEMENT OF W. FRANK BLAIR, CHAIRMAN, U.S. NATIONAL COMMITTEE
FOR THE INTERNATIONAL BIOLOGICAL PROGRAM

Mr. Chairman: It is both a pleasure and a privilege to appear before this subcommittee and to participate with you in examining the provisions of Senate Joint Resolution 89. This Resolution expresses the sense of the Congress supporting U.S. participation in the International Biological Program. I and my colleagues strongly support the provisions of this Resolution and sincerely hope that it will be reported favorably to the Senate and that the Senate will unanimously support it.

For reasons which I will develop later, this program now needs the endorsement of the Congress so that the sense of our Legislative Branch is available for all to see. The parallel House Resolution (H.J. Res. 589), as you know, was voted and passed in the House on 12 November. The vote on the House Resolution was preceded by an extensive series of Hearings with the House Subcommittee on Science, Research, and Development.

In my presentation to you today I will only briefly outline the past history and attempt to focus your attention principally on the present status of our efforts and the potential of the IBP, pointing out the benefits to this nation as a principal participant in this international undertaking.

Before I outline the chronology let me mention that initial concepts for the program were based on (1) a concern for maintaining and improving our environmental quality, (2) a concern for improving biological productivity on a world basis, (3) a concern for better understanding of man's relationship with his environment, and (4) a recognition that those scientific disciplines, melded in effort toward one broad goal, had never previously been brought together as a total team. Thus, biologists resolved that they and scientists not usually grouped with them should address themselves to a central theme, "the biological basis of productivity and human welfare".

The early planners, severely aware of mounting problems of our environment, the serious effects that environmental deterioration would have on biological production and on our social structure both rural and urban; and also being very much aware of the accomplishments of the International Geophysical Year (IGY), attempted to pattern this international biological program along the lines of the IGY.

With this introduction I would like to briefly state the chronology of the IBP.

BRIEF CHRONOLOGY OF THE IBP

- July 1964 The International Council of Scientific Unions (ICSU) established a Special International Committee for the International Biological Program (SCIBP). A three-year planning phase was to extend through June, 1967 and a 5-year research phase ending June 30, 1972 were proposed.
- 1965 The U.S. National Academy of Sciences, after evaluating a report of its *ad hoc* committee which examined the international scientific concepts proposed, established its own National Committee for the IBP. Our National Academy of Sciences is the principal adherent to the International Council of Scientific Unions and is the logical body to express the sense of U.S. scientists for such programs.
- 1966 Members of our U.S. National Committee, assisted by other interested and concerned scientists, further refined and defined a program for U.S. participation in the IBP. More than 100 were involved in this strenuous workshop effort. They were isolated captives for six days. From this key meeting in the United States emerged the concept for design of multidisciplinary studies, each addressed to rather specific goals and each clearly contributing to the central theme and purpose of the program. We have called these studies Integrated Research Programs (IRP's). We have generally grouped them within two components in the U.S. program: (1) Environmental Management, and (2) Human Adaptability to the Environment. For reasons which I think are very apparent we have, almost from the beginning of U.S. participation oriented our program toward environmental quality. For all purposes, practical, scientific and any other, they are synonymous.

1967 The first proposal for a research design study within the U.S. program was funded by NSF. This study proposed the planning for systems analyses and research on six types of biological communities, or biomes as we call them. They are grasslands, desert, deciduous forests, coniferous forests, tundra and tropical forests. Mathematical models, replicated and redundant, representing the total interplay of all factors living and non-living within these systems, were planned. The concept was that such modeling, subjected to continuous tests and validations, would provide a profound predictive technique useful to national, state and local planners as they consider changes that they may impose or plan on the environment, and as they consider the effect of the environment, and as they consider the affect of the environment on their own operations.

1967 Within this central concept for Analysis of Ecosystems the Grasslands Biome was started in northeastern Colorado. The location of its intensive effort is the Pawnee Site, an area under the control of the U.S. Department of Agriculture. This study is now in its second year and is the most advanced of the U.S. Integrated Research Programs—supported by grant from NSF and AEC and supported by land, facilities, and personnel from the U.S. Department of Agriculture.

1968 Our U.S. National Committee for the IBP, in response to apparent needs for a clearer definition of the U.S. Program, needed for both the scientists and our concerned lay public, published and widely distributed a brochure on the U.S. program. The brochure was entitled "Man's Survival in a Changing World". It described the two components of the U.S. program (1) Human Adaptability to the Environment and (2) Environmental Management. It groups and describes the Integrated Research Programs appropriate to each component.

1968 The U.S. National Committee, initially organized for conceptual planning, was reorganized for phase two of the program. It was restructured into a small Executive Committee, a Program Coordinating Committee (PROCOM) to assure coordination among and across all the Integrated Research Programs and an International Coordinating Committee (INTCOM) to maintain coordination with the programs of other nations and with the SCIBP central structure.

1969 The first significant new budget program in support of U.S. planning became apparent. The National Science Foundation, during Authorization Hearings on its proposed FY/70 budget described its plans for supporting IBP in FY/70. Initially recommended by the Foundation at \$5 million, the appropriations process necessarily reduced this to \$4 million. The establishment within the Foundation of this "new" program was, in my opinion, bold and courageous. It is not easy for new budget programs to have their beginnings in these days of retrenchment in science. In establishing this program I believe that the Foundation went as far as it possibly could toward support of our U.S. program. I believe likewise that the Foundation recognized that the budgeted amount was less than one-third the minimum essential needed for effective U.S. participation in the IBP. I believe also that the Foundation had counted on greater amounts from other agencies since many of the Integrated Research programs are directly pertinent to the mission purposes of other agencies and should not be considered the exclusive funding burden of the Foundation. Although some support from other agencies has materialized, that support has not approached our needs, and important IRP's are now held in the planning stage.

WHO PARTICIPATED IN THE IBP AND HOW MUCH?

Today, 57 countries participate in the IBP. I have attempted in Fig. 1 to classify the degree of participation into 3 categories. North America, Europe, the USSR and Japan show the highest levels of participation. At a second level, various countries have established IBP committees and have identified ongoing research as pertinent to the objectives of the IBP. At a third level, a national chairman and sometimes a committee have been named and recognized by the SCIBP, but no new IBP research has been initiated. Africa and Latin America have found it difficult to participate actively in the IBP (Figs. 1 & 2). We are working closely with South American scientists and with scientists of the Organization of American States on programs and projects of common and pressing interest to all countries of this Hemisphere.

INTERNATIONAL COORDINATION

International management of the IBP is under sponsorship of ICSU and is effected through SCIBP. The geographic representation of SCIBP is shown in Fig. 3. The heavy representation of European countries reflects the economics of large international committees rather than any effective domination of SCIBP by the European countries. Many of the European members represent scientific unions which are members of ICSU, and they were selected because of their proximity to the European cities in which international meetings are most frequently held.

SCIBP coordinates the IBP efforts world-wide through 7 international panels each with a convenor and international membership. SCIBP organizes meetings of its Bureau (Officers of SCIBP), its panels, and, in alternate years, a General Assembly of all national members—from the 57 nations mentioned previously. It supervises the IBP Secretariat or Central Office. The latter is provided housing by the Royal Society in London.

MANAGEMENT OF THE U.S. PROGRAM

In mid-1968, the U.S. National Committee, originally organized for planning, was restructured to increase its effectiveness in managing the research phase of the U.S. effort. A 7-man Executive Committee is the responsible body for guidance of the U.S. Program (Fig. 4). In this it has the advice and assistance of a 19-man Program Coordinating Committee (PROCOM) made up of the directors of Integrated Research Programs and an 11-man International Coordinating Committee (INTCOM) constituted to coordinate the U.S. program with the programs of other nations and with the SCIBP management. A 10-man Biometeorology Panel of NAS/NRC serves in an advisory capacity on all elements of our total program.

Now that we are concentrating on the research phase of the IBP, our U.S. Executive Committee, with advice from PROCOM and INTCOM, has general responsibility for the successful execution of our U.S. program. It oversees and assures internal reviews at appropriate times for all elements of our program, and maintains relationships with the granting agencies, and attempts at all times to assure program understanding within the agencies. It acts as an intermediary between the program directors and agencies, both Federal and private, that have interest in IBP.

ROLE OF THE NATIONAL SCIENCE FOUNDATION

Dr. Donald Hornig, the previous Director of the Office of Science and Technology, earlier requested the National Science Foundation to coordinate Federal interest in this program. Dr. Lee DuBridge, the present Director of the Office of Science and Technology, more recently reinforced and strengthened this request to the National Science Foundation. The Foundation funded \$500,000 for IBP research during FY/69, and plans to fund \$4 million during FY/70—the Foundation has already funded over \$2½ million in its FY/70 program.

Within the granting agencies there is no distinction between IBP proposals and other research proposals that may be appropriate to agency missions. Both undergo the same scrutiny in their several review panels. In fact, there is the impression at times that IBP proposals receive a more rigorous review than others. It would be more appropriate and helpful for the concerned granting agency to examine our total IBP program in context with their missions; and during their evaluations of component projects assist us in preserving the integrity of the program. I believe this thought is implicit in S.J. Res. 89 and I believe that the Federal agencies will welcome the provisions of the Resolution.

I mentioned earlier that both Dr. Hornig and Dr. DuBridge had asked the National Science Foundation to assure adequate coordination among the Federal agencies in support of the IBP. For this purpose the Foundation has established the Interagency Coordinating Committee (ICC). Its Chairman is Dr. Harve Carlson, Director, Division of Biology and Medicine.

THE U.S. PROGRAM—INDIVIDUAL PROJECTS RELEVANT TO THE IBP

In the planning stages for U.S. participation in the IBP those concerned with U.S. planning, both in the Federal structure and in the institutions participating, attempted to identify ongoing research projects that had objectives pertinent to those of the IBP. This same type approach was pursued in almost all other coun-

tries. We have listed ours in a report released by the U.S. National Committee more than a year ago. We continue to maintain abstracts of individual research projects that are relevant to the IBP.

The main thrust of our U.S. effort, however, is contained in our two components, Human Adaptability and Environmental Management and that thrust becomes more precisely apparent in the Integrated Research Programs appropriate to each component. These multidisciplinary studies, as a body, represent the main contribution that U.S. scientists can make to IBP. Our major efforts during the past 1½ years have been concentrated on the development and support of the Integrated Research Programs which we believe are essential to our national interests.

INTEGRATED RESEARCH PROGRAMS

Our major contribution to the success of this international effort and to better approaches for the solutions of domestic and international problems of the environment will depend on the success of our Integrated Research Programs.

These are coordinated multidisciplinary programs directed to answering questions that can be answered only by teams of scientists of many specialties integrating their research toward a common goal. The basic criteria of an IRP are (1) it is clearly determined to be an essential part of the U.S. program, (2) that it contribute to and be coordinated with other IRP's, (3) that a system for internal coordination be explicitly described, (4) that a system assuring maximum probability of discerning higher order generalizations be included. With these criteria we may emphasize that the whole of any IRP is greater than the sum of its parts, we may likewise emphasize that the whole of the U.S. program is greater than the sum of its IRP's.

The report and brochure mentioned earlier are being updated and reprinted. The formal report of the National Committee will concentrate on science, and will reduce emphasis on administrative detail. The brochure "Man's Survival in a Changing World" will more accurately reflect our current program.

The IRP's of the U.S. program fall into three more or less distinct patterns: (1) multidisciplinary projects that are domestic with respect to research participation but which are closely coordinated internationally in methodology and in assessment of results; (2) multinational projects in which there is active participation of scientists from several countries in research at the same time and place; (3) coordination of ongoing individual projects on an international basis, with the main new component being better coordination of research in many countries on the same general problem.

NATIONAL PROJECTS WITH INTERNATIONAL COORDINATION

The biome studies under the IRP for "Analysis of Ecosystems" are illustrative of this type of IRP. Six biomes (or major biotic formations) have been proposed for intensive study by multidisciplinary teams of scientists in order to gain an understanding of how these ecosystems function. The ultimate goal is the production of mathematical models with predictive value for each system. Such models must be developed if this country and the world are to succeed in managing the environment in man's best interests.

The Grasslands Biome Subprogram is most advanced in the U.S. planning; and this has proven a prototype for the development of subsequent biome studies. I will not discuss this project further, as I will call later on Dr. George Van Dyne for a discussion of this program and the biome studies generally. However, I would like to refer to the management structure of this program as an illustration of the complexity of an IRP (Fig. 5).

Study of the four biomes that the National Science Foundation plans to support: grasslands, deciduous forests, coniferous forest and desert, cover much of the area of the continental United States. The study of the Arctic Tundra obviously is becoming of more pressing interest because of the oil "strike" on the Alaskan north slope. We are giving careful attention to the best way of obtaining support for this biome. We have had direct and indirect inquiries from some oil company officials; and recently Secretary Hickel has asked both the Academy of Sciences and Academy of Engineering for "a high level development study for arctic Alaska and polar America." We are participating with other activities in response to the Secretary and have specifically recommended that our Tundra Biome study is directly responsive to part of the Secretary of Interior's request.

The sixth biome of the U.S. planning has received last priority which is out of accord with its world importance as opposed to immediate domestic importance.

Ecologically unwise use of the huge Amazon forest could have environmental repercussions with global effects, yet we know less about this forest as an ecological system than we know about any of the five other biomes. Because of budget restrictions, this biome study is still in a very preliminary planning stage. In my own thinking, I can envision the importance of a multinational center for a study of the tropical forest located somewhere in Colombia or Peru, or possibly Costa Rica.

Other IRP's that involve mainly national effort, but with international coordination are those on "Biosocial Adaptation of Urban and Migrant Populations", "Conservation of Environments" and "Phenology". I will later call on Dr. Everett Lee to describe the first of these.

MULTINATIONAL PROJECTS

Several IRP's involve cooperative research by scientists from several countries. The IRP on "Population Genetics of the American Indian" (Fig. 6) to be described later by Dr. James V. Neel, is illustrative of this type of project, as is the IRP on "Biological Productivity in Upwelling Ecosystems" (Fig. 7). The sub-program on "International Studies of Eskimos" of the IRP on "International Studies of Circumpolar Peoples" (Fig. 8) illustrates the kind of cooperative effort that has been possible among U.S., U.S.S.R., and European scientists. Another IRP on "Biology of Human Populations at High Altitudes" brings together the U.S. and Peruvian scientists in a joint program.

The IRP for "Origin and Structure of Ecosystems" has three major components (Fig. 11). One is addressed to the question, "Are there only limited adaptive possibilities for a given environment?" The procedure involves comparisons of ecological niches and structures in apparently similar systems that have evolved under similar physical environments in the northern and southern hemispheres. The results of this research are pertinent to the validity of the ecosystem concept. The areas being compared are the dry lands (Chaco and Monte vegetation) of northern Argentina and similar areas (mesquite and creosote bush desert) of the southwestern United States and northern Mexico (Fig. 9) and the Mediterranean scrub vegetation (chaparral) of Chile and California.

A second component of this IRP has as a main objective the understanding of the ecological diversity and evolutionary history of Anuran amphibians of the New World. The philosophy of this research is that it is equally as important to understand the diversity of life of the earth as it is to understand the productivity of ecosystems. It is also imperative that a better method than the hit or miss efforts of individual scientists is called for if there is to be an adequate assessment of biological diversity before the results of environmental alteration and pollution drive many species to extinction. Specialists throughout the range of this group in the New World are working together (Fig. 10). Centers for treatment of materials by the most modern methods of analysis have been established in the United States and in Latin America. Central data storage is at the University of Texas.

The third component of this IRP centers in Hawaii and is directed mainly to an understanding of the ability of colonizing species to invade ecological systems relative to the age and degree of disturbance of the system. The generalities that may come from this component are important because of the increasing disturbance of world environments as a result of man's activities, and because modern methods of transportation facilitate the movement of more and more weed species of plants and animals about the world at accelerated rates.

THE COORDINATION OF ONGOING RESEARCH

Certain areas of science have had a fairly large amount of research in progress and have been supported from several funding agencies. Until recently biologists and their co-workers have been fairly independent of each other even when working in the same field. Our IRP's are directed to a better coordination of the efforts of all workers who are committed within the defined purpose of each of these multidisciplinary studies. Dr. Benninghoff will later describe his program on Aerobiology and will develop for you how this IRP is carried out and coordinated—maintaining both its national goals and the benefits of international coordination.

SIGNIFICANCE OF THE IRP'S

The multidisciplinary research described in our Integrated Research Programs is setting a new pattern, and I might say an inspiration, for environmental research. It has been labeled "big biology"; and among biologists perhaps

this label is appropriate. However, when compared to the physical sciences and the multi-billion dollar programs that have emerged from those disciplines grouped in the physical sciences, U.S. participation in the IBP is a small modest program. It represents one of the first, perhaps the first, effort among biologists and among other disciplines to so coordinate and plan, *that we may maximize advancement of knowledge for better understanding of our environment and of man as an essential part of that environment.*

FUNDING

Adequate funding for doing the research that has been planned by the U.S. scientists, for this country's participation in the IBP, has not been achieved. It can be achieved in FY/71, if those Federal agencies with missions to which IBP research relates, respond to the provisions of S.J. Res. 89.

It is our hope that passage of this Resolution, already passed in the House, will result in a broadened base of support for the U.S. program. Section 2(b) in particular should make it easier for administrators in those agencies with missions in common with IBP objectives to justify support of IBP research. Section 2(b) of the Resolution, as you know, was amended in the House and restricts obligations or transfers of funds in support of the program to monies which were appropriated for the fiscal year ending June 30, 1970 or any prior fiscal year. It seems to me that all agencies participating in the IBP or which have missions in common with IBP objectives now need to cite their planned support during the FY/71 authorization and appropriation process. The President of the National Academy of Sciences, Dr. Philip Handler, has called this matter to the attention of Dr. DuBridge, the President's Science Advisor. I sincerely hope that the agencies will respond and that Senate action on S.J. Res. 89 will facilitate agency responses and support.

The funding situation for FY/69 and FY/70 and the projected needs for FY/71 are shown in Table 1. I understand that NSF will recommend \$7 million in its FY/71 budget for the IBP. This is less than one-half of the \$16 million that the U.S. National Committee estimates is needed. Other agencies, following the provision of Section 2(b) of S.J. Res. 89 should include IBP in their budget planning and should cite these plans during Authorization and Appropriation Hearings on the FY/71 budget.

Consideration of the needs of the IBP in the budget planning of other agencies than just NSF is a necessity if the U.S. program is to succeed.

AFTER IBP?

Administratively the IBP is scheduled to end in 1972. In my opinion, we and all others may be said to have been slow in organizing our research plans. I think that none of our leading scientists in any country initially recognized the stresses and strains involved in first developing plans for organization, and second obtaining support for them. For these reasons our U.S. National Committee has recommended that IBP be extended to 1974. During this extended period all national programs and the international group will be expected to closely examine and evaluate research initiated under IBP, and determine how best to assure transition of that research that should be continued. I will mention four efforts, none of which are yet clearly defined, but for which IBP is already making both administrative and scientific contributions.

"MAN AND THE BIOSPHERE" PROGRAM

The United Nations is sponsoring an international program called "Man and the Biosphere" (MAB). The responsibility for this program has been assigned to UNESCO. There has been close liaison between the UNESCO planners of MAB and the IBP group, and as a consequence the proposed MAB program is very similar to the International Biological Program. Some parts of the IBP research may best be continued under this intergovernmental umbrella.

"SCIENTIFIC COMMITTEE ON PROBLEMS OF THE ENVIRONMENT"

ICSU recently established a permanent "Scientific Committee on Problems of the Environment" (SCOPE). The anticipated activities of this committee conform very much to those of IBP. Thus, this committee could provide a non-governmental scientific umbrella for continuation of cooperative international research projects that would be most appropriate for non-governmental sponsorship. SCOPE is also expected to serve in an advisory capacity to the UN

agencies, hence, there should be excellent coordination between the MAB program and whatever international research is sponsored by SCOPE.

"GLOBAL NETWORK FOR ENVIRONMENTAL MONITORING"

One of the activities of the IBP has been the development of a feasibility study of a Global Network for Environmental Monitoring (GNEM). This has been done through a small committee of which I am a member along with Dr. Bengt Lundholm of Sweden and Dr. N. N. Smirnov of the USSR. Each committee member, after convening groups of experts in his own country, generated individual reports. In addition, the committee produced a closely agreed upon preliminary summary report. A final report will be presented to the next meeting of the SCIBP in the early fall of 1970.

We presently have a task force of US experts producing a modular design for a baseline station for monitoring both physical and biological variables.

It is my opinion that a global network would be feasible only under inter-governmental sponsorship. It seems very important that a clear proposal for a global network be made to the UN Conference of 1972 on Problems of Human Environment.

A NATIONAL INSTITUTE OF ECOLOGY

Much of the US program in the IBP, such as the biome studies, could appropriately be continued under a National Institute of Ecology. In fact, these studies have set a pattern for the kind of research that one would expect to be a major part of the task of a national institute.

Such an institute has been under discussion for the past several years. The National Science Foundation is presently supporting a feasibility study for a National Institute of Ecology.

* * * * *

Mr. Chairman, I hope that I have identified some of the most pressing reasons in support of S.J. Res. 89. I believe that passage of this Resolution is essential. We need clear evidence that both the Legislative and Executive Branches support these beginning efforts for increased understanding of man and his environment, and these beginning efforts toward providing a predictive base useful to our national, state and local planners. These two years during which I have been Chairman of the U.S. National Committee for the IBP have exposed me to new concepts of thinking—political, economic as well as ecological. Surely I am little experienced in the former two and I believe that we are just now only making competent beginnings in the latter. More profoundly, I sincerely believe that favorable action by your Subcommittee and by the Senate will be a signal within the scientific community, within the Federal structure, and within all concerned lay groups that science and government are joined toward developing knowledge needed for better planning and solutions for so many of our national problems. We are recommending a modest program. I sincerely believe it deserves your support.

I would like for Drs. Neel and Lee to briefly comment generally and as specifically as appropriate on the Human Adaptability aspects of our program. I would like also for Drs. Benninghoff and Van Dyne to do the same on the Environmental Management aspects of our program. But before we do this, Mr. Chairman, let me express my thanks and let me ask if there are any questions at this time.

FIGURES

- Fig. 1. Map showing level of participation by the various countries in the IBP.
- Fig. 2. Map showing geographical distribution of the members of SCIBP.
- Fig. 3. Chart showing organizational structure of SCIBP.
- Fig. 4. Chart showing organizational structure of the U.S. National Committee for the IBP.
- Fig. 5. Chart showing organizational structure of the Grasslands Biome Subprogram.
- Fig. 6. Population Genetics of the American Indian.
- Fig. 7. Biological Productivity in Upwelling Systems.
- Fig. 8. International Studies of Circumpolar Peoples.

Fig. 9. Structure of Ecosystems.

Fig. 10. Evolutionary and Ecological Diversity.

Fig. 11. Organization of Integrated Research Program Origin and Structure of Ecosystems of the IBP.

TABLE 1.—INTEGRATED RESEARCH PROGRAMS—US/IBP

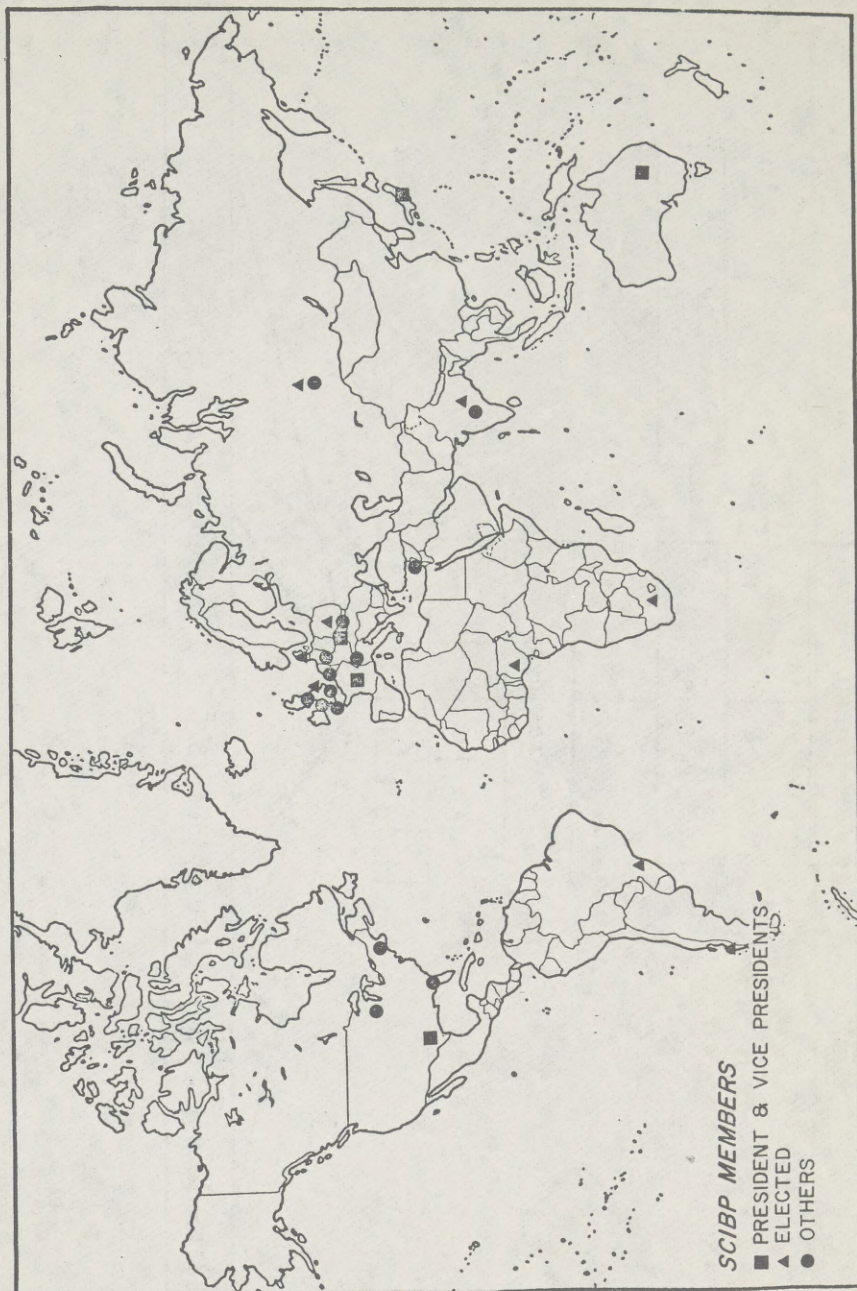
Program	Support in \$1,000			Additional commentary
	Fiscal year 1969 ¹	Fiscal year 1970	Fiscal year 1971 ²	
1. Biosocial adaptations of migrant and urban populations.	-----	\$ 50.0	4 350	Fiscal year 1970 coordinating proposal prepared for NSF; fiscal year 1971 will include \$300,000 in new starts and continuing coordination at \$50,000.
2. Biology of human populations at high altitudes.	77.0	39.0 \$ 375.0	4 494	Fiscal year 1970 proposals submitted to NSF and DHEW; fiscal year 1971 planning at somewhat increased level.
3. Population genetics of American Indians.	150.0	150.0	150 \$ 200	Fiscal year 1969 and 1970 supported by AEC. AEC will support \$150,000 in fiscal year 1971. AEC has strongly recommended that NSF support \$200,000 increase.
4. International study of circumpolar peoples.	121.0	117.0 \$ 190.0	4 310	Fiscal year 1970 central coordination and proposal on Aleuts being prepared. Fiscal year 1971 plans continuation of central coordination and Aleuts and continuation of ongoing Eskimo research.
5. Nutritional adaptations to the environment.	39.0	-----	4 310	Fiscal year 1969 support of central coordination was an end of the year grant and provides for fiscal year 1970. Fiscal year 1971 proposals are being prepared. Three groups will be submitted to NSF, USDA, DHEW, AID, and others. The 3 are: (1) coordination \$60,000, (2) new starts \$250,000, (3) continuation of included ongoing approximately \$3,000,000.
6. Human Chronobiology	-----	-----	4 295	Proposals in advanced stage of preparation for submission to DHEW.
7. Analysis of ecosystems	112.0	4 150.0	4 150	Proposals for fiscal years 1970 and 1971 being prepared (NSF).
Grasslands biome	451.0	1,800.0	4 2,300	Proposal for fiscal year 1971 being prepared (NSF).
Deciduous forests	226.0	-----	4 2,700	Proposal for fiscal year 1971 being prepared (NSF and AEC).
Desert	20.2	\$ 1,777	4 2,400	Proposal for fiscal year 1971 being prepared (NSF).
Coniferous forests	37.0	15.0	4 1,600	Do.
Tropical forests	-----	\$ 90.2	4 300	Do.
Arctic tundra	-----	58.7	4 1,000	Proposal concept prepared.
8. Convergent-divergent evolution.	211.0	\$ 913.0	4 1,300	Proposal for fiscal year 1971 being planned (NSF). Hawaii included in fiscal years 1970 and 1971.
9. Aerobiology	51.7	(³)	4 450	Proposals for fiscal year 1971 will include \$50,000 (NSF) for central coordination and \$400,000 new starts in USDA, DHEW, and NSF. Assumes \$2,000 ongoing will continue.
10. Upwelling ecosystems	94.0	\$ 237.0	4 300	Proposal for fiscal year 1971 being prepared.
11. Marine mammals	-----	4 175	4 175	Proposal for fiscal year 1970 reviewed by IBP and being rewritten for NSF. Fiscal year 1971 is planned at same level.
12. Phenology	-----	-----	4 200	Proposal concept for fiscal year 1971 prepared, planned for submission to NSF.
13. Biology and ecology of nitrogen.	-----	4 37.0	4 43	Proposal for fiscal year 1970 being reviewed by IBP for submission to NSF. Fiscal year 1971 planning at slightly higher level.
14. Biological control	360.0	\$ 450.0	4 600	Proposals for fiscal year 1971 being prepared for NSF. All fiscal year 1971 are new starts. Fiscal years 1969 and 1970 support from USDA and states. Planning for fiscal year 1971 assumes continued level of fiscal year 1970 ongoing. Total ongoing and new for fiscal year 1971, \$1,050.
15. Conservation of genetic materials.	-----	-----	-----	This IRP is being carried out, at no added costs, by USDA. Therefore no additional funds will be sought.
16. Conservation of environments	-----	-----	4 40	Proposal concept for fiscal year 1970 being prepared for support directly by NAS. Fiscal year 1971 support will be sought from NSF.
17. Staff support NAS/IBP	211.0	234.0	4 290	See proposal budget sheet.
Total	-----	-----	15,957	-----

¹ All sums shown for fiscal year 1969 have been made available to the programs.² All sums from proposals in preparation except for program 3.³ Proposals submitted.⁴ Proposals in preparation.⁵ Grant extends into fiscal year 1970.

Fig. 1. Level of participation by the various countries in the IBP



Fig. 2. Geographical distribution of the members of SCIBP



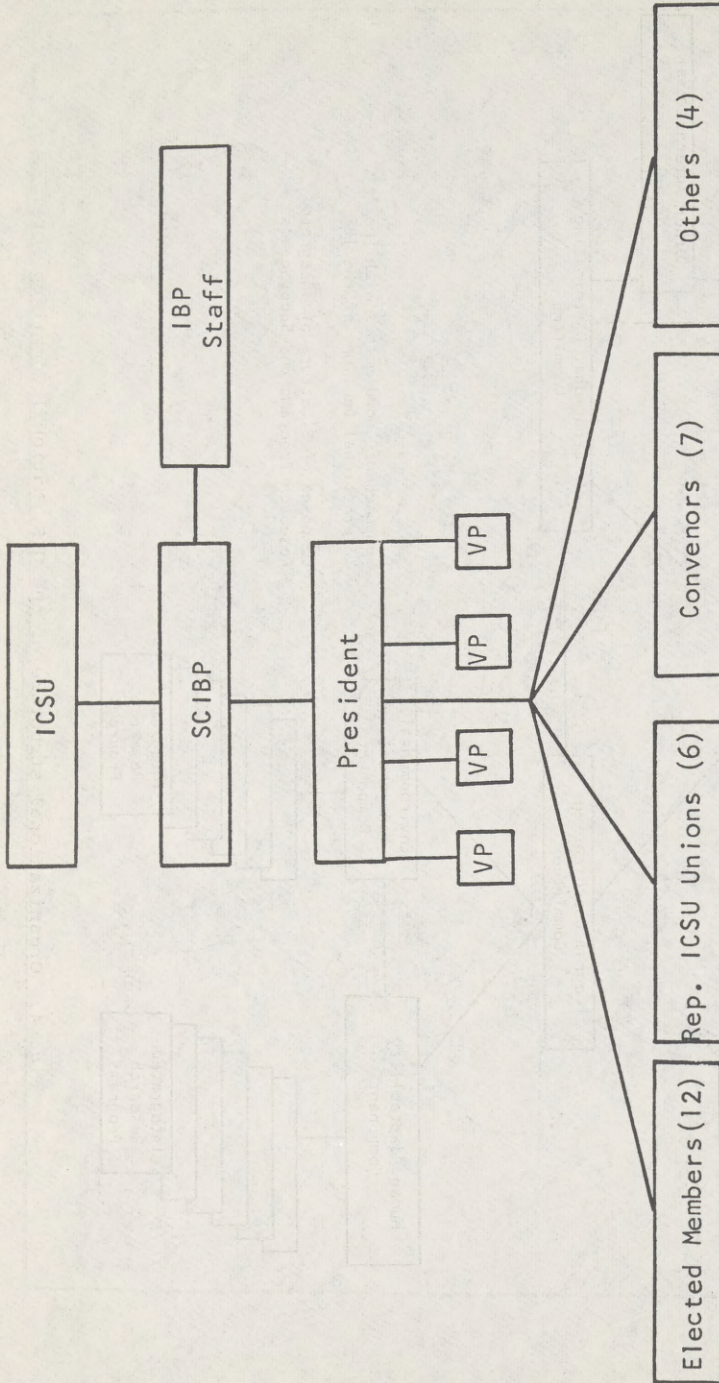
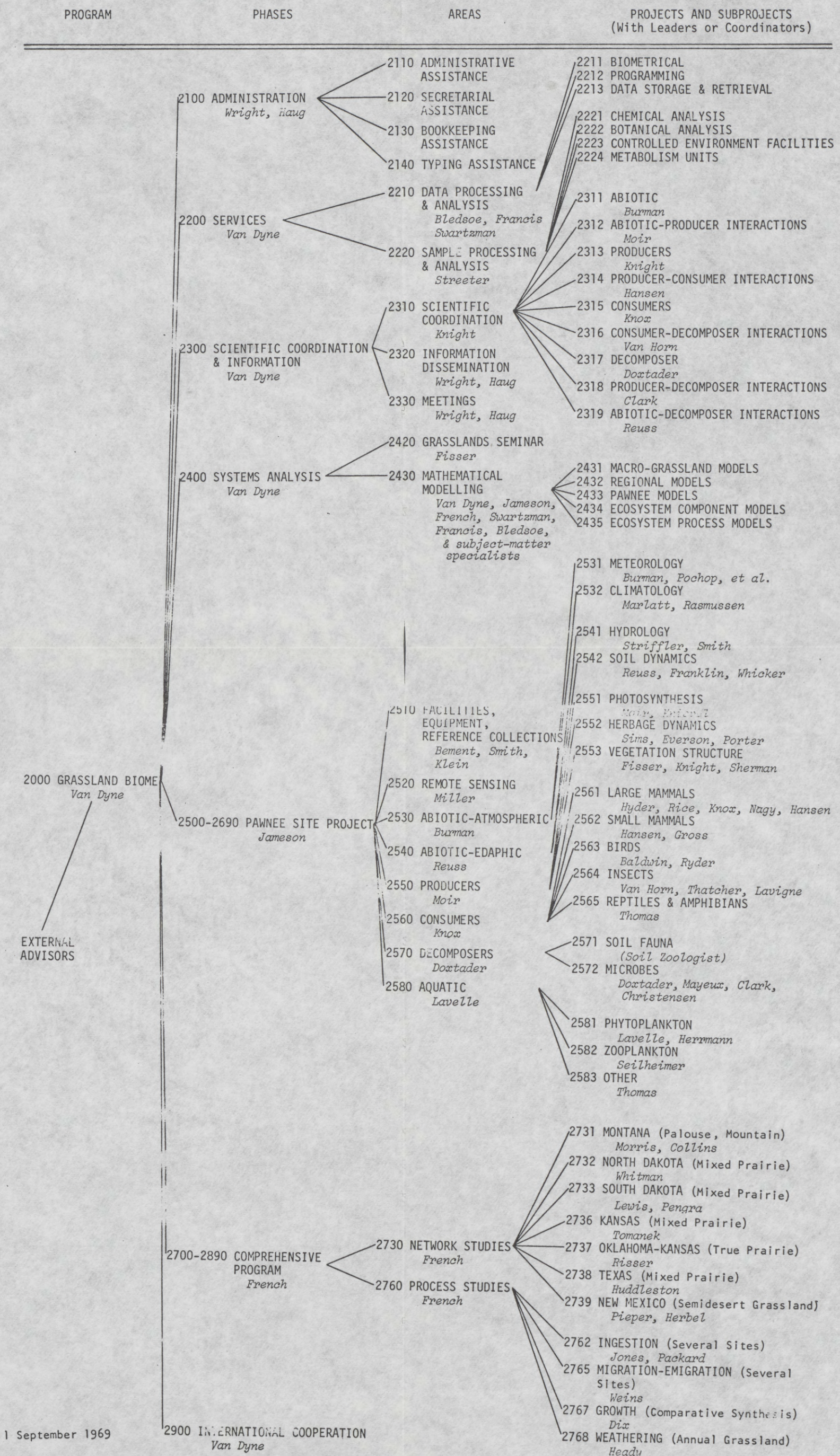
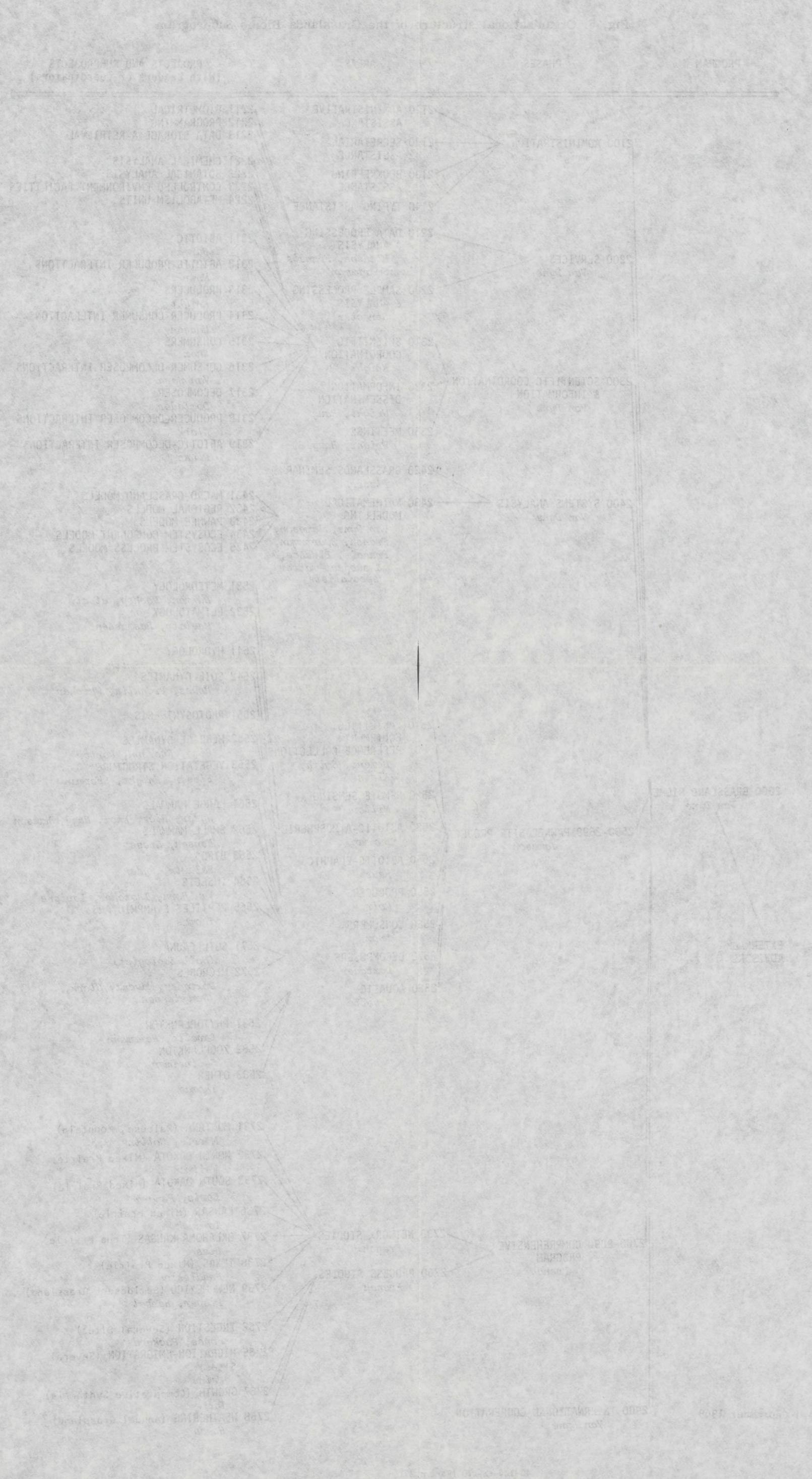


Fig. 3. Organizational structure of SCIBP

Fig. 5. Organizational structure of the Grasslands Biome Subprogram





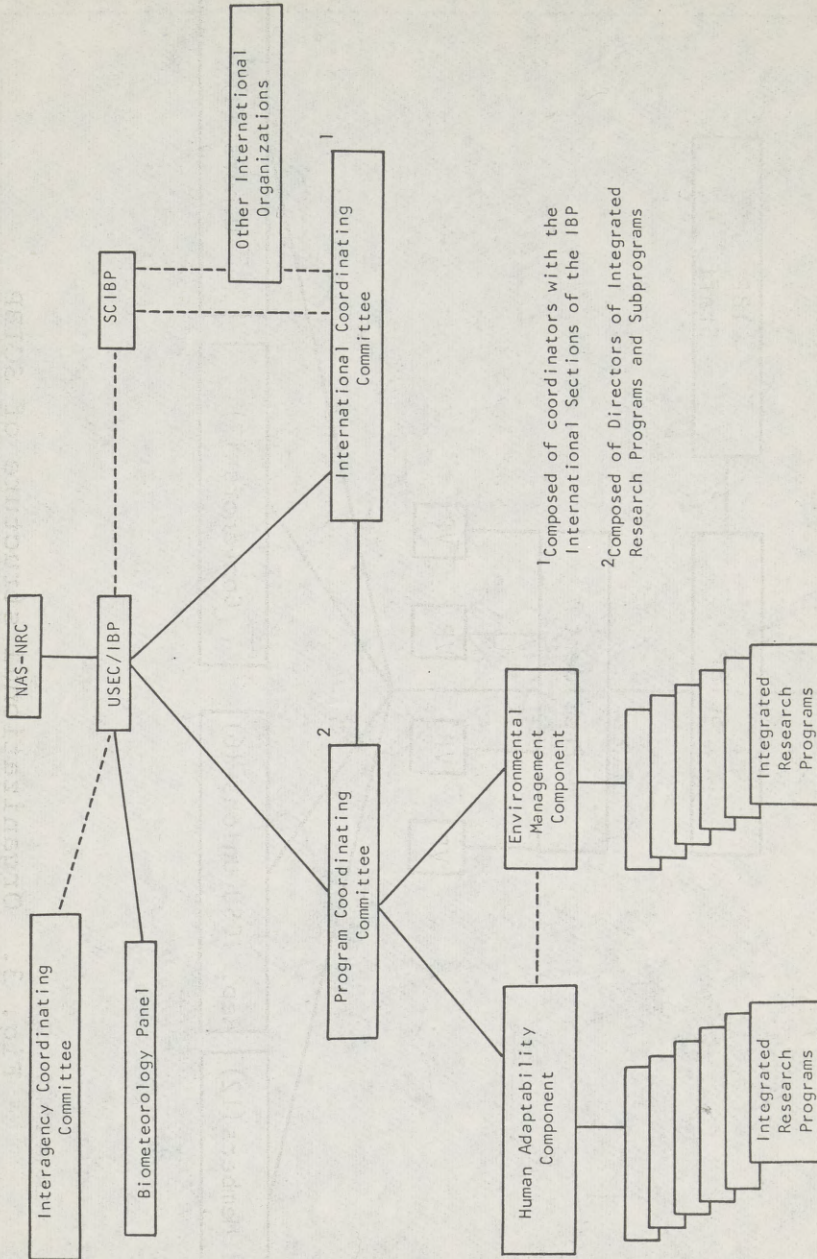


Fig. 4. Organizational structure of the U.S. National Committee for IBP

Fig. 6. Population Genetics of the American Indian

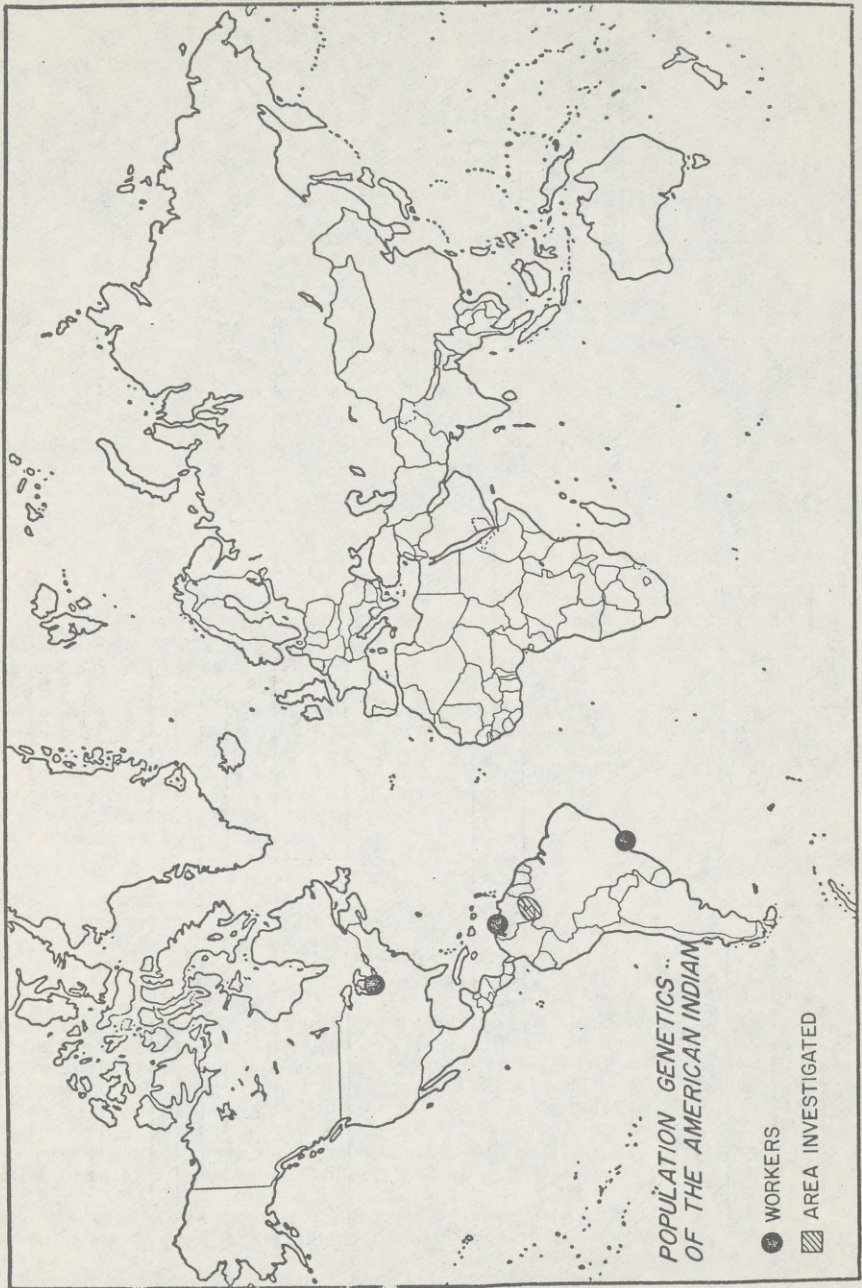


Fig. 7. Biological Productivity in Upwelling Systems

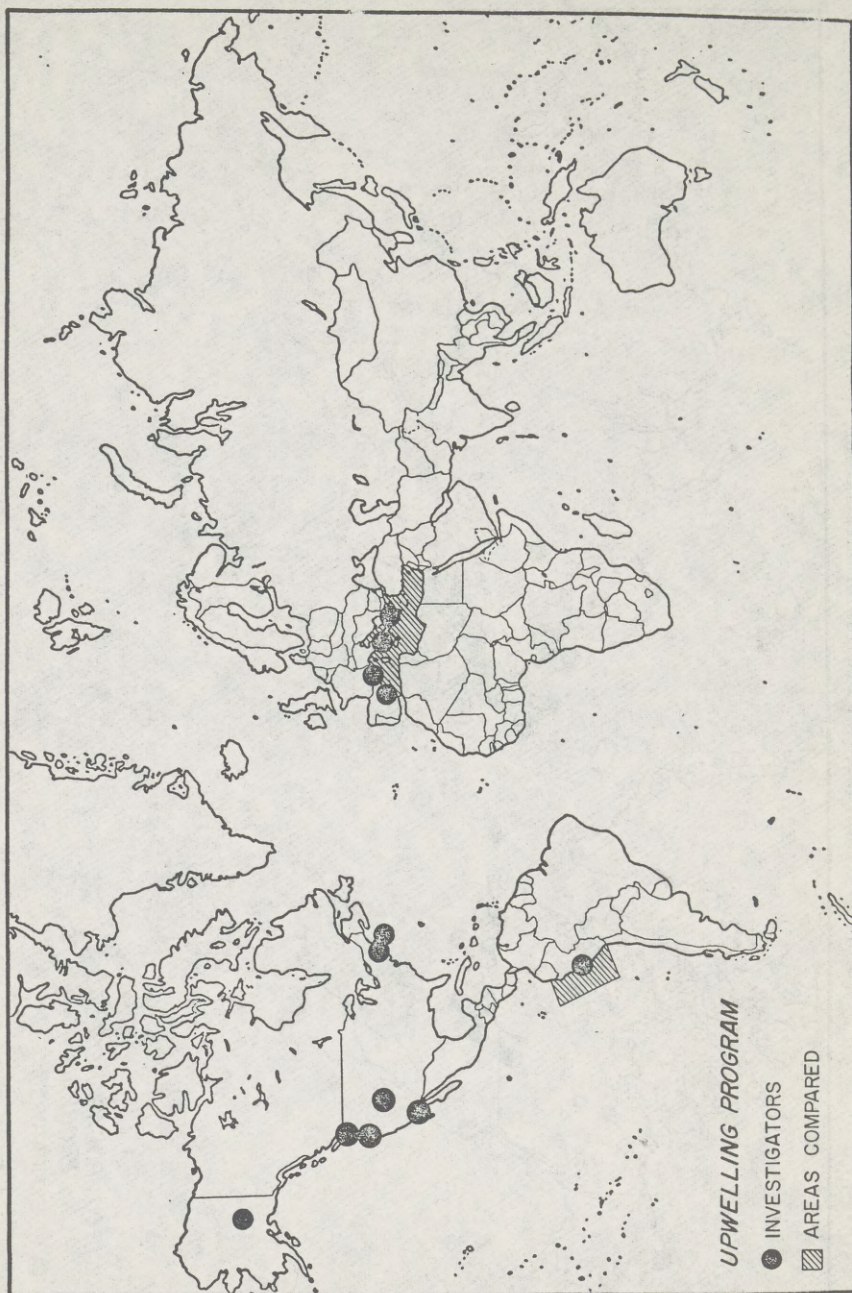


Fig. 8. International Studies of Circumpolar Peoples

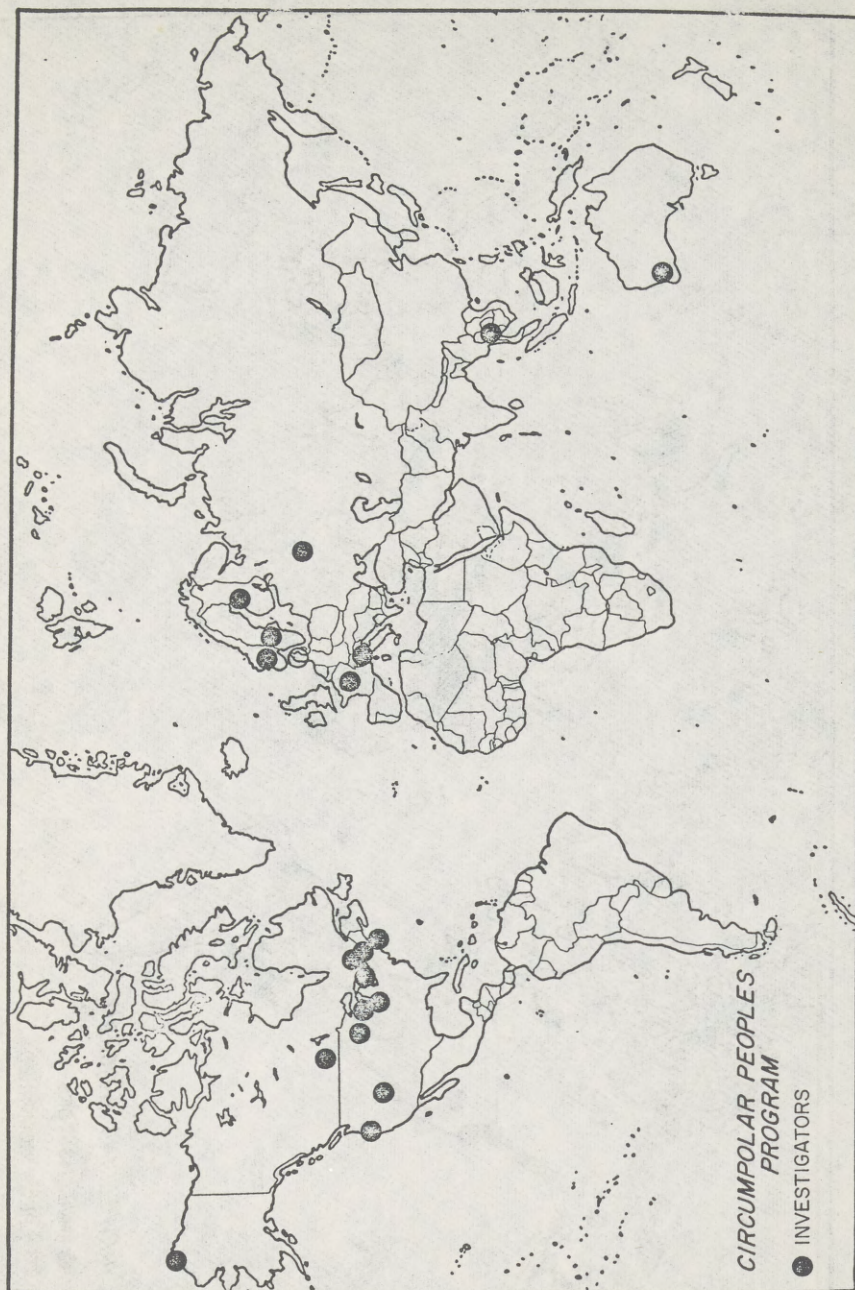


Fig. 9. Structure of Ecosystems

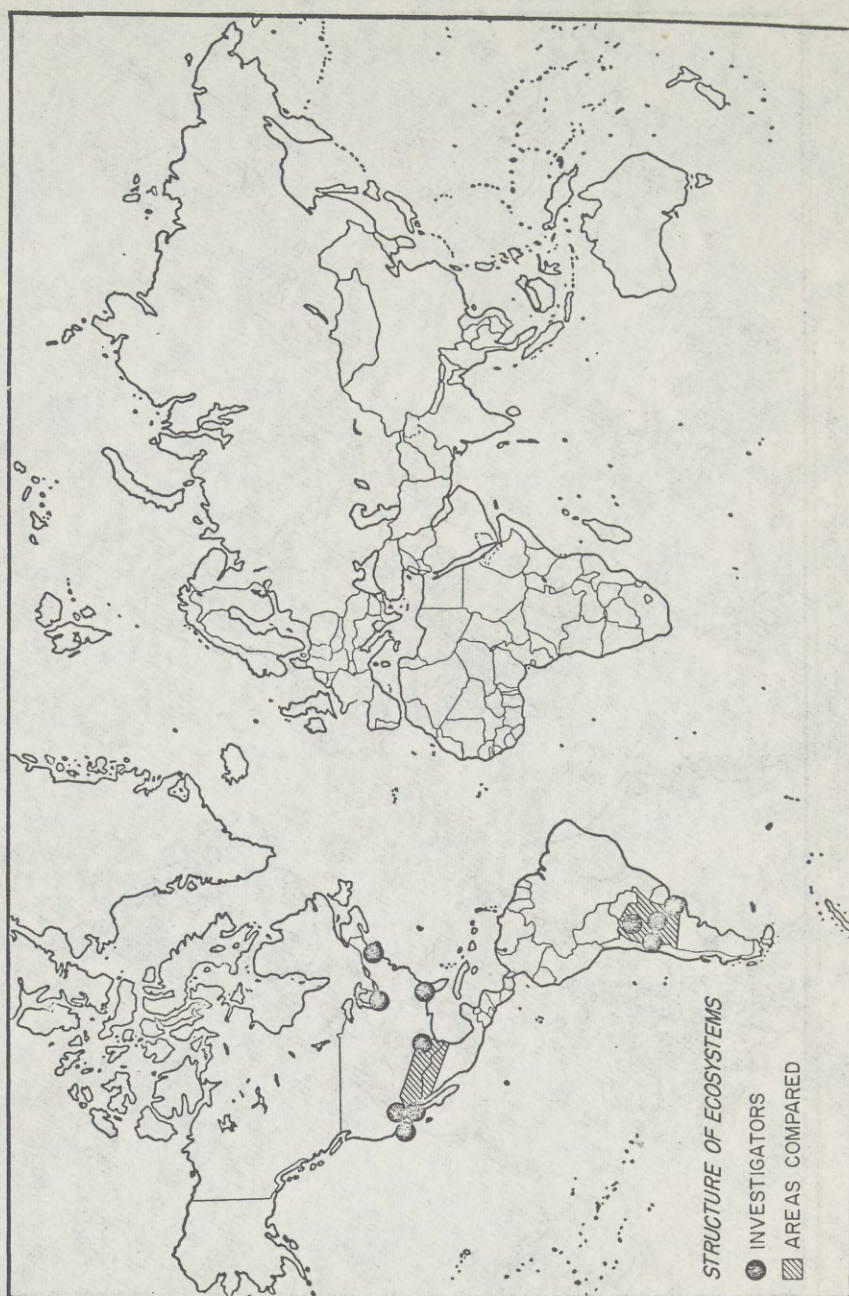
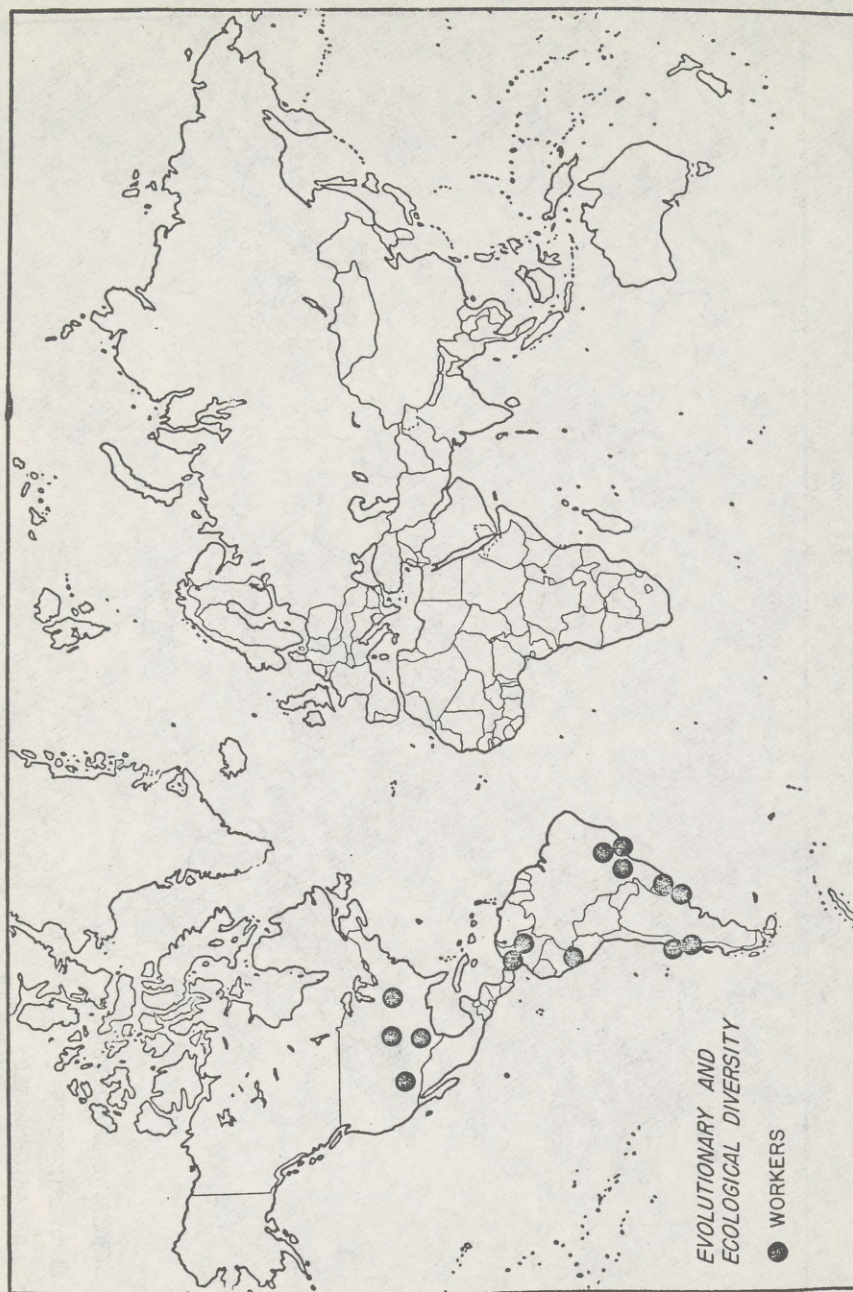
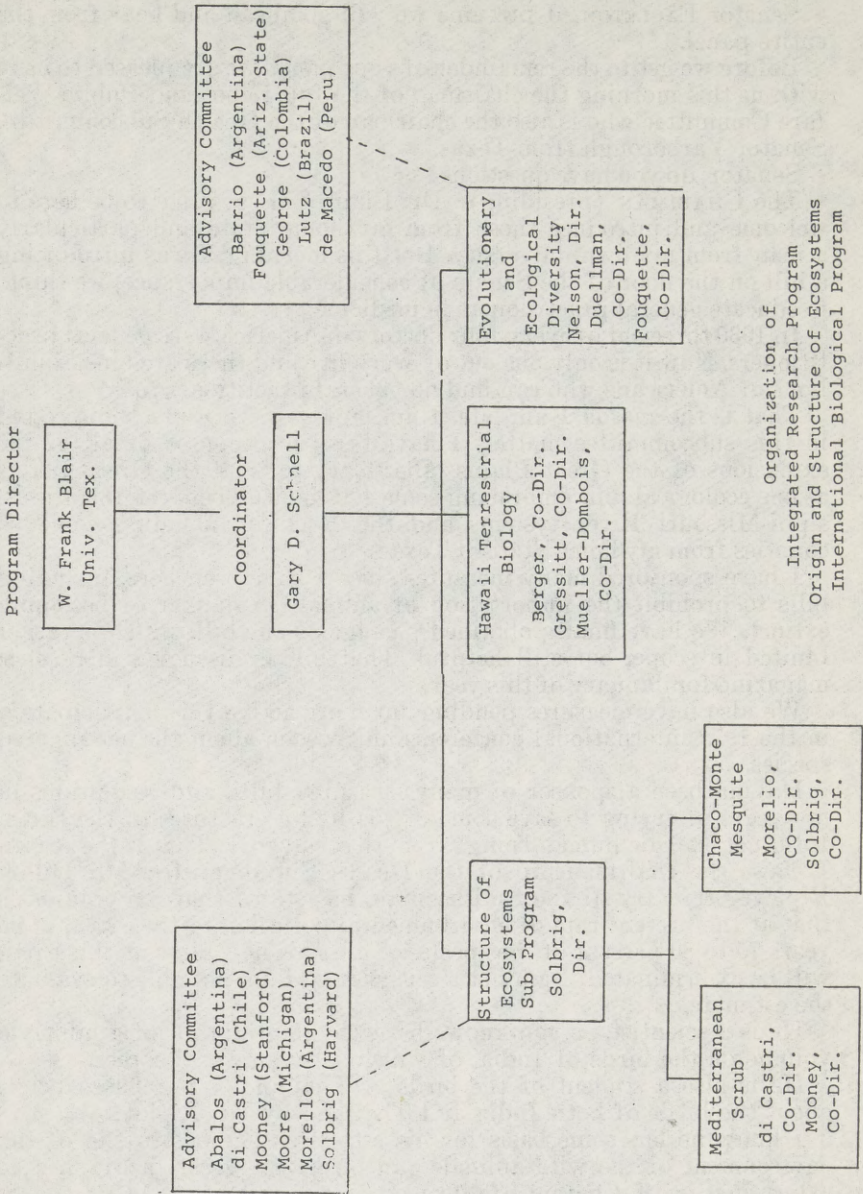


Fig. 10. Evolutionary and Ecological Diversity





Dr. BLAIR. Mr. Chairman, would you prefer to direct any questions to me now or have the presentations and then direct them to the panel?

Senator EAGLETON. I presume we will go ahead and hear from the entire panel.

Before we get to the remainder of your panel, we are pleased to have with us this morning the chairman of the full Labor and Public Welfare Committee who is also the chairman of the Health Subcommittee, Senator Yarborough from Texas.

Senator, do you have questions?

The CHAIRMAN (presiding). Dr. Blair, I always like to be here to welcome and introduce those from my home State and particularly a man from my own university. But this morning, I was introducing a bill on the floor of the Senate of considerable importance, we think, to educate general practitioners in medicine.

In 1930 three out of every four doctors in America were general practitioners. Now it is only one out of every five and there are tens of millions of Americans who can find no general practitioner to go to.

That is the reason I am late. I am, however, very much interested in this subcommittee matter. I have been a cosponsor of all of the extensions of the Great Plains bills to try to treat the Great Plains as one ecological unit embracing some 400 counties between the Mississippi-Missouri River systems and the Rockies, including some 96 counties from my home State of Texas.

I have sponsored many measures since I have been here, including bills to prohibit the importation of animals in danger of becoming extinct. We have finally obtained passage of one bill, which is rather limited in scope, but still helpful. That bill is discussed in Science magazine for January of this year.

We also have measures pending for more active U.S. participation in the 1972 international conference in Sweden about the endangered species.

Having been a sponsor of many measures, bills, and resolutions in my years of trying to save some of the living creatures of the earth, I did not exclude human beings from that category. That is the reason I chose the chairmanship of the Health Subcommittee. Dr. Dillon Ripley, Secretary of the Smithsonian, has stated that his opinion is that at the present rate of environmental pollution of the earth, in 25 years 75 to 80 percent of the species of animals now alive on this earth will be exterminated. I am not a scientist, so I am not able to evaluate the estimate.

He is a scientist, as you know; he is the joint author of a multiple volume on the birds of India, of which I have several copies.

He is also a student of the birds of Thailand. I purchased books about the birds of both India and Thailand by Dr. Ripley.

I know he has some basis for his estimate. The destroying of the environment of the wild animals and birds is a great factor in that extermination of different life forms.

Therefore, I commend you and all of your panelists for this work. I have a great interest in it, and because of having lived in a rural area, a forest area, and then having lived 3½ years in the desert in El Paso, I have developed an interest in total environment.

I hope I can be of service to you scientists in trying to help you preserve and protect the environment. A small number of scientists are

trying to protect this earth, and this little thin layer above, which is the habitat of men.

Thank you, Mr. Blair.

Dr. BLAIR. Thank you, Senator.

I might say from the people I talked to from Latin America on the endangered species bill, I think this legislation has probably done our Latin American relations more good than anything that has been done in the last several years.

The CHAIRMAN. Of course, we have international, and national laws stating that you cannot export alligator hides or anything else across State lines in this country unless they are tagged showing they are legally taken under the laws of those States.

We have many statutes that protect the endangered species. But the men take these species, transport them over the State lines and put them on the markets. I don't think this law is strong enough and has teeth enough.

But it is a long step forward. If the Secretary of the Interior and others would proceed to use the power they have now in these laws, they can go a long way. We can amend them later, as we find the defects.

But it has taken years to get this law.

I have two other committee meetings, Senator Eagleton, to which I may be called away at any moment. Thank you.

I am grateful to Senator Eagleton for agreeing, as a member of the Health Subcommittee, to chair this particular hearing because the chairman must stay here all the time. As chairman of the Health Subcommittee, this is an area of primary interest to me.

But I am being called out to other subcommittees from time to time.

Thank you.

Senator EAGLETON (presiding pro tempore). Thank you, Senator.

Dr. Blair, you may proceed.

Dr. BLAIR. I would like to introduce Dr. James Neel, University of Michigan, who heads our program dealing with genetics of the American Indian and who will speak about this and other human adaptability aspects of IBP.

Dr. Neel?

Dr. NEEL. As you have heard, the IBP is basically a two-pronged program, one prong directed towards ecology and problems of the productivity of the earth, the other prong towards the problems of human adaptability. How does man adjust to the rapidly changing world? What is the biomedical price we pay for adjustment? Are there limits, beyond which the price is too high?

In the pursuit of the adaptability side, especial attention has been directed towards what we might call experiments of nature. These are situations where for one reason or another man finds himself under special stresses. Thus the adaptability side of IBP involves studies of man at high altitudes, man in the Arctic Circle, man in the jungle, and man migrating from a rural to an urban environment.

The IBP program for which I bear a primary responsibility involves studies of some of the most primitive Indians still to be found in South America. I am sure that to some of you, given the many serious problems with which U.S. finds itself presently confronted,

this sounds like a bit of escapism, especially since we usually do our major fieldwork in January and February, at a time when the Ann Arbor climate leaves a great deal to be desired. We don't see it quite that way.

It now appears that man or manlike creatures have been on the earth at least 2 million years, and possibly even 3 million. During most of this time, he has lived in very small bands, subsisting by hunting and gathering. Relatively recently, and by that I mean the past 1,000 or so years, our way of life has been changing very rapidly, and within the past 100 years, the change in the condition of human living has probably been greater than in all previous time.

Our studies of primitive man are based on two propositions. First, we argue that many human diseases result from a response to our changing environment, and to appreciate exactly what is involved we must go back and get the kind of baselines that can only come from certain kinds of studies of primitive man.

Second, we know that most of human evolution occurred under these jungle conditions, and again we feel that to understand the genetic implications of our great cultural changes and our changes in reproductive patterns, we must go back to primitive man in order to get a proper perspective.

We are all only too aware currently of the possible genetic risks inherent in increasing exposures to radiation and a wide variety of chemicals. Isn't it important that we go back and study populations not yet exposed to these various agents, the better to appreciate just what all of these agents may be doing to modern man.

There is an urgency to this type of investigation which does not obtain for many other kinds of biomedical studies. All over the earth, primitive man is rapidly disappearing. We will very soon have lost the opportunity to document these cultures. I have frequently said that ours is really the first generation of scientists that have had the tools to ask a number of very fundamental questions concerning such people, and we are probably the last generation which will ever have the chance.

The CHAIRMAN. May I ask a question there? Is it correct that there are more scientists today than have lived during all the rest of human history combined?

Dr. NEEL. That is correct.

The CHAIRMAN. With mature scientists like you who have graduated and have lived half of your lives as scientists, we are now getting the first chance to listen to scientists who are concerned with all of these questions.

Dr. NEEL. We tend to think of jungle man as living under strange stresses. Actually, if he were mounting the IBP, he would see us as the ones under stress. He got along quite well with his environment for over 2 million years. It is doubtful how well we are getting along with our environment.

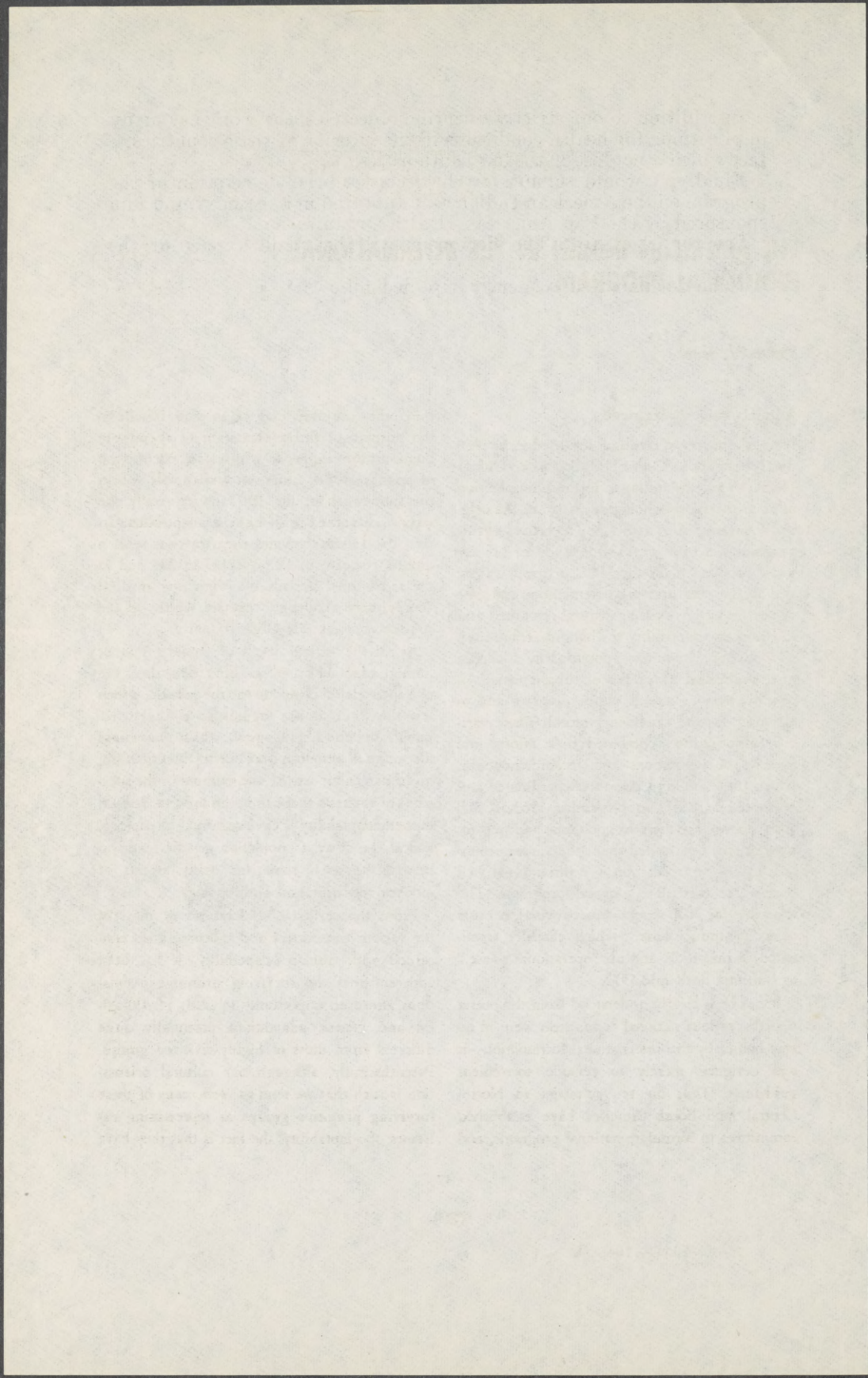
In closing these brief remarks, let me express the strong conviction that one of the effective ways to international understanding is through collaborative effort of this type. The IBP is surely one of the important current scientific moves towards internationalism. Our own collaborators include very responsible scientists in both Brazil and Venezuela.

In addition to our strictly scientific objectives, the work has many implications for health conditions in the interior of these countries, a fact which is not lost on the local authorities.

Finally, I would submit for the record a brief description of the program on the American Indian as it appeared in a recent symposium sponsored by the Pan American Health Organization.

Senator EAGLETON. The document will be made a part of the record.

(The document subsequently supplied follows:)



THE AMERICAN INDIAN IN THE INTERNATIONAL BIOLOGICAL PROGRAM

James V. Neel

Administrative background

As is a matter of common knowledge, in 1960 the International Council of Scientific Unions (ICSU) took the initiative in the promulgation of an International Biological Program. As originally envisioned by ICSU, the objectives of this program were the world-wide study of (1) organic production on the land, in fresh waters, and in the seas, and the potentialities and uses of new as well as existing natural resources; and (2) human adaptability to changing conditions. A Planning Committee appointed by ICSU in turn established a number of subcommittees to consider various aspects of the program and to elaborate a more extended protocol. These various subcommittees combined their efforts into a series of suggestions and recommendations, which the Planning Committee coordinated and submitted to ICSU in November 1963. ICSU, after approving these suggestions and recommendations, then called upon the various countries having representation in it through national societies to formulate national programs. The timetable for IBP, several times revised, consists of a "planning phase," which officially terminated in mid-1967, and an "operational phase," to continue until mid-1972.

It has been clearly understood from the outset that the various national committees were in no way bound by this international formulation—it was designed merely to provide convenient guidelines. Thus far ten countries in North, Central, and South America have established committees to formulate national programs, and

four other countries may do so soon. It will be the purpose of this presentation to attempt to point out the manner in which a variety of types of studies of the American Indian fall within the framework of the IBP and especially the section concerned with human adaptability. In fact, the Indian provides the Americas with a unique resource in IBP-oriented studies and at the same time presents interdigitating medical and humane challenges that are worthy of the consideration of this Organization.

At all the various levels of consideration of human adaptability, it has been clear there are two interrelated components: the genetic, which sets the limit of the organism's ability to respond, and the physiological, which determines the range of response available to the organism, given its genetic set. At one extreme in the spectrum of interests that can be brought to bear on human adaptability is environmental physiology, and at the other is population genetics—and in between there is room for many aspects of modern medicine and anthropology.

From the earliest considerations of most of the various committees and subcommittees concerned with human adaptability, it has been apparent that the surviving primitive populations afford an opportunity to study physiological and genetic adaptations potentially quite different from those of highly civilized groups. Parenthetically, although our cultural orientation is such that we tend to view many of these surviving primitive groups as representing extremes of adaptability, the fact is that they have

lived under their conditions far longer than we under ours. Viewed from their vantage point, we are the ones pressing for new limits of adaptability, and it is only an article of faith that we will adapt to our man-made environment as successfully as they have done to theirs. We must note in passing that some of the adaptations of these groups are complex and ingenious, and that the term *primitive* as commonly used is something of a misnomer, amounting to "pre-literate with a relatively simple technology."

In late 1962 the World Health Organization convened in Geneva a Scientific Group on Research in Population Genetics of Primitive Groups. Its purpose was to consider studies of populations of unusual genetic interest, with particular reference to the surviving hunting and food-gathering groups of the world, to advise on the most suitable populations for such studies, and to draw up appropriate research designs. The pertinence of this to IBP-related developments is obvious. In the preliminary inventory of these societies published in the report of the Scientific Group, various South American tribes figure prominently (26). This report, incidentally, was updated in the summer of 1967 and a revised version has just been issued as WHO Technical Report 387.

A recurrent consideration in the consultations of both IBP-related and WHO-related groups has been the rate at which these primitive groups are disappearing. It can be said without exaggeration that ours is probably the last generation privileged to study such groups in a relatively pristine state. If there are important scientific lessons to be learned—and the WHO document would seem to develop that case adequately—then there is an urgency to this problem not shared by many other areas of research.

The dimensions of Indian-oriented studies

These are days in which those of us who are concerned with human biology view our species as beset by a growing number of pressing problems of our own making: the population increase, trace chemicals in foodstuffs, air pollution, water pollution, the so-called stress diseases, cultural alienation, to mention only a few. Each

of these problems has reached such a magnitude as to call for concerted action on a hitherto unknown scale. But I submit that behind these immediate problems lurks a far larger issue. Now that man so largely controls both the environment and his reproduction, is there any long-range objective more important than that we understand the genetic potentialities of the individual and the species, the manner in which this potential interacts with an environment that is increasingly man-made, and the rate of genetic change in response to a changing environment? You will recognize that I have only restated in a different context the need to understand the genetic aspects of human adaptability. The American Indian offers prime research material for this objective. The principal lines of attack can be conveniently summarized under three headings (see 12).

1. *Population structure and natural selection in primitive man.* One of the basic tenets of biology is of course a belief in the role of natural selection in shaping each species to its ecological niche. As biologists we believe that natural selection has guided human evolution and will continue to guide the evolution necessary for a successful genetic adjustment to a changing world. It is clear that modern man evolved under circumstances approximating the conditions found in primitive cultures. Otherwise stated, there is no evidence that the developments of the past few thousand years have yet resulted in any very significant modifications of man's genetic potential. It follows that one way of understanding the genetic impact of our changing environment is from the baseline supplied by detailed knowledge of primitive man in his primitive ecosystem. The simple fact is that at present we know virtually nothing about how selection works in man. What few insights we have are largely based on the results of artificial selection with experimental animals and deal with traits, such as extremes of egg production or milk yield, considerably more important to us than to the animal species involved.

What the geneticist terms "population structure" places limits on the effectiveness of natural

or artificial selection. Thus, hand in hand with efforts to understand selective pressures must go efforts to understand the genetic structure of populations. To the geneticist, this means patterns of mating, fertility, and survival; amount of inbreeding; migration patterns; mutation rates; and so on. Although some data on these subjects are to be found in the voluminous anthropological literature, in the main what is available simply lacks the precision and depth necessary to the precise statistical treatments of the geneticist.

Even with all the facilities of modern science and the conveniences of our culture, such comprehensive studies remain extremely difficult in civilized countries. How much more difficult are they, then, in the remote primitive populations—problems of logistics and communication being what they are. Even so, from our own experience of the past several years and that of several other groups with kindred interests, it is clear that a variety of types of data relevant to population structure can be collected.

In 1962, aided by a grant from this Organization, Dr. Francisco Salzano of the University of Rio Grande do Sul, Brazil, and I, with several collaborators, undertook a pilot study on the Xavante of the Brazilian Mato Grosso (13). These and further studies on the Xavante, in 1963 and 1964, raised a number of rather basic questions for population genetics (14), but it was felt that the Xavante were neither a large enough group nor sufficiently undisturbed for a critical approach to these questions. Accordingly, after a careful consideration of the possibilities, a second study was undertaken, concerned with the Yanomama Indians of Venezuela and Brazil and involving as principal colleagues—in addition to Dr. Salzano—Drs. Miguel Layrisse and Tulio Arends of the Venezuelan Institute for Scientific Research (IVIC) and Drs. William J. Schull and Napoleon Chagnon of the University of Michigan. We have now been in the field on three different occasions. The composition of the team varies from year to year, but ideally it includes an ethnologist, a linguist, a physical anthropologist, a geneticist, and several physi-

cians. Although the precise nature of the data collected depends upon local circumstances, under optimal conditions we assemble as complete demographic and genealogical data as possible; conduct physical, dental, and anthropological examinations; and obtain blood, urine, saliva, and stool specimens for a variety of genetic and other determinations. The effort to understand better man's interaction with his environment carries far beyond the identification of genetic traits—we are fortunate to have the collaboration of such groups as the Communicable Disease Center of the U.S. Public Health Service, the Virus Institute at IVIC, and many specialized laboratories at the University of Michigan.

This is not the time for a detailed review of the findings on either the Xavante or the Yanomama, which in any event must be regarded as preliminary. Not at all surprisingly, both the population structure of these people and the biological pressures on them are qualitatively and quantitatively different from those of civilized groups. These are populations in which infertility is rare, practically all women contributing to the next generation; in which effective fertility seems intermediate, and infant and childhood mortality also intermediate; and in which the variance of male reproductive indices is significantly greater than of female (15). A surprising amount of genetic microdifferentiation between villages has been encountered (1), originating, we believe, in the fission-fusion pattern that dominates village proliferation and results when a new village comes into being in a very non-random sampling of the tribal gene pool. We reason from this that if new tribes originate in general as new villages do, then chance may have played a greater role in much measurable human genetic variation than heretofore seemed likely. The roles of traumatic, infectious, and nutritional disease in determining survival are far different than in the next step on the cultural ladder—that is, in relatively densely populated agricultural societies.

We do not pretend to understand as yet the full genetic implications of all that we see. One reason for our lack of understanding is that a

substantial portion of the mathematical theory of population genetics is currently being reworked. A second reason is that the data are so complex that precise mathematical formulations do not appear imminent, and we are being forced to involved computer simulation programs to explore the genetic consequences of the differences between these societies and our own. However, even at this stage it is very clear that it will be possible to define objectives and test hypotheses in a way that will justify the effort expended.

I mentioned above that a substantial portion of the mathematical theory of population genetics is being reworked. One of the most provocative developments in the biomedicine of the past twenty years has been the realization of the extent of man's concealed genetic variability, as revealed by modern biochemical techniques. Many of the newly recognized variant types occur in populations in such frequencies that we speak of the underlying systems as genetic polymorphisms. The maintenance of such polymorphisms is thought to require selective pressures of one kind or another; not only is the nature of these forces unknown, however, but under the previous formulations the mortality and fertility structure of our population scarcely seems adequate to accommodate the necessary selection, and new formulations are being considered (7, 9, 25). Understanding how all this variability is maintained is one of the great challenges to the human biologist (see discussions in 8 and 16). Now, the genetic polymorphisms are well represented in all the primitive populations studied to date. This is where they came into being. Accordingly, it seems self-evident that, despite the inherent difficulties, we must make every effort to conduct studies in depth of population structure and the relationship at this cultural level between the polymorphisms and specific biological attributes.

There is an urgent scientific need for similar studies, while the opportunity exists, on as many as possible of the other unacculturated groups of Indians. None of the surviving primitive Indian communities can safely be labeled "typical"—

each may be unusual in one or several respects. Only from the perspective of numerous studies in depth can we begin with any assurance to factor out the significant common denominators that have guided human evolution. Already parallel studies are in progress on such groups as the Cayapó of Brazil by Salzano and colleagues and the Kashinawa of Peru and Brazil by Johnston and colleagues, as well as in other parts of the world, and more are to be hoped for.

2. *The rate of human evolution, i.e., genetic diversification.* Despite the many unanswered questions discussed earlier in this session by Professors Griffin, Cruxent, and Laughlin, the date and place of arrival of the Indian in the Americas is more accurately known than the corresponding information for any other major subdivision of mankind. In view of what can be deduced concerning population density in northern Europe 20,000 years ago, we may surmise that the total number of immigrants across the Bering Bridge, whether they came in one or in several discrete waves, was not large. The genetic characteristics of this original group will of course be forever conjectural, but let us assume that the tribal population(s) concerned had the range of variability we see in such a group as the Yanomama. (I am assuming in this discussion that the contribution to the gene pool of individuals reaching the Americas other than by the Bering Bridge is negligible.) Once here, extension throughout the Americas seems to have been rapid. In this extension, the diversity of habitats explored and occupied represents most of the extremes of the habitable portions of the earth. If we make the assumption of a reasonably homogeneous beginning, then the diversity of types of Indians at the time of the rediscovery of this continent five centuries ago constitutes an unusual opportunity to measure the rate of human evolution.

Much of the early thinking on this topic drew on morphological characteristics, and these, as Professor Comas has just demonstrated, still remain valid and pertinent. However, in recent years the newly discovered polymorphisms mentioned earlier have provided a powerful battery

of objective indicators of genetic distance. Dr. Layrisse has just provided us with an overview of how great the range is with regard to a variety of specific systems. In theory, for any given genetic system the position of each Indian population with respect to all the others can be defined by a point in a space that has one less dimension than there are alleles in the system, the precise position in this space being determined by the frequency of each allele. Further in theory, when many different genetic systems are considered simultaneously, the position of each population vis-à-vis the others can be plotted in a space that now has as many dimensions as there are genetic systems. Previously, the computations when a considerable number of systems was involved were as laborious as this description sounds (6, 22). But the advent of the modern computers has dramatically altered the situation, and now a number of groups are developing computer-based measurements of population distance (see 3).

Although considerable progress has been made, there is still a great deal to be done in the way of characterizing the genetic attributes of the relatively pure Indian groups, as a basis for exploring the evolutionary problem discussed above. Incidentally, the HA/IBP/IUBS emphasized the need for continuing efforts at the genetic characterization of all the human strains, so that this type of investigation of the Indian fits readily into a larger framework. The published data on the Indian are widely scattered, no survey having been attempted since those of Mourant (10, 11) and Salzano (18). Dr. Richard Post, Dr. William Schull, and I have now completed a compilation of all publications prior to November 1967 that deal with the principal genetic polymorphisms known to occur in the Indian.¹ The rate of discovery of new polymorphisms being what it is, any such compilation is soon dated, but for the specialist it at least provides a nidus for updating. The 271 papers on which the tabulation is based attest to the strong interest in this subject. Since the data on unmixed Indian groups have in most

contexts far greater interest than the data on mixed, an effort has been made to recognize three levels of miscegenation: (1) essentially none; (2) known, but probably accounting for less than 5 per cent of the gene pool; and (3) greater than 5 per cent. The tabulation contains data on the following polymorphic systems (these being the ones on which there seemed enough data to warrant a tabulation): ABO, Rh, MN, Kidd, Duffy, Diego, P, Lewis, haptoglobins, transferrins, and Gm. Gene frequencies have been computed for each study with computer programs written in Fortran and available on request.

In closing this section, let me agree with those who feel there has already been quite enough of surveying populations for gene frequencies in the vague hope that someday the information will be valuable (see discussion in 2). In the case of the Indian, however, such surveys bear on a clearly defined problem on which considerable progress may be expected in the near future.

3. *The response of genetic systems to a rapidly changing environment.* As I mentioned earlier, we recognize that our species is all over the world subjected to a rapidly changing environment. Unfortunately, only in the last few years have biology and medicine found themselves in a position to begin to document with any precision what biological adjustments really take place. We have probably lost forever the opportunity to study what occurred in Caucasian populations. We are about to lose the opportunity to document what happens in Negro and Mongoloid (including Indian) populations.

The transition of surviving primitive Negro or Indian groups will be telescoped into a far shorter time period than was true for Caucasian groups. Thus, some Indian groups will be called upon to move from the Stone Age to the Atomic Age in a few hundred years, whereas the transition for most Caucasian groups took thousands. It seems reasonable to argue that here is an opportunity to study changes in population structure and adjustments to new stresses that we must not lose.

As for the previous two sections, so here the

¹ See Appendix of this volume.

intellectual challenge is to convert an easily enunciated but somewhat diffuse series of problems into specific issues susceptible of precise study. A number of exact studies of population structure in transitional groups have already been completed or are in progress, notably those of Salzano and colleagues on the Caingang of Brazil (19, 20), of Layrisse and colleagues on the Warao of Venezuela, of Covarrubias and colleagues on the Pewenche of Chile, and of Cann and colleagues on certain Quiché speakers of Guatemala. There are also studies in the United States on groups in a more advanced stage of the transition, namely by Spuhler and colleagues on the Navajo (21) and Hackenberg on the Papago (5).

Also in progress are studies of specific medical issues that arise in transitional groups, as the latter portion of this session will attest. The work of Roche and colleagues in particular will illustrate just how rapid and subtle may be the changes introduced by minimal acculturation. If genetic factors are important in the susceptibility to the thyroid hyperplasia and diabetes mellitus now so common in certain Indian groups, then, because of the recency, frequency, and intensity of the phenomena, these groups may be unusually favorable material for the study of these genetic factors.

Some unpublished studies of Drs. Warren Eveland, William Oliver, and myself may help point to some of the nuances of this transition. Six *E. coli* strains were isolated by Dr. Eveland from each of 77 Yanomama stools, each stool from a different subject. An effort is in progress to type each of the resulting 462 strains, using some 140 different typing sera. Thus far approximately 44 per cent of the strains fail to type out. By contrast, experience indicates that only a very small fraction of *E. coli* strains isolated in the United States would fail to type. What remains to be determined is whether this is a unique finding in a long-isolated population or whether similar studies on other such groups will reveal the same pattern, with the inference of a predictable shift in the intestinal flora with acculturation.

Some moral issues

It has seemed appropriate, in a presentation to an audience of scientists, to stress research opportunities. But as in the 1960's we increasingly recognize the issues created by scientific inquiry divorced from ethical and humanitarian considerations, it also seems appropriate to consider briefly what these studies, and especially the type mentioned in the last section, might mean to the Indian. We have no accurate census of the relatively pure Indians left in the Americas, or of the persons of mixed but "substantial" Indian ancestry. Estimates of the order of 16,000,000 (17, 20, 24) have been made for the former, while the latter come to easily several times that figure. We are talking about large numbers of people.

Who among us can read the history of the relations between the early settlers of his country and the Indians without deep shame for the barbarism heaped upon a people who were driven to defend the land they occupied? The world is watching my country as it agonizes over the Negro problem—it might equally well be watching the Americas for signs of a belated moral resurgence with respect to the Indians. How satisfied are any of us with the official programs of our governments for the health, economic advancement, and education of the Indians? How can we translate the results of our scientific investigations into concrete action programs, programs that must be carefully related to other government measures? It is a dubious favor to lower infant mortality among the Indians without parallel economic measures to ensure food for the extra mouths. Nor does it seem likely that Indians' accident-proneness (see references in 23), so easy to attribute uncritically to their heritage of violence and lack of familiarity with our gadgets, will yield to education until the frustrations that contribute to accident-proneness are relieved.

In a world that seems to be groping for perspective, the Indian provides a reference point from which to view the fantastic disruptions that modern men, intrinsically still little different in all essential biological attributes from

Indians, have brought about. There are those who will take umbrage at my characterization of us representatives of Western culture as "intrinsically still . . . Indians." I am aware of the so-called intelligence tests that purport to show the inferior intellectual qualities of the American Indian, just as I am aware of similar results with the American Negro. These results can be and have been used as an excuse for less-than-equal schooling. But in both instances it is a matter of a culturally deprived and alienated group—perhaps also subjected to early nutritional deficiencies, whose role in impaired intellectual performance we are just beginning to recognize—being judged by tests designed by and standardized on a very different group (see also 4). By these remarks I do not mean to dismiss the possibility of intellectual differences between ethnic groups, but only to insist that to date the

data are grossly inadequate and we who call ourselves scientists must adhere to the null hypothesis, the more so since its various alternatives can be so conveniently misused by those who would evade their social responsibilities.

Be this last digression as it may, each time I return from the field there is a period of culture shock as I realize how greatly in a short period of time we have contrived to disrupt our ecosystem, and how profound is our ignorance of the long-range results of this disruption. Now in this time of greatly intensified concern over these problems, studies in depth of the Indian, within or without the framework of IBP, will surely contribute not only to his well-being but also to our own perspective and, eventually, the necessary adjustments toward which we are evolving.

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Senator EAGLETON. So that I need not repeat it, the full statements of all our panelists and witnesses today will be made a part of the record.

Senator Yarborough?

The CHAIRMAN. You mentioned primitive tribes of the Amazons. Which are they and where are they located?

Dr. NEEL. Thus far, most of our efforts have been directed towards the Shavante of the Brazilian Mato Grosso and the Yonamama of the headwaters of the Orinoco and some of the northern tributaries of the Amazon. These are tribes which were essentially completely uncontacted until some 20 years ago. They are just now beginning to make meaningful contact with civilization.

There is a fleeting moment when you can obtain a true picture of life as it was among these people. In another 20 years they will be so acculturated that we doubt whether we can get a true insight into their culture in all its ramifications.

The CHAIRMAN. Are those the tribes that the Brazilian Government has put out rangers to protect the settlers from?

Dr. NEEL. Senator, this is a very complicated situation right now. The Brazilian Government has developed an Indian protective service. But I think it is as much with the idea of protecting the Indian from the settler as the settler from the Indian.

The CHAIRMAN. I have read it. I wanted to ask you of the accuracy of this. A popular magazine is printed to sell instead of being scientific. Are these so-called protectors out there really exterminating those Indians? Is that true?

Dr. NEEL. This is a very sensitive matter with the Brazilian Government right now. I understand they are just bringing to trial several hundred people on charges of atrocities against the Indian. Basically, the interior conditions there are not too different from what they were when the United States was making some of its contacts with Indians 200 or 300 years ago.

The CHAIRMAN. We are seeing a repeat of the pattern in the United States?

Dr. NEEL. Yes.

The CHAIRMAN. Thank you. I was interested in what I had been reading in magazines and wondering about the accuracy of it.

Senator EAGLETON. Dr. Blair?

Dr. BLAIR. I would like to call next on Dr. Everett Lee, who is really a social scientist. One of the things that the IBP has done has brought scientists including ecologists and people of many disciplines together in attacking some of the problems of our society.

I would like to call on Dr. Lee to talk about a program that is still developing after a number of false starts. Under Dr. Lee's direction it is getting on the road.

Dr. Lee?

Dr. LEE. Thank you, Mr. Chairman.

In the IBP component of the biosocial adaptations of my grant and urban populations, we complement Dr. Neel's program by focusing attention upon modern peoples and explicitly recognizing the intimate intertwining of social and biological factors in the redistribution of population in the development of man.

We could say for example that death is a biological fact but the length of life is very highly dependent upon the social situation, education, et cetera.

Man makes his environment. The entrance of man into an area changes it sometimes beyond any chance of return to its original state, but man's leaving a particular environment also makes for changes in that environment, which may give us some reason for cheer.

While it is true in this country that the expanding suburbs erode thousands upon thousands of acres of what was once pleasant countryside, it is also true that more and more of the interior is returning to woods or else has a thinner and thinner population year after year.

I think it is not improper to say that for a good part of the United States—if we had an ecological program which could predict what might happen—we might have a second chance.

This is not an unusual situation. What we are seeing in this country with the vast expansion of the cities and the lessening need for people in agriculture makes for a situation in which we could begin to plan for a redevelopment of a good part of the country.

It is true, however, that although we are a Nation of migrants, as President Kennedy once put it, migration is a process which we have never really studied. Probably the best statement we have, for example, of the vast movement of the Okies out of the dust bowl into California was the work of a novelist, John Steinbeck.

The social and biological scientists weren't there at that moment to take a look at this movement. We don't know what happened to these Okies once they got into California or what the success of their children has been since then.

Here and in other countries, a rapid transition of poorly prepared people from rural to urban life is taking place; often, from a peasant existence which has changed little over the course of the centuries to residence in huge megalopolises. In the United States much of the movement is to the ghetto; in Latin America and India to squalid shack towns which grow up around the cities.

We have major flows of people from rural Mississippi, for example, to Chicago, from the Pamas into Buenos Aires, from Indian villages in the Andes to the coastal cities, and from Eskimo villages into Anchorage or for that matter into Seattle or Chicago.

The transition is abrupt. It causes difficulties for the people involved, it causes difficulties for the areas which they leave, and it causes difficulties in the areas into which they move.

We know very little about the process of migration, of the factors which enter into a decision to move, or of the factors which speed up or impede assimilation in the area of destination, and we know little about the complex effects upon the general environment, natural and man-made, at both origin and destination.

Studies are now being made all over the world but these are not coordinated with each other. Few people outside a country know about the studies within that country. We have attempted to gather together and initiate a series of studies in diverse places. I can illustrate this by some of those which we now have listed for our component of the IBP.

The selection and assimilation of migrants from rural Mississippi to Chicago, the dietary practices of migrants from the rural south to

the cities of the North-Central States, the health and intelligence of migrants from rural Scotland into Scottish cities, the physique, health, intelligence, and success of migrants from farms to cities, or from places of one size to another in Sweden, the effect of industrialization upon the mental and physical health of peasants in Yugoslavia, the effects upon rural villages in Latin America and in the barrios of the large cities, of the heavy movement out of countryside and into the cities in Latin America, the assimilation of Jews from northern Africa and Asia into Israeli cities, and the effect of life in the Kibbutz upon their children.

There are also a number of studies in Africa, for example, of males who move into the cities but leave their families in their villages, as is also done in India.

We feel it is possible to bring together a large number of studies which could be much improved through the coordination of the scientists from a number of foreign countries and with the help of scientists from the United States.

We have had few sophisticated investigations of an enormously important phenomenon in modern life, one which will become more and more important as other countries follow along the route which has been taken by the United States and other western countries in industrialization and in the concentration of population in relatively small areas, while other parts of their countries become available for different uses.

Thank you.

The CHAIRMAN. Dr. Neel, you mentioned the fleeting moment when civilized man first comes into contact with primitive peoples as against a study of the brief period of time before that primitive culture is altered by its contact with a more highly developed culture.

In the case of Australia, I read a number of books about the aborigines and some of them were written within the last 20 or 30 years. Do you think that was far enough back in point of time to catch the original primitive culture of the aborigines in Australia? Do you think the books written in the past generation were written after their culture was so changed that the authors did not really catch the primitive spirit of the aborigines? What is your judgment?

Dr. NEEL. The early works on the aborigines caught certain aspects very well, some of their cultural practices. But in many of the medical problems, for instance, that we are concerned with, the time simply was not right for comprehensive studies.

As I emphasized, it is only within the last 10 or 20 years that we have had the technical armamentarium to ask a great many questions unheard of 100 years ago. Unfortunately, with respect to the Australian aborigine, his habitat is now so disturbed, that except for one or two small bands, it is probably too late to try to do the kind of studies on them that we could still do on the South American Indian.

The CHAIRMAN. Are those small bands the ones in the forests of Northern Australia rather than the desert?

Dr. NEEL. There are a few in the northern areas, but actually the least touched groups are in the deserts primarily because nobody wants the deserts. They leave them to the aborigine.

Senator EAGLETON. We are pleased to have with us this morning at this time the ranking minority member of the Labor and Public Welfare Committee, Senator Javits from New York.

Senator JAVITS?

Senator JAVITS. Thank you, Mr. Chairman.

Dr. BLAIR, I had one question to ask of you. I am a trustee of the Salk Institute for Biological Studies which is supposed to be a very eminent and distinguished organization. I am going out there this coming weekend for my annual visit.

Could you instruct me as to what I could do in the following areas: First, to take a reading on your program so that I would be more informed with respect to its implications and so on, and second, if there is any help or assistance that this great institution can render in what you are proposing to us?

Dr. BLAIR. We certainly appreciate the question, Senator. My colleague, Dr. Neel, says he would like to answer it.

Dr. NEEL. Senator Javits, by coincidence, I have been invited to give the second annual Lasker lecture at your Salk Institute in May and will be discussing the program with them out there rather extensively.

As you know, this has been one of the great strongholds of what we call reductionist biology, as illustrated by the recent triumphs with DNA. The title of my lecture will be "Some Lessons From Primitive People." I believe they have invited me because they are beginning to turn their attention there to these very complex problems that we can't approach through the test tube but must approach through other techniques.

There is no very specific answer that can be given other than to say that the institute is obviously beginning to orient itself towards the kinds of problems that we are discussing this morning.

Senator JAVITS. In other words, in answer to my two questions, you say for practical purposes they have not been in the field with which the international biological program is going to concern itself, but they are now turning in that direction.

What would you recommend I do as a trustee to help the IBP program in terms of their contribution to it?

Dr. NEEL. I think the standard answer is to give a sympathetic ear to them as they begin to come forward with a new line of thinking. As you are well aware, this is a period of reappraisal in the scientific community. The Salk Institute is sharing in that reappraisal and what the scientists appreciate is a good sounding board as they try to work their way toward another kind of study.

Senator JAVITS. It is a very eminent institution which could make a great contribution, I gather?

Dr. NEEL. It is indeed.

Senator JAVITS. What is the trade term for the biology that you are speaking of now as contrasted with reduction biology?

Dr. NEEL. I am going to use the term systems analysis as opposed to systems approach.

Dr. Van Dyne?

Dr. VAN DYNE. I don't know if it is appropriate. A reductionist is a man who studies small things. He learns more and more about less

and less until he knows everything about nothing. The ecologists have been accused of being expansionists. They study large things. They learn less and less about more and more until they know nothing about everything. [Laughter.]

Senator JAVITS. Thank you, gentlemen. I won't protract this any longer. But I think I get the point.

Dr. BLAIR. On behalf of the panel, I certainly appreciate your interest in the IBP and your effort to convey your interest to the Salk foundation.

Senator JAVITS. That would be valuable to the total program?

Dr. BLAIR. Yes, sir.

Senator EAGLETON. Thank you, Senator.

Dr. LEE, with regard to these various migratory studies that you have mentioned, about people from Mississippi migrating to Chicago, or from the rural areas of Sweden into the cities of Sweden and so on, what does the IBP do in terms of disseminating these studies? Who reads them? Who receives them? What is done with them?

Dr. LEE. So far, they are read by very small groups of people and often only in the country in which the studies have been made. Actually the best studies have been made in Sweden but they appear only in Swedish and have been read by few people outside that country.

There is a great need for an overall coordinating agency which would attempt to discover what is going on in various countries, to sponsor some things which might not otherwise be done and to pull the findings together.

Senator EAGLETON. Is that the role that IBP is to serve?

Dr. LEE. To serve as a coordinating agency and spur research. I would say so.

Dr. Blair?

Dr. BLAIR. This is one of the three kinds of international cooperation in the IBP as identified earlier.

It is really mainly an effort in the direction of standardizing procedures, better flow of information and coordination of research, with the hope that this coordinated research will be, as we have said many times, greater than the sum of its parts.

In a way, this kind of approach contrasts with the one that Dr. Neel described, where Brazilian, Venezuelan, and United States scientists are all getting their hands dirty at the same time working on the same problem at the same place. These are two different kinds of international cooperation. They both have value.

Senator EAGLETON. Senator Yarborough?

The CHAIRMAN. I am on the Appropriations Committee that appropriates money for the Library of Congress. We have appropriated money—never enough, I am trying to get the money that was asked for—but we appropriate certain moneys for a considerable body of work in translating foreign scientific and technical papers into English for the Library of Congress.

Has any effort been made to get these papers in Swedish on the migration from rural areas to cities? Has any request been made from the Library of Congress for translation of those?

Dr. LEE. Yes, and the Library of Congress here is always sympathetic but never has enough funds for what it would like to do. The

Library of Congress has done some of this with its foreign populations program in the past. I am sure it would do much more in this regard if it had the money.

The CHAIRMAN. I know the presentation that was made was that they never received enough money.

Senator JAVITS. Mr. Chairman?

Senator EAGLETON. Senator Javits.

Senator JAVITS. I think it would help us to get this resolution passed, assuming that this is all checked out, if you have implemented the chart that you have submitted on participation, major, marginal and nominal with some specifics, there is nothing that would interest us in the Congress more than the fact that other people are doing as much or more than we are.

Therefore, I ask unanimous consent that this may be included in the record, if you could give us a specific idea of what other people are spending, what other people are doing in the way of countries, to implement the chart. It think it would be very helpful to us in getting action.

Senator EAGLETON. If we could have that information, Doctor, it will be made part of the record.

Dr. BLAIR. We will provide it for the record.

(The information subsequently furnished follows:)

NATIONAL RESEARCH COUNCIL,
Washington, D.C., March 13, 1970.

Senator THOMAS F. EAGLETON,
New Senate Office Building,
Washington, D.C.

DEAR SENATOR EAGLETON: During the hearing on S.J. Resolution 89, which you chaired, Senator Javits requested that I furnish, for the record, the research contributed by the member countries of the International Biological Program (IBP).

The Central Office of the IBP, in London, is compiling the information on the contributions of the various countries. They hope to provide the information to me during the week of 15 March. In the interim I am providing the information available to me. Research support provided by some countries can be compiled from reports of the National Committees.

Computing a comparable figure for national support of IBP projects is difficult for several reasons. The interpretation of what constitutes the IBP varies somewhat from one country to another. Some countries have included on-going research; some have included only IBP initiated research; others have included a mix of both. The total amount of support is difficult to obtain because of the varied sources of support. A few National Committees have received funds directly from their governments for support of IBP research. In other countries, IBP projects are funded by an organization similar to the National Science Foundation. Most national programs include projects which are supported by university or private funds and projects performed by government laboratories. Obtaining amounts of support for these projects is particularly difficult.

The sums shown in the attached table are not always comparable as explained in the comments. The amounts are funds available or granted for research during a twelve-month period and do not include dues paid for support of the Central Office of the IBP. NSF has furnished the dues of the member countries by separate communication.

Sincerely,

W. FRANK BLAIR,
Chairman, U.S. National Committee,
International Biological Program.

NATIONAL SUPPORT FOR IBP RESEARCH

Country and year available	Amount	Comment
Argentina: 1969-----	\$33,000	From personal communication amount granted by the Argentine Government.
Canada:		
1969-----	1,120,000	{ Amount available to be granted by Canadian National Research Council. During 1970 additional support of \$1,120,000 available from other sources to support IBP projects, some of which were ongoing.
1970-----	1,260,000	
Finland: 1968-----	36,000	Amount granted by Finnish Government. Additional projects performed by government laboratories.
Japan:		
1967-----	204,750	{ Granted by Japanese Ministry of Education. During 1968 an additional \$92,000 granted for special IBP research and travel.
1968-----	194,450	
Norway: 1968-----	265,000	Amount granted by Norwegian Government.
Sweden: 1968-----	388,000	Approximate amount. Support from many sources.
United States:		
1969-----	4,300,000	{ Anticipated to be available for new research. Granted for new research by several Federal agencies. Additional \$200,000 available during 1969 and during 1970 for support of the U.S. National Committee for the IBP and for dues to support the central office of the IBP.
1970-----	1,800,000	

NATIONAL RESEARCH COUNCIL,
Washington, D.C., April 1, 1970.

Senator THOMAS F. EAGLETON,
New Senate Office Building,
Washington, D.C.

DEAR SENATOR EAGLETON: On 9 February, during Hearings on S.J. Res. 89 held by the Senate Subcommittee on Health, Senator Javits asked that we submit for the record a comparison of the efforts of all nations participating in the International Biological Program.

We, in turn, immediately asked the International IBP Central Office in London for this information, and we have just received a response. The response is so qualified that we have supplemented it with other information contained in international reports from the Central Office.

The information for the record that Senator Javits requested is enclosed. I regret that so much time was required in responding to the request. I felt that it was essential to obtain the most reliable information that we could possibly obtain from the IBP Central Office in London.

I sincerely hope that this information will be useful to you and to the Subcommittee, and that S.J. Res. 89 will be successfully voted on in the Senate.

If I can provide further information on the IBP that would be useful to you, please let me know.

Sincerely,

W. FRANK BLAIR,
Chairman, U.S. National Committee,
International Biological Program.

INFORMATION FOR THE RECORD SUBMITTED BY W. FRANK BLAIR ON S.J. RES. 89

Question. Senator Javits—I think it would help us to get this resolution passed, assuming that this is all checked out, if you have implemented the chart that you have submitted on participation [of other nations], major, marginal and nominal, with some specifics. There is nothing that would interest us in the Congress more than the fact that other people are doing as much or more than we are.

Therefore, I ask unanimous consent that this may be included in the record. If you could give us a specific idea of what other people are spending, what people in other countries are doing, I think it would be very helpful to us in getting action.

Answer. The world map shown in Figure 1 of my statement of 9 February represents broadly my personal interpretation of the degree of participation of participating nations in the International Biological Program.

My judgments in connection with this map are based on knowledge gained from (1) participation as a Vice-President of the IOSU Special Committee for the IBP (SCIBP), (2) participation in meetings of the Bureau of SCIBP.—The Bureau is the policy making body of SCIBP, (3) participation in the III General Assembly for the IBP in Varna, Bulgaria in March 1968, (4) visits to other

nations, particularly those in South America, in connection with the IBP, and (5) discussions with some International Convenors and Chairman of other National Committees during my visits to other countries.

No precise information is available from any source as to specific funding by all participating nations for research programs and projects, nor is specific information available as to research efforts in terms of man-years devoted to IBP.

Some information on this question has been supplied by the International Central Office in London. This was received in Washington on 31 March 1970. The significant portions of this response (from Dr. E. B. Worthington, Scientific Director of the IBP Central Office) are quoted as follows:

"No-one, it seems, has attempted an analysis of the estimates and accounts of the government departments, research councils, universities, foundations, etc. which finance bits and pieces of IBP—nor would this be a rewarding exercise.

"Apart from finance, we have approached the comparison of the national efforts in IBP in two ways, one in terms of the number of projects which are included in the Index (and not all of which are viable), the other in terms of the number of man-years as estimated from the Index, bearing in mind that this information is not given for many of the projects. Two tables attached show the result of this analysis comparing the United States with the rest of the whole programme, and it is interesting to note that, on the basis of projects, the USA total comes out as 12% of the whole, and on the basis of man-years, about 10%. If figures for finance were available I imagine that the USA proportion would be considerably higher. We are sure, however, that any such figures should be used with extreme discretion, for I do not think that they would show much significance if subjected to statistical tests.

"Another manner of approaching this is to divide the 40 or so countries which make a really significant contribution into groups—first, second and third class, so to speak. If this is done on the basis of man-years shown in the Index, the first class numbers four: Japan, USSR, USA and UK. But any division of the rest into second and third classes would be not only invidious but also misleading.

"To get a proper comparison, it is clear that much more detailed and more accurate information is needed, and I think this could be collected only on the sectional, or theme, level. Some sections are undertaking a general review at present."

Dr. Worthington's tables are:

TABLE I

	Projects listed in index of national projects	Total, United States	Percent, United States
Productivity, terrestrial.....	341	36	10
Production, processes.....	487	23	5
Conservation, terrestrial.....	268	37	14
Productivity, fresh water.....	217	42	19
Productivity, marine.....	251	52	21
Human adaptability.....	297	31	10
Use and management.....	176	24	13
Total.....	2,037	245	12

TABLE II

	Man-years, derived from index of national projects	Total, United States	Percent, United States
Productivity, terrestrial.....	9,954	623	6
Production, processes.....	7,584	245	3
Conservation, terrestrial.....	4,639	258	6
Productivity, fresh water.....	4,862	430	9
Productivity, marine.....	5,543	717	13
Human adaptability.....	6,645	581	9
Use and management.....	3,916	1,392	36
Total.....	43,143	4,246	10

In analyzing the above information, some irreconcilable facts seem apparent. For example, Dr. Worthington shows Japan as one of the four leading nations participating in IBP—and indeed from my knowledge of Japan's participation in IBP—and indeed from my knowledge of Japan's participation in IBP, I would agree. Japan, in 1969, reported that 1,198 research investigators were working on 88 IBP projects during the prior year. Yet funds granted in 1968 for IBP in Japan—as summarized in a report of the Japanese National Committee—total only \$205,000. It seems apparent that the bulk of support for the number of researchers reported must have been provided from other sources—and I would guess that Japan, in its fiscal planning, is faced with some of the same problems that S.J. Res. 89 attempts to deal with in the fact.—This analysis, I believe, also illustrates Dr. Worthington's meaning when he says, "I do not think that [such figures] would show much significance if subjected to statistical tests."

Similar and even more incomplete analyses seem apparent with respect to the U.K. and the USSR.

Attached as an Appendix is a summary of nations participating in IBP, showing the number of IBP projects as reported by each nation, and the number of IBP research investigators as stated in reports from the IBP Central Office. The reports from which the tabular information is summarized are furnished separately to the office of the Senate Committee on Labor and Public Welfare.

In summary, in answer to the question, the following seems apparent to me:

Other nations are participating in the IBP—some on a scale of effort exceeding that of the U.S.

Precisely comparable figures on the degree of participation of individual nations are not available.

APPENDIX

Nation	Number of IBP projects	Number of IBP researchers	Nation	Number of IBP projects	Number of IBP researchers
Argentina.....	22	10	Israel.....	45	32
Australia.....	164	150	Italy.....	29	41
Austria.....	11	33	Japan.....	88	1,198
Belgium.....	19	7	Korea, Republic of.....	14	20
Brazil.....	76	115	Malawi.....	2	22
Bulgaria.....	25	9	Malaysia.....	5	7
Canada.....	38	486	Mexico.....	(1)	(1)
Ceylon.....	3	(1)	Netherlands.....	45	86
Chile.....	8	21	New Zealand.....	108	121
Republic of China.....	3	1	Nigeria.....	15	39
Colombia.....	1	(1)	Norway.....	31	37
Congo (Dem. Rep. of).....			Panama.....		
Czechoslovakia.....	75	144	Peru.....	10	(1)
Denmark.....	24	111	Philippines.....	128	127
East Africa.....	3	(1)	Poland.....	10	11
Kenya.....		(1)	Rhodesia.....	33	6
Tanzania.....	1	1	Romania.....	51	262
Uganda.....	1	(1)	South Africa.....	51	33
Ecuador.....	3	5	Spain.....	33	105
Finland.....	21	88	Sweden.....	2	(1)
France.....	50	179	Thailand.....		(1)
Germany, Democratic Republic of (DDR).....	62	19	Tunisia.....	12	2
Germany, Federal Republic of (BRD).....	70	44	United Arab Republic.....	167	342
Ghana.....	11	6	United Kingdom.....	245	935
Greece.....	10	41	United States.....	209	793
Hungary.....	34	166	U.S.S.R.....		(1)
India.....	72	124	Uruguay.....	8	17
Indonesia.....	18	21	Venezuela.....	2	(1)
Ireland, Republic of.....	10	25	Vietnam, Republic of.....	39	134
			Yugoslavia.....		

1 None stated.

Senator EAGLETON. Dr. Lee, as to the thrusts of these migratory studies, I will call them, are they more to study the effect of such migration or do some of them zero in on policies that would deter migration? Is it commendable or proper that we try to deter migration from rural areas of the world into giant urban centers?

Dr. LEE. It might be. I think this is a policy decision. We have to know a great deal about it before we can do it properly. For example, we have many counties in the United States in which migration has taken place in such fashion that as many as 70 percent of the high school graduates leave the county about the time of graduation, or when they drop out of school. This leaves a population which sometimes has more people aged 70-80 than aged 20 to 30.

A good many of the young adult people who are there still are people who may have been trapped by early marriage and excess fertility. Therefore, so you have many children at the bottom of the age pyramid, and many old people at the top.

It is sometimes proposed that industrialization would stop migration from such an area. This may be true, but you must realize that if you decide to bring industry into such an area, you have to bring migrants into the area who are of the right age to take industrial jobs and who have the appropriate education.

The fact is that heavy out migration radically changes the composition of population. Major efforts are necessary to change the direction of such a movement.

Senator EAGLETON. What are other major efforts in a general way that you would consider other than industrialization of now non-industrial areas in order to stabilize, if that is the population—its flow, if not the actual numbers?

Dr. LEE. I don't mean to dodge your question. What I do want to say is that we do not know enough about the effects of the kind of movement which is now going on to say for certain that such a flow should be halted.

It is probably true that the flow which takes place is in the direction of increasing economic return for the people who leave. What little we do know indicates that the people who do leave are better off than those who stay. We should never forget that many people who go leave not for themselves, but in hope of education and other benefits for their children.

I would simply like to say again that the very fact that we have so much land which is emptier than it formerly was gives us a chance to consider over some period of time what might better be done with this area. Whether it means that more people should return to it is another question. Whether we should have new cities or whether we should put emphasis on so-called growth centers is still another question.

I personally think that new cities are called for but, I do not think that we have had sufficient research to be certain of that.

Senator EAGLETON. You said you personally think this is a very useful thing to do?

Dr. LEE. To emphasize new cities or growth centers, yes. For example, our country is now crisscrossed by major highways which create easy access into areas which formerly were quite difficult to get to. I think there is little doubt that new cities will spring up at the intersections of these roads or that places already there will expand.

At the moment, I see no real possibility for a reruralization of the American population. That is simply a personal point of view based on very little knowledge.

The CHAIRMAN. Concerning the periods which you are talking about, with the reforestation by forces of nature rather than man, the area in which I grew up was a farm area, not susceptible to irrigation or large scale mechanical operations.

The forests have come back and the wildcats and wolves are there and there were none when I was a boy. They were not restocked. They just came back from forested areas farther away. There was no restocking even of deer. But they are there now. They made their way back from far eastern Texas or Louisiana.

Dr. LEE. This has been repeated over and over all along the east coast. You might say the glory of New England, its beautiful leaves in the fall, occurs because the original forests were cut and the land is now covered by a different kind of second-growth trees.

The CHAIRMAN. I would like to request permission to print in the record at the conclusion of this first presentation a copy of Senate Joint Resolution 156 with the statement attached establishing an inter-agency commission to make necessary plans for the United Nations Conference on the Human Environment scheduled for 1972 and for other international conferences and meetings related to the human environment introduced by me last October.

The statement points out that we are doing very little to make a really meaningful contribution to that conference to be held in Sweden in 1972.

I want to thank you Senator Eagleton, for chairing this meeting and I want to express our appreciation to the panelists. I regret that I will not have an opportunity to hear the rest of you or the next panel but I have been called three times to go to another committee where I have some duties also.

(Senate Joint Resolution 156 and statement referred to follows:)

91ST CONGRESS
1ST SESSION

S. J. RES. 156

IN THE SENATE OF THE UNITED STATES

OCTOBER 6, 1969

Mr. YARBOROUGH introduced the following joint resolution; which was read twice and referred to the Committee on Foreign Relations

JOINT RESOLUTION

To establish an interagency commission to make necessary plans for the United Nations Conference on the Human Environment scheduled for 1972 and for other international conferences and meetings relating to the human environment.

1 *Resolved by the Senate and House of Representatives*

2 *of the United States of America in Congress assembled,*

3 That (a) there is established a commission to be known

4 as the Interagency Commission on the Human Environ-

5 ment.

6 (b) It shall be the purpose of the Commission to make

7 necessary plans for United States participation in (1) the

8 United Nations Conference on the Human Environment

II

1 scheduled for 1972, and (2) other international conferences
2 and meetings relating to the human environment.

3 SEC. 2. (a) The Commission shall be composed of an
4 appropriate number of members appointed by the President
5 from the Department of State and other appropriate Fed-
6 eral departments and agencies. The President shall desig-
7 nate one member as Chairman and one member as Co-
8 chairman.

9 (b) Members of the Commission shall be reimbursed
10 for travel, subsistence, and other necessary expenses in-
11 curred by them in the performance of their duties.

12 SEC. 3. The Commission shall appoint and fix the com-
13 pensation of such personnel as may be necessary to carry
14 out the provisions of this joint resolution. Such appointments
15 shall be without regard to the provisions of title 5, United
16 States Code, governing appointments in the competitive
17 service, and such compensation shall be fixed without regard
18 to the provisions of chapter 51 and subchapter III of chapter
19 53 of such title relating to classification and General Schedule
20 pay rates. The Commission may obtain the services of experts
21 and consultants in accordance with section 3109 of title 5,
22 United States Code.

23 SEC. 4. The Commission is authorized to request directly
24 from any Federal department or agency any information it
25 deems necessary to carry out the provisions of this joint reso-

1 lution, and to utilize the services and facilities of such depart-
2 ment or agency; and each Federal department or agency is
3 authorized to furnish such information, services, and facilities
4 to the Commission upon request of the chairman to the extent
5 permitted by law and within the limits of available funds.

6 SEC. 5. The Commission is authorized to enter into
7 contracts with Federal or State agencies, private firms, insti-
8 tutions, and individuals for the conduct of research or sur-
9 veys, the preparation of reports, and other activities neces-
10 sary to the discharge of its duties.

11 SEC. 6. There are authorized to be appropriated such
12 amounts, not in excess of \$500,000 for any fiscal year, as are
13 necessary to carry out the provisions of this joint resolution.

OCTOBER 6, 1965.

YARBOROUGH CALLS FOR U.S. TO LEAD WORLD-WIDE FIGHT AGAINST POLLUTION

Senator Ralph W. Yarborough, D-Texas, said today the United States "should lead the way in international programs to manage the environment for the good of all mankind."

"This is one area where we need not be reticent for fear of accusations of imperialism," Senator Yarborough said. "Our economic resources and know-how compel us to take the lead in the world wide quest for an optimum relationship between population and environmental resources."

Senator Yarborough's remarks came as he introduced a Senate Resolution calling for the creation of a commission to make the necessary plans for the United States' participation in the 1972 United Nations Conference on Human Environment and other international conferences and meetings relating to the environment.

The commission, as proposed by Senator Yarborough, would be composed of delegates appointed by the President from the department of State and other appropriate federal departments and agencies.

Senator Yarborough said this commission "would be given the authority to enter into contract work with federal or state agencies, private firms and institutions, for the conduct of research or surveys, the preparation of reports and other activities necessary to the proper planning for these conferences. This legislation would additionally authorize sufficient monies to carry out the extensive planning work."

Senator Yarborough told the Senate that planning for the 1972 United Nations Conference on the Human Environment thus far "is a shoestring operation which will not equip our delegation for a leadership position. Despite endorsement by State Department spokesmen, no well staffed office has been established. The various agencies which would logically be involved are represented on a committee but there is no evidence of a program or the means to see it through. My office has been advised that at present only one staff man from the State Department and only one staff man from the President's office of Science Technology are working on this country's preparations for the conference and their efforts are part time."

Senator Yarborough said present efforts to prepare for this conference "fall tragically short" of the need. He said his proposed resolution "will enable the Administration to undertake such a crash effort."

Citing many articles which outline the threats to mankind from pollution, Senator Yarborough said "the United Nations is the only effective means the nations of the Earth have of coping with the environmental crisis in an organized manner."

"For far too long, we have been indifferent to the disruption of our environment by pollution. It is time now to man an all-out assault," Senator Yarborough said.

Senator EAGLETON. Thank you, Senator. The Senate Joint Resolution 156 and Senator Yarborough's statement in connection therewith will be printed in full in the record at the point indicated.

Dr. BLAIR. Next is William Benninghoff, University of Michigan, to talk about a somewhat different integrated program of the U.S. participation in the IBP.

Dr. BENNINGHOFF. I wish to speak to the matter of the aerobiology program. The integrated research program on aerobiology embraces atmospheric dispersal studies of particles such as plant disease spores, pollen grains, fragments of algae and molds, and minute insects such as aphids.

The subject matter scope in this program has been extended to include air pollution effects on plant growth and on viability of airborne spores, because these effects which are so important to primary production by green plants were not being treated elsewhere in the IBP structure. For similar reasons a portion of the program includes also study of plant losses due to disease.

The general objective of the aerobiology program in the IBP nationally and internationally is information exchange and collation making use simultaneously of all the disciplines and facilities that exist in order to reach understanding and management solutions in the most efficient manner.

Some animal and plant diseases are carried by minute insects borne on winds, just as are the showers of pollen and fungus spores that cause allergic reactions for many unfortunate humans. There are observations being made of many of these phenomena. Some are casual and not very reliable. Others are at regular and frequent intervals and are detailed and reliable. These observations are being made by Federal, State and municipal agencies, academic institutions, and private research or engineering companies.

It has just occurred to me that today is the 100th anniversary of the U.S. Weather Bureau. We have had 100 years of service from that very important organization.

Except for groups at one Government level, such as the agricultural experiment stations, information exchange is unorganized. Standards for observations and records have been established in only a few instances. There are no centers for information storage and ready availability in this area.

Both nationally and internationally, we have not organized our resources efficiently for improving our knowledge of airborne materials of biological significance so we continue to fight many of the same battles against crop diseases, hay fever, and insect plagues, for example, over and over again.

If we were to make our observations by suitable standards and marshal the records in appropriate form, we would much sooner be able to find the patterns of occurrences, the coincidences of cause and effect, and thereby the keys to improved control of these biological systems.

The aerobiology program is endeavoring to help biologists, meteorologists, atmospheric chemists, and others concerned in the task of organizing their efforts along these lines. The complexities of many of our ecological problems today demands interdisciplinary team efforts and the interdependence of ecological systems on the earth forces us to consider areas and organisms in countries other than our own. For example, cereal rust spores can be blown from Australia 1,300 miles across the Tasmanian Sea to New Zealand grain fields. Biologists must cooperate internationally, and the IBP provides new and better opportunities.

There will be no international effort in the field of aerobiology in the foreseeable future unless the United States takes the lead and provides at least the initial driving forces by convening conferences and offering media for information exchange.

It is already late to be organizing global networks of stations for monitoring changes in the environment, for example, changes in the lead compounds, ozone, and organic particles in the atmosphere. Now that this is getting underway various aspects of aerobiology should be examined for their suitability for monitoring by such networks.

With relatively modest amounts of new money put into the IBP for organizing efforts along lines of the integrated research projects,

aerobiology for example, a rich return can be realized in the form of greater efficiencies in the search for understanding and solutions to problems.

The IBP is a program in being that can lead us to the kind of biological investigations essential for adequate stewardship of the earth's living things and their surroundings.

Mr. Chairman, I believe Dr. Blair would wish me to speak to the tundra biome subprogram at this point.

Because I am the biologist on the National Academy of Sciences' Committee on Polar Research, I was asked to speak for the tundra biome subprogram of the ecosystems analysis program. This subprogram is designed to improve our knowledge and management control of ecological systems in cold regions, sometimes referred to as the tundra-taiga biome subprogram, it embraces the conifer forest biome, that is the taiga, of the far north and the subalpine and alpine zones of mountains in temperate latitudes as well as the treeless tundra region around the Arctic Ocean.

These areas until recently were considered too remote, too poor in biological resources, and too inhospitable to be worth more than academic study and mineral exploitation on a marginal basis. Within the past three decades these areas have been made accessible. They are being settled by year-around residents with full complements of urban comforts and facilities, leading to successfully worsening tangles of problems—settling foundations, collapsed roads, broken sewers, contaminated water, et cetera.

The ecosystems in cold regions are weak and fragile and slow to recover from disturbance. They are in delicate balances with snow, water, ice, and frozen ground. They cannot be healed in several years by applications of top soil, fertilizers, and grass seed.

Although the Tundra-Taiga ecosystems are near the bottom of the list of productive systems as far as economic yield is concerned, they are critical to persistence of the plant and animal species they include and they are essential for stabilization of the landscapes against excessive thaw, of frozen ground and against intensively disruptive frost action in surface layers.

It will be necessary to make use of vegetation cover for its thermal insulation at some places and for its ability to hold snow drifts elsewhere. The biology of potable water supplies and of sewerage treatment need to be worked out for these cold environments. Our knowledge and experience is far from adequate for planning new settlements in the North.

Since World War II many of us have been urging increased study of ecosystem dynamics and of landscape processes in the Far North in preparation for the day when settlement and intensive use would come to that region. With the Arctic Slope oil discovery, that day has come. Industry designers and development planners are asking for guidance. We have pitifully little knowledge from which to answer.

It is even more disturbing that we are not able to move forward with the plans and scientific expertise already mobilized toward the effort of organizing our information acquisition and dissemination capabilities into a much more efficient system.

We have the nucleus of this system in the Tundra-Tiaga Biome subprogram of the IBP. It is functioning, available, and staffed by men who want to put their abilities and energies to this cause.

Industry indicates willingness to share in the cost, which will be far less than the value of the return would indicate. This one IBP subprogram is capable of catalyzing a whole new kind of partnership of Government, industry, and academic capabilities for planning and guiding regional development.

The promise inherent in this kind of IBP activity leads us to urge the most favorable response possible from the Federal Government.

Thank you.

Senator EAGLETON. Thank you, Doctor.

What is your evaluation of the consequences of building this oil pipeline across the Alaskan Slope? Are you for it, or against it? Are you for it with reservations and qualifications?

Dr. BENNINGHOFF. I really don't hold an opinion for it or against it, as I see it. The resource is there and it would be foolish to think that we would leave it undeveloped. It is going to be developed. We can only attempt to guide that development in the way that will cause the least damage to the landscape systems.

There will be a scar across Alaska from the Arctic Ocean to the central Pacific coast caused by the pipeline. If tankers are used in the Arctic Ocean, there will be from time to time accidents in which there will be problems of containing or mopping up crude oil in the Arctic Ocean. These will be monumental problems.

The best we can do is to try to prepare to meet these problems and to be ready with advice that will minimize the undesirable consequences.

Senator EAGLETON. Dr. Blair?

Dr. BLAIR. We have one final witness. Dr. George Van Dyne will speak about the Analysis of Ecosystems program and about the subprograms under this program.

Dr. Van Dyne?

Dr. VAN DYNE. I have no prepared statement and my comments will be "off the cuff."

I am George Van Dyne from Colorado State University and I am pleased to be here. I am representing really three groups. First, I am representing the largest IBP program, the integrated research program on analysis of ecosystems. There are something like, conservatively speaking, 600 scientists involved in this program. Secondly, I am representing the grasslands project within that program, in which there are about 80 scientists. Thirdly, I have some comments that represent personal opinion.

Going back, the analysis of the ecosystems program as a study is to see what really makes these systems function, how they are put together, and how does man stress them and manipulate them and what are the responses.

I think one comment that has come out in discussions this morning is that many people think ecology concerns only people who are interested only in preserving or setting aside something to look at. In your State, for example, Senator there is a grasslands acreage set aside by the university scientists that is very useful, but it is too small for many studies. I don't think that the thrust of the IBP is just to set aside things and look at them.

We are very much interested in understanding how man interacts with nature, what he does to it. The problem with the Arctic tundra is a good example. Really, to understand and answer the question "What will happen," is our first interest, not "are we for it or against it." We can't answer the second question until we understand more how these systems are coupled, how they are put together, and what are the feedbacks. Let me give you a very good example from the grasslands project of the importance of knowing this intricate interaction.

We have a lot of lark buntings in grasslands. This is a small sparrow-like bird. In fact, it is the State bird of Colorado. We have found out that this bird tends to nest, i.e., choose its nest site, near saltbush plants. A saltbush plant is very palatable plant to cattle. In fact if the cattle graze the area heavily, the saltbush plants are eliminated. When you eliminate them, you eliminate the nesting sites.

The lark buntings eat a lot of insects. In fact, they eat some 30 different species of insects and spiders. They eat about 13 per meal. They need 600 to 900 kilocalories, depending on the temperature, per kilogram of body weight to live.

We have made some preliminary calculations. Suppose man manipulates this environment in such a way as to eliminate the plants that the lark buntings use as their nesting area for protection, or for what other reason, I am not sure. It could have a significant affect on the grasshopper population which is one of the preferred diets of the lark bunting. And yet the grasshoppers compete for the same food that the cows and sheep and other animals that man puts on the land are eating.

So this is a very simple example of the intricate feedback type of operation that goes on in these grasslands.

These results and feedbacks are typical of all of the biome programs. The six biomes, of course, being grasslands, coniferous forests, and deciduous forests (the three in which man primarily lives or from which he draws his food) and the deserts, tundra (which Dr. Benninghoff mentioned), and tropical forests. They provide extremes.

If we selected only the biomes in the midcontinents and the temperate latitudes, we would have not as broad an example or a range of examples on which we could develop ecological theory and data against which we could test the theory.

One of the long-term goals of the analysis of the ecosystems program is to put together our information about how these ecosystems are structured and how they function into mathematical models. Then we can make predictions of what would happen. And we would be prepared to answer just the kind of question you asked, "Are you for or against exploitation of oil in the Arctic?"

Now, it is not a fair question. "What would happen if you did this . . .", is a fair question. That is the question we would like to answer. We would like to get the information to do so.

There is a lot of detailed scientific knowledge (in a conventional sense) that will come out of these studies. For example, we have learned there are many more new organisms in a given locality than we ever believed were there before. This is adding to science in a conventional way.

But we are also adding to science by putting together all of this information into predictive models that can be used to look into the

future. We can ask questions of models. As we would say in the jargon, "We would like to develop the models and then exercise the models".

We are using a systems analysis approach. It is a framework or structure for putting together all of these bits and pieces of information. We are trying to do this in the grasslands project, and in the analysis of the ecosystems project we have as an integral part of the study a means of tying things together so that "the whole is greater than the sum of the parts". We are trying to do more than give lip service to this concept. This has required organizing large teams of scientists.

I have mentioned there are 80 in the grasslands project. We have about 36 of these scientists working at one location. They come from eight different institutions and Federal agencies and cooperate in planning and conducting and analyzing a set of experiments. This involves studying not only how the native grasslands perform without stress, but also how the system responds to stresses of grazing, of moisture, and of nutrients. We will continue in our studies with stresses of herbicides and pesticides and other sorts of insults to the environment.

We have another three dozen scientists who are working at other places. We have studies in Texas, New Mexico, Oklahoma, Kansas, South Dakota, North Dakota, Montana, Washington, and California. In these studies we don't have as many people in one place, but the studies are designed as comparable and we can use the results as test points in the models. They are not "random" studies. It is not a free "piggyback ride" for a lot of different scientists. There is a specific design. Certain measurements must be made. In fact, we are trying to mobilize scientific experts to do studies. A scientist in Oregon is doing a bird study on several sites; a scientist in Texas and one in Kansas are working as a team doing a study on small mammals.

We have an additional five scientists who work in a service capacity to the rest of the program. They are concerned with the data processing and sample processing and analyses. Our experience thus far is that this can be a very economic way of doing this kind of research. There is a great efficiency of providing these services. There is also difficulty in getting scientists to do service to their fellow man.

Then we have three scientists in the program involved in the management, the problems of organizing meetings, writing reports, and so forth. But all told, it represents a kind of division of labor and division of effort that has not been common in scientific research in environmental biology.

This is the first major undertaking that has drawn together scientists including atmosphere scientists who "think large" down to soil microbiologists who "think small". This has been a very novel experience. I think this experience will have spinoff far beyond the value of the specific studies we are doing now.

There is a great public awareness of environmental problems. I am sure you are all aware of it. We have seen recent articles in *Time*, *Life*, and *Newsweek*; in fact this Friday evening you will see on television an NBC news documentary on "Survival on the Prairie" pointing out some of the problems that the Senator Yarborough referred to—of how man reacts to nature and the dominance of weather on the prairie systems.

This interest has also exploded on the campuses. Senator Nelson unleashed a time bomb when he promoted "environmental teach-ins." I think it has been a very useful thing. We have seen a lot of imagination and energy of the students channeled into a very beneficial effort. Their concern for environment is very strong. We all have an environmental conscience.

This is beginning to feed over into industry. Next week there will be a public affairs council meeting which represents several hundred industries and their concern with environment and the quest for quality of environment.

All I am pointing to is that within the next few years, I am sure all of this talk is going to be translated into action. We are going to start doing something about improving our environment, about looking at the problems of degradation, of pollution, and of quality in the broadest sense.

And to be able to mobilize scientists and do something about this, we have got to have a pattern or a structure. I think the IBP has provided the medium by which we are getting together a broad group of scientists to begin to work together shoulder to shoulder.

The National Science Foundation support has been instrumental in this, too. But it hasn't been easy all the way. Another thing is surprising for me. Maybe I am a little younger than some and naive. But it was surprising to me to learn how difficult it is to get these scientists to work together. It takes a long time for them to get over their individual hangups, their insecurities, and for them to expose their ignorance in related fields.

In our grasslands project, as an example, in our first 15 months, we held five 2-day workshops and we had about 50 scientists participating. They ranged, again, across people interested in the physical, plant, animals, insects, and microbe parts of the ecosystem. We took a crude model of the grassland and broke it into 32 parts and assigned these parts to people to review and present at these workshops.

At each workshop we had scientists of various disciplines. We discussed the problem. We broke it down into detailed investigations of the literature, both what is printed and what is in the data files that isn't printed, and tried to interpret this in the context of the research we were planning.

All during this period it was amazing how long it took the individual scientists to learn to come out and open up and ask questions of each other, to expose their ignorance on rather elementary matters. But over the period of these workshops, I think it is important that they did. Now we have a very cohesive working unit. There is a great deal of interchange, now it isn't embarrassing at all for a man operating in plant physiology to ask an ignorant question perhaps about how one animal catches another and eats it and what effect this has on the food web.

So I think the IBP has a broad-reaching effect also in the concept of preparing scientists who have conventionally been "lone wolves," who have worked alone, to work more together, to put together their information and their knowledge so that "the whole is greater than the sum of the parts."

I think there are some problems that we face. We have overcome

some of these. But there are problems we face in terms of the way the individual scientist views his position. Largely, our reward system in the past in this area of science has been more geared toward highly individualistic accomplishments. You are judged on the number of papers you published, and the deeper you dig into specific areas, sometimes the better.

But we are asking people now not to worry about looking at the very minute detail in the system, but looking at the gross aspects of it and how they interrelate to each other and how they better relate to man. This requires a scientist to change their "peck order" a little bit.

The second thing it requires is the institutions in which these scientists operate to structure a little bit differently. We have problems now of very real barriers between colleges and between departments within colleges. We must devise frameworks within our institutions in which we can get past these real and artificial barriers set up between disciplines.

Third, I think it requires some change on the standpoint of funding agencies in order to get them to work together more effectively and lay out plans. These plans may not be long term, not an "open grab-bag" for 20 years, but to lay out discrete programs that will last for a period of maybe 5, 6, or 8 years and to function them in a way that can be set up and operated efficiently, not by piecemeal funding from one agency to another.

It is going to require changes there and also in the structure of the way the bookkeeping is actually done. We must eliminate some of the time that is spent now in the detailed bookkeeping and put more on the individual research projects once they have been accepted.

This is the bulk of my comments. I realize I have rambled and spoken fast, but I am emotionally involved in the program and can't speak any other way.

Senator EAGLETON. Thank you, Doctor. You have spoken quite well and quite convincingly.

A couple of questions to the entire panel. Anyone can respond, or Dr. Blair, you can direct the answer.

Do you think at this point, considering the growing public interest, public awareness and public concern for ecological matters, the environment, quality of life, whatever it is called, the Government ought to consider trying to pull all of this together, whether it be the Great Plains, the tundra, or air pollution in the cities, in one cohesive identifiable department?

Dr. VAN DYNE. I don't know much of the structure of the Government. But I do know I had a chance to be interviewed and react to a group of some 30 agencies that are supposed to cover IBP. My personal opinion, and on limited information, is that the present structure does not do the task. I think there are just as strong barriers between departments in the Federal Government as there are between departments in the university system.

I think it is going to require a different structure. We are looking at a different kind of problem. We are not looking at a problem that we can package off into agriculture or we can package off into environmental pollution, as maybe the AEC has been concerned with, or into some other agency such as the Weather Bureau.

We are looking at total systems. This is the key point: that a total system, involving the plants, animals, microbes, weather and man is a different system than we have been packaging into the Federal agencies. It is certainly different than what we have packaged into the different departments of the university.

So I think it is going to require a different structure than we have had to the present. This is a personal opinion only.

Senator EAGLETON. Have any of you had a chance to study the legislation that resulted in the creation of the President's Council of Environmental Advisers? Is this a significant step in the right direction, in your judgment? Does it go far enough?

Dr. BLAIR. This again is a personal opinion. But it certainly is a step in the right direction. I think it remains to be seen. I think the legislation really, if you interpret it the way I do, means that there must be a much greater effort toward what we might call monitoring the environment in which we live than I can see possible under the present structure.

I am answering your question by saying that the Federal agencies have grown like Topsy in respect to environmental matters. There is a little piece here and a little piece there. No one has ever looked at our environment as a whole. It seems to me that some sizable Government agency must look at the environment as a whole if it is going to carry out the charge of this legislation.

Senator EAGLETON. Are there statistics available that would compare what we are spending and have spent in space exploration with what we spend on studying the ecology of our own plant?

Dr. BLAIR. There are certain figures in the Congressional Record, I believe. It is a lot about environment these days. The figure that comes to my mind is \$40 billion to the Apollo program. It would be nice to get \$500,000 in fiscal 1970 or 1969, \$4 million in fiscal 1970. I think this is perhaps the answer.

Senator EAGLETON. Of course the appropriation for IBP doesn't represent the total.

Dr. BLAIR. I was using this simply as an example of the different levels of support for different things. Personally I think our national priorities need a very serious reassessment in terms of the environment. This has never been adequately done.

Senator EAGLETON. Dr. Van Dyne?

Dr. VAN DYNE. In comparison to what you say, \$50 billion in the space effort—

Senator EAGLETON. I think Dr. Blair said \$40 billion.

Dr. VAN DYNE. I believe there was a figure a few years ago, perhaps 2 years ago, that something like \$500 million is spent in the whole area of resource management by agencies, including Agriculture and Interior, that pertain to environmental problems. We use this figure because we thought if we could just do a few percent improvement in this management, it would go a long way towards paying for IBP.

Consider in IBP, for example, one of these biome programs when it was laid out about in 1966. An estimate was made that \$2 million is what it would take to run a biome program per year. That estimate has gone up now from \$2.25 to \$2.5 million per year. But we are working with a resource system combining grasslands, deserts, and forests.

The Federal agencies alone are spending something like \$500 million yearly in just the management aspects for these biomes, and the Federal agencies don't own all the grasslands, forest, and deserts. There is a very large sum of management dollars being spent by private industry and by individual citizens.

So I think the dollar values are orders of magnitude in difference. The space effort has been very interesting and has achieved a great deal. But it has probably cost two orders of magnitude more than what is going into resource management alone, and resource management costs now are two orders of magnitude larger than IBP.

Senator EAGLETON. My final question, Doctor, is why is this resolution needed? This IBP would go on with or without this resolution, I take it. Why should we pass this?

Dr. BLAIR. I think really the main reason why we need this resolution is that the success of the IBP is dependent on support by the Federal Government of this country and is in line with our national capabilities. We have planned a program in which we can feel some national pride, and one that can set a pattern for the rest of the world. However, the Federal agencies need to feel that our program has the full support of the Congress.

We have not been able to achieve more than a fraction of what we feel has been necessary to do the job adequately, through the mechanisms we have used in the past. There are agencies with a great interest in the IBP but in my experience, there is also a feeling in the agencies that perhaps they are doing something irregular in supporting the IBP even when it parallels their mission.

I think the main impact of this resolution would be with the Federal agencies, where it would make it possible for the people who are enthusiastic about the IBP to assist the IBP financially without feeling that they are doing something that perhaps they should not be doing.

Senator EAGLETON. I said that was my final question.

Here is my final question. I gather in reading your statement that it is your belief in order to do the kind of job you think should be done, it would take \$16 million, whereas the NSF is recommending \$7 million. Is that correct?

Dr. BLAIR. That is our understanding. This would be money through the National Science Foundation. We obviously have gotten some support from other agencies. But it has been only a half million dollars this year. So we are still far short of being able to do what we really think should be done. These figures are not casually arrived at. Much sweat, blood and pain has gone into the estimates on which they are based.

Senator EAGLETON. My thanks to you, Dr. Blair and to the other eminent gentlemen of your panel. We appreciate your interest and your testimony.

The Chair is pleased to recognize before calling on our next panel, the Senator from Maine who has a deep interest in our environment and those things affecting our environment both within this country and internationally as well.

Senator Muskie.

STATEMENT OF HON. EDMUND S. MUSKIE, A U.S. SENATOR FROM
THE STATE OF MAINE

Senator MUSKIE. Thank you very much, Mr. Chairman.

I suppose in the record of this hearing in the past, if my comments were submitted rather than read, I might well follow the example of the distinguished chairman on the very distinguished program yesterday in the course of which he was seen but not heard.

Senator EAGLETON. I received many compliments for not being heard.

Senator MUSKIE. Mr. Chairman, I appreciate the opportunity to appear before this subcommittee today in support of Senate Joint Resolution 89 or as it will ultimately pass the Congress, House Joint Resolution 589.

I do so because of my interest to which the chairman has referred, in protecting and enhancing the quality of our environment. I don't suppose anybody is against that objective at this point. It has been well sold.

But nevertheless we have to come to grips with the very specific task of doing the things that need to be done to achieve that objective. So I am grateful to you, Mr. Chairman, for the interest and concern which you have shown in this program.

We have learned, I think, that we must take worldwide action to avoid disaster. As an atomic mass becomes critical, our biological communities are also reaching critical stages in development. If we continue to toy with the delicate balance of nature, we will not survive.

Environmental pollution is simply incompatible with human health and welfare, so we must begin to make changes in our life styles. But before we know what kind of changes we should make, we must know where we are in relation to our environment. Before we plan changes, we should be able to predict consequences of carrying out our plans.

The U.S. participation in the international biological program constitutes, I think, one of our first efforts, perhaps the first, to acquire the knowledge to support environmental planning and management, which must take place not only in a single country, but all around this planet.

It is not a cure. It will not provide finished answers to our environmental problems. But it is a start toward understanding the relationship between man and his environment and it is a good start. The U.S. program has been reviewed in some detail by the Subcommittee on Health.

I understand that it is totally oriented toward research, supporting systems, analysis, and model and that the two primary components that make up the U.S. efforts include basic and applied research, one on environmental management, and the other on man's adaptability to his environment.

This is an ecological program in the broadest and most cooperative sense. It includes engineers, social scientists, physical scientists, meteorologists as well as life and biological scientists and ecologists. They must share data and plan jointly.

The program includes studies of the biosocial adaptations of migrant and urban peoples, human genetic changes and adaptations, human adaptations to the Arctic climate and high altitudes, and studies of the modeling of the total ecological systems. This new knowledge will

make it possible for us to plan the investments that must be made to enhance the quality of the environment.

One scientist participating in the U.S. program neatly described the purpose when he said, "Our problem is simple and pressing. We will surely be required to advise and our advice will be included in the plan. Will our advice be based on sound knowledge, or will it be hit or miss?"

I hope that the Senate will support Senate Joint Resolution 89. The United States National Committee for the IBP and the Interagency Coordinating Committee should semiannually advise the Senate Committee on Labor and Public Welfare of the status, progress, and problems of this program.

The focus of our environmental protection effort must be manned, manned today, manned tomorrow, and manned in relation to all the other forms of life which share our biosphere. If we see man as a part of his entire environment, and broaden our concern to reflect that focus, we can set our goals for the benefit of all man. This, Mr. Chairman, is the value of the international biological program.

I think it is highly important to emphasize our concern around this planet. We have thought of it and of all subjects that we can think of as fragmented in terms of the essence, this is the last one we should consider in those terms.

We share these vital resources of this planet, whatever our natural origin, race, color. We share them all alike. If there is anything that is going to create wonder on this planet, it will be the limitations of the environment. I think it is long past the time when we should be supporting the IBP.

Thank you, Mr. Chairman.

Senator EAGLETON. Thank you, Senator Muskie. We especially appreciate your presentation, since as is known, you are the principal sponsor of Senate Joint Resolution 89 and your testimony is very welcome in light thereof.

Our next panel is led by Dr. Carlson, Director, Division of Biological and Medical Sciences of the National Science Foundation.

STATEMENT OF DR. HARVE CARLSON, DIRECTOR, DIVISION OF BIOLOGICAL AND MEDICAL SCIENCES, NATIONAL SCIENCE FOUNDATION; ACCOMPANIED BY DR. ERNEST S. TIERKEL, DIRECTOR, OFFICE OF SCIENCE AND ASSISTANT SURGEON GENERAL, DEPARTMENT OF HEALTH, EDUCATION, AND WELFARE; DR. R. KEITH ARNOLD, DEPUTY CHIEF FOR RESEARCH, FOREST SERVICE, U.S. DEPARTMENT OF AGRICULTURE; AND DR. JOHN R. TOTTER, DIRECTOR, DIVISION OF BIOLOGY AND MEDICINE, U.S. ATOMIC ENERGY COMMISSION.

Dr. CARLSON. Mr. Chairman, it is a pleasure to appear before this subcommittee and to discuss with you some aspect of the National Science Foundation in relation to the international biological program.

I have with me three members of the Interagency Coordinating Committee for IBP who I would like to introduce to this subcommittee: Dr. John R. Totter, Director of the Division of Biology and Medicine, U.S. Atomic Energy Commission; Dr. Ernest S. Tierkel,

Assistant Surgeon General and Director of the Office of Science in the Department of Health, Education, and Welfare; and Dr. R. Keith Arnold, Deputy Chief for Research of the U.S. Forest Service, representing the Department of Agriculture.

I believe that if IBP were being planned today it would be called the international ecological program. When the present name was chosen some 5 years ago, it was recognized that this international program did not encompass all of biology. It was intended from the beginning to emphasize the interactions between living organisms—including man—and the world around them.

Ecology was then so little known to the general public that a more inclusive title for the program seemed necessary. Today, however, the significance of ecology to human welfare is widely recognized.

IBP is a program of basic research on ecological processes in plant and animal communities and in human communities. The objective is to obtain the information which is required to achieve the optimal solutions for some of our environmental problems.

Such information will only be useful when it is properly incorporated into the design of action programs and I must emphasize that action programs are beyond the scope of IBP. We look to IBP to produce information and people who can contribute to action programs.

The concept of IBP and its research design were developed by scientists acting on their own initiative. The U.S. participants in IBP then solicited support from the National Science Foundation and from other appropriate agencies, public and private.

The Foundation staff and the staffs of other cooperating agencies have played an important role in shaping the components of the program as they are funded but the initiative has come from the participating scientists themselves.

IBP has served as a focusing mechanism to get large scale integrated ecological research started in this country. In the past, ecological research has typically been conducted through relatively small projects involving one or two senior scientists and a few assistants. A new dimension has been introduced with the advent of multi-investigator, multidisciplinary attacks on significant ecological problems whose solution is beyond the competence of a single investigator working alone. Dr. Van Dyne emphasized this in his statement just a few minutes ago.

These integrated projects cannot, of course, substitute for the innovative research of imaginative individual scientists. Both approaches must be allowed to flourish simultaneously, and the Foundation intends to continue support of individual ecologists, largely through its general ecology program.

IBP is also intended to focus attention on aspects of human adaptability to environmental stress, including the stresses of harsh climates and rapidly changing social conditions. As with the studies of ecological processes in nonhuman communities, IBP research in human ecology emphasizes an integrated attack on complex problems by teams of competent investigators from several disciplines.

The need for large-scale, integrated research on ecological problems will not disappear with the termination of IBP, whether that comes in 1972 or 1974. It is not expected, however, that IBP projects, once funded, will continue indefinitely. Some will be phased out as their

principal objectives are attained; and all are planned to reach a terminal date when the accomplishments can be evaluated.

It is noteworthy that the fixed cost of ecological research installations is less than in many fields of science. Even a large research program can be terminated when it ceases to be productive without excessive loss of investment in physical plant. We do, therefore, expect to evaluate progress as the research continues and at its termination.

If such research is successful, we will certainly seek ways to continue it, and to use the IBP experience as a basis for future plans. We look to both the National Academy of Sciences and the Interagency Coordinating Committee for IBP to play a role in this evaluation.

The National Science Foundation has been designated as the lead agency for Federal participation in IBP, and NSF is the only agency that has so far been given new funds specifically designated for support of IBP programs.

Research already in progress under sponsorship of the Department of Agriculture, Department of Health, Education, and Welfare, Atomic Energy Commission, and other Federal agencies contributes in a significant way to the broad objectives of IBP and to specific IBP programs.

We believe that the mission-related research of other Federal agencies will benefit substantially from the existence of IBP and its integrated research programs.

An Interagency Coordinating Committee serves to keep all agencies abreast of IBP activities and on occasion has been effective in developing joint funding of IBP projects which are clearly related to the mission objectives of two or more agencies.

This joint funding has in some cases been achieved through interagency transfers of funds. Thus, in fiscal year 1968, AEC transferred \$50,000 of research grant funds to NSF. NSF then incorporated this amount in a larger award to Colorado State University in support of ecosystem research in the IBP Grasslands Project. This mechanism permitted one agency to assume responsibility for monitoring a project whose research objective was clearly in the interests of both agencies.

Similarly, in fiscal year 1969, NSF transferred funds the other way, making \$186,400 available to AEC for support of IBP research at Oak Ridge National Laboratory. In addition, AEC, USDA, and the Smithsonian Institution have contributed to the support of the U.S. National Committee for IBP in each of the last 2 years.

For convenience, this support has been provided through interagency transfer to NSF, which, in turn, contracts with the National Academy of Sciences-National Research Council for the services of the IBP National Committee secretariat. It is to be hoped that this type of cooperation can and will continue.

I would like to say a word about international aspects, since this is an International Biological Program. IBP is a program of international cooperation among scientists, not among governments. The U.S. National Committee for IBP is a non-governmental body of scientists, operating under the aegis of the National Academy of Sciences-National Research Council.

The same is true of the IBP committees in most contributing coun-

tries. Each individual nation's efforts in IBP are financed by that nation as was brought out by Dr. Blair several times this morning.

The United States, like other participating nations, makes an annual contribution to the operation of the central IBP organization in London. Our dues assessment this year is \$25,000. Some parts of the U.S.-IBP programs have involved work in foreign countries by U.S. scientists. This has been the case when work is required at a foreign site and where the manpower and resources in a foreign country are not adequate for U.S. objectives.

In such cases, however, cooperating foreign nationals are financed by their own governments and there is a substantial foreign contribution of effort and facilities. It is noteworthy that so many nations, some with very limited resources, have resolved to devote so much to a cooperative international program dedicated to better understanding of the ecological processes that make life possible on our planet.

Mr. Chairman, my colleagues and I will be very happy to answer any questions you may have.

Senator MUSKIE. I wonder if your colleagues would like to make a brief statement and comment upon the role of their own agencies in this program?

Dr. CARLSON. Dr. Arnold, will you please respond?

Dr. ARNOLD. Mr. Chairman, the Department of Agriculture strongly supports the objectives of the IBP and, thus, the intent of the Joint Resolution 89. Many of our research, operational, and advisory programs need the kinds of information that is generated by IBP type studies, and we have a large number of our scientists participating in the planning and the conduct of those programs. Several of the major experimental sites are on Department of Agriculture experimental forests and ranges. These are four subject areas of particular concern to the Department of Agriculture.

The first is in the analysis of ecosystems program where we have direct interest in all six of the major biome studies. The conservation of ecosystems is another component of the IBP in which we have a large stake. The Forest Service began to set aside reserves of natural areas in the 1920's and because of the interest of IBP, that reservation of natural areas has grown now to 336 by all agencies of Government.

The third area is the conservation of germ plasm in plants. A major role of the Department of Agriculture is in collecting, evaluating, and preserving germ plasm of important agricultural and forestry crops.

The fourth area is that of aerobiology. We have a vital interest in the movement and dissemination of plant disease spores which are responsible for the major plant disease epidemics that we will need to seek biological controls much more potent and effective than we have had before.

Dr. CARLSON. Thank you, Dr. Arnold. Dr. Totter, would you respond for the AEC?

Dr. TOTTER. Mr. Chairman, the AEC, as you know, has been interested in ecological research since its inception or actually since, the beginning of the Manhattan district where there were many applied problems which immediately required a solution. As Dr. Neel said a while ago, one has to know what the biomedical costs of the develop-

ment of atomic energy will be and ways in which any possible cost can be minimized.

We have a number of areas now in common with the IBP and have since the beginning, I think Dr. Carlson will tell you, supported very strongly the development of IBP, both with money, as Dr. Carlson has said, and with moral support.

The studies in which the AEC is interested range from the eastern deciduous forest biome (partly managed from our Oak Ridge Laboratory by our ecological program there), and other biomes to the human studies of Dr. Neel, which he mentioned a while ago. These also are jointly supported by AEC and NSF.

This, I think, requires a little bit of elaboration. Dr. Neel is doing very fundamental, basic studies in human genetics. From our point of view, this is a highly applied program, because we must know what happens to possible mutations entering into the human genome through radiation and perhaps other sources.

It is then both highly fundamental and applied. Much of our AEC work is of this nature. The tracing of radioactive nuclides as they enter into the biosphere has been an applied necessity for AEC's requirements. The tracing of these substances has also been a strong contributor to fundamental ecology.

Other areas in which we hope to develop more joint efforts with IBP are the desert biomes, and part of our areas near the Nevada test site and the Richland, Wash., areas.

Thank you.

Dr. CARLSON. Dr. Tierkel, would you care to comment?

Dr. TIERKEL. Thank you, Dr. Carlson.

Mr. Chairman, our interest in the international biological program is as great as some of the other agencies, but perhaps a little bit more involved than some of the others. We enter the picture, of course, as the problems and programs relate to the health of man. This encompasses our environmental health program, with which you are familiar, including air pollution studies, our solid waste management, our pesticides program, and so on.

We do need basic biological information in order to apply intelligent control mechanisms in the environment. We are particularly interested in seeing developed biological monitoring systems so that we can devise a sensitive method for evaluating the pollution of our environment.

In another sense, we are interested, too, in the type of activity that the IBP undertakes in the research programs since we are actively engaged, at our National Institutes of Health, in model systems for biomedical research. These factors often enter very closely with the type of biological activity undertaken by the universities and foundations in this type of endeavor. Perhaps some examples of this are consideration, since we have become acutely aware of the pesticides problem, of genetic and biological manipulations of insect and animal vector populations that we know transmit infectious diseases in order to supplant the use of chemical methods with safer techniques for reducing these vector populations.

These are just a few examples of the things that we are interested in and for this reason, we do support the concept and the objectives of the international biological program.

We also offer the usual channels for carrying out these research functions through our Division of Research Grants in the National Institutes of Health, and, of course, these are excellent opportunities for expanding this program.

For this reason, we concur with the other departments in supporting the resolution in question. Thank you.

Dr. CARLSON. Thank you, Dr. Tierkel.

Are there other questions, Mr. Chairman?

Senator MUSKIE. I have just one. I would like to make the point that I am not a member of this committee, but since the chairman is good enough to let me put questions to you, I would like to put this one to sharpen the purpose of this joint resolution.

In the House report, defining that purpose, there is this:

The purpose of the joint resolution is to authorize all Federal departments and agencies having functions or objectives related to the International Biological Program to obligate or transfer money from appropriate funds to provide such other support as appropriate for that effort.

The resolution provides no new authorization or specific appropriation. It is designed to assure that appropriate Federal agencies will be able to support the IBP as the Office of Science and Technology has requested without any questions as to legality or Congressional intent.

That is, as I understand it, the purpose of the resolution. Have you been bothered by questions of legality or congressional intent in making your resources available to this program?

Dr. CARLSON. At the present we have not. The Interagency Committee will meet tomorrow and discuss this in depth so that all of the member agencies are aware of the intent of the resolution.

Senator MUSKIE. Do any of the others have any comments on that? Do you feel the resolution is essential to insure that there is no doubt about your authority to cooperate with the program?

Dr. TOTTER. As far as the AEC is concerned, the resolution was very helpful to us in preparing a budget and defending a budget. We have not had difficulty of the sort that you asked about in transferring funds, since there is a longstanding mechanism for that within the AEC. So we never had any difficulty.

In fact, between the AEC and the NSF, there is enough overlapping responsibility in this area and enough differences in the agencies that we can have quite great flexibility.

Senator MUSKIE. Nevertheless, the resolution would be helpful in giving you support for your budget requests?

Dr. CARLSON. Yes.

Dr. ARNOLD. In answer to your question, Senator Muskie, the Department of Agriculture missions are very closely paralleled to many of the objectives of IBP. We have not had difficulty supporting the IBP program, but we do feel that the resolution would be helpful.

Senator MUSKIE. Thank you very much.

Senator EAGLETON. Gentlemen, I asked the earlier panel whether in light of the deep and abiding interest that has now developed in the matters of ecology and our environment, there was sufficient cohesiveness insofar as the governmental approach on this matter is concerned.

What is your opinion as to whether it is too widely dispersed through a whole assortment of governmental agencies and whether it should be pulled together under one head, Cabinet level or below, but with a greater cohesiveness than may now be the case?

Dr. CARLSON. Mr. Chairman, I would like to comment on that question as the individual who has been chairman of the Interagency Coordinating Committee since its inception. I will then invite my colleagues to comment. I have looked at the Interagency Coordinating Committee to provide this cohesiveness. Possibly we didn't get as much of the funding from the other agencies as we would have liked, but at least there was a group speaking to a common denominator. I am convinced that there is good cooperation between the different agencies within our Government today. We don't always agree, but there is a good give and take, realizing that no one has a monopoly on wisdom. I would like to continue to have the Interagency Committee serve as the focus and also to provide additional funding, which the university scientists spoke to in previous testimony.

Senator EAGLETON. The thrust of my question was, Doctor, a bit broader than just the IBP, as important as that is. I referred to the whole range of Federal programs relating to ecology and environment, as to whether we have reached the point where we need a central government agency to deal with this problem rather than its present rather wide diffusion through an enormous number of Federal departments, including HEW, Interior, Transportation, Agriculture, AEC, and I am sure I have left several out.

Dr. CARLSON. The first step in that direction has been the appointment of several committees concerned with the environment and methods of attack on the specific problems that face the Nation immediately and those that we look to in the future.

Speaking as an individual, and I am not speaking for the National Science Foundation, I still believe that there is a group of agencies which is really concerned with the problems that are facing us today, as far as pollution, and all of the other aspects of it, resulting from the population growth. I think that these agencies can work together as a team. I think this is what has made our Nation great. We have had different agencies developing major programs in the past and we can work together in the future.

So my own personal, and again I am not speaking for the National Science Foundation, opinion is that I think we can attack these problems through the agencies as they now exist.

Senator EAGLETON. I am sure we can do it that way. Do I take your testimony to mean that the present diffused approach is in some way preferable to a consolidated approach?

Dr. CARLSON. No, sir, I believe that we should have a consolidated approach. It is diffused, because we do have a number of agencies. But I believe that most of the agencies now are fully aware of the problems that the Nation does face and I further believe that as a group we can and will be able to focus in the major issues in the very near future. But I have not given you the answer. I am sorry. I recognize that.

Senator EAGLETON. Would any of the other gentlemen care to comment on that same question?

Dr. TOTTER. I would not speak for the AEC because I don't know what the policy is with respect to an answer to this question. I would like to mention personal comments.

First, Dr. Carlson made quite an understatement a while ago when he told about the difficulty of getting the Interagency Committee to focus on the IBP problem, and also to provide it with funds.

I watched with sympathy while he struggled for about 3 years to get this on its feet. He was highly successful and is to be commended for that.

I think we see a repetition of this in other areas similar to the IBP. The fact is that if one has time enough, it will work the way Dr. Carlson has done it, and in the way it is doing now. If there is a crisis to demand a rapid solution to it, it is probably not a very good way to go about it.

I think that given time and education that the present system will work and it works for the reason that each mission-oriented agency has a focus; it is more easy for them to defend their budget for that mission. When the mission is related to a broader area as in the case we are speaking about here, eventually they will support that wholeheartedly.

The disadvantage of a single agency I think is the disadvantage of not having sharp focus. A new environmental program, let us say analogous to the NFS itself would go through the same difficulty of the budget defense the NSF has had, a lack of very sharp focus on the specific problems.

Senator EAGLETON. You mentioned, Doctor, the time factor. If we had time, you would prefer the present approach. If time is not on our side, then you might prefer a more consolidated approach.

What is your evaluation of the time factor? Do we have it in abundant luxury or is time running out on us?

Dr. TOTTER. I think the 5-year IBP program was a little bit short for this kind of operation to work most successfully. There is certainly a lot of public concern which borders in some areas on hysteria. I don't think we will get anywhere by blindly responding to hysteria. We have to be thoughtful about what we do.

If there were some way to guarantee a continuing concern of Congress, then I think perhaps a single agency instrument would be better and certainly respond more quickly providing it was adequately financed.

Senator EAGLETON. On this question of financing, which approach seems to meet with better results, a diffusion of programs through several departments or the more consolidated approach with one department making a major effort to obtain substantial funds covering the entire area of ecology?

Dr. CARLSON. The answer to that, Mr. Chairman, obviously, would be that if we could have all of the funds that are necessary to support the programs that the very capable scientists have designed in one agency, this would be ideal.

Unfortunately, this is not the case, and, therefore, I revert to the multiagency approach for the support of the international biological program. Such an approach makes sense because different parts of the IBP program have an important bearing on the missions of a number of different agencies. Granted, it has not been ideal, but it has made some real steps in supporting a new program in a period of very tight budgets. Although we will probably not be able to support all that the scientists would like in the coming year I do hope that we will be able to support the major parts that the U.S. National Committee will recommend for consideration.

Senator EAGLETON. Could you submit for the record a complete list of participating nations and their respective annual dues assessment for the operation of the central IBP organization?

Dr. CARLSON. Yes, sir, we will do that.

(The information subsequently submitted follows:)

NATIONS PARTICIPATING IN INTERNATIONAL BIOLOGICAL PROGRAM—DUES ASSESSED FOR SCIBP CENTRAL OFFICE ACTIVITIES, CALENDAR YEARS 1968-70

Country	National dues		
	1968	1969	1970 estimate
Argentina.....	\$500	\$500	\$500
Australia.....	3,000	5,000	5,000
Austria.....	100	500	500
Belgium.....	1,000	1,000	1,000
Brazil.....	500	500	500
Bulgaria.....	500	500	500
Canada.....	4,000	7,500	7,500
Ceylon.....			
Chile.....			
China.....	100	100	100
Colombia.....			
Congo.....			
Czechoslovakia.....	200	500	500
East Africa.....			
Kenya.....			
Tanzania.....			
Uganda.....			
Ecuador.....			
Finland.....	1,000	1,100	1,100
France.....	5,000	10,000	10,000
Germany (DDR).....	500	500	500
Germany (BRD).....	1,000	1,000	1,000
Ghana.....	100	100	100
Greece.....	200	300	300
Hungary.....	100	500	500
India.....	100	100	100
Indonesia.....	100	500	500
Ireland.....	500	500	500
Israel.....	5,000	5,000	5,000
Italy.....	2,500	2,500	2,500
Japan.....			
Korea.....			
Malawi.....		500	500
Malaysia.....			
Netherlands.....	1,000	1,100	1,100
New Zealand.....	100	500	500
Nigeria.....	100	100	100
Norway.....	1,000	2,000	2,000
Panama.....		500	500
Peru.....			
Philippines.....	100	500	500
Poland.....			
Rhodesia.....	100	500	500
Roumania.....		200	200
South Africa.....	1,000	1,000	1,000
Spain.....	500	500	500
Sweden.....	5,000	5,500	5,500
Thailand.....	100	500	500
Tunisia.....			
United Arab Republic.....	100	100	100
United Kingdom.....	10,000	20,000	20,000
United States.....	10,000	17,500	25,000
U.S.S.R.....	2,500	2,500	2,500
Uruguay.....			
Venezuela.....	250	500	500
Vietnam.....			
Yugoslavia.....	100	100	100
Total.....	57,850	85,900	100,300

Note: There are additional items of support to the Scientific Committee of IBP (SCIBP) which are not covered by the dues assessments. Offices and some overhead support are provided by the Royal Society of London, equivalent to about \$10,000. Bulgaria was host to the SCIBP General Assembly in 1968, and it is estimated that Bulgarian cost for this effort was several times its dues assessment. The technical sections of SCIBP hold their coordinating meetings in various countries so that (1) the needed individual participation is facilitated and (2) the drain on the SCIBP Treasury is reduced to a minimum. These meetings have been held in the Soviet Union, the Scandinavian countries, France, the United Kingdom, Italy, Japan and other countries. Czechoslovakia, Poland, and other countries have contributed in other ways, e.g., printing costs and organizing of meetings.

Source: Information provided by the Secretariat, U.S. National Committee for IBP.

Senator EAGLETON. At this point I order printed the prepared statement of Dr. Carlson and a letter to Senator Javits from Dr. Jonas Salk.

(The material referred to follows:)

PREPARED STATEMENT OF DR. HARVE J. CARLSON, DIRECTOR, DIVISION OF
BIOLOGICAL AND MEDICAL SCIENCES NATIONAL SCIENCE FOUNDATION

It is a pleasure to appear before this Subcommittee and to discuss with you some aspects of the National Science Foundation's relations to the International Biological Program. I have with me three members of the Interagency Coordinating Committee for IBP whom I would like to introduce to this Subcommittee: Dr. John R. Totter, Director of the Division of Biology and Medicine, U.S. Atomic Energy Commission; Dr. Ernest S. Tierkel, Assistant Surgeon General and Director of the Office of Science in the Department of Health, Education, and Welfare; and Dr. R. Keith Arnold, Deputy Chief for Research of the U.S. Forest Service, representing the Department of Agriculture.

I believe that if IBP were being planned today it would be called the International Ecological Program. When the present name was chosen some five years ago, it was recognized that this international program did not encompass all of biology. It was intended from the beginning to emphasize the interactions between living organisms—including man—and the world around them. Ecology was then so little known to the general public that a more inclusive title for the program seemed necessary. Today, however, the significance of ecology to human welfare is widely recognized.

IBP is a program of basic research on ecological processes in plant and animal communities and in human communities. The objective is to obtain the information which is required to achieve the optimal solutions for some of our environmental problems. Such information will only be useful when it is properly incorporated into the design of action programs and I must emphasize that action programs are beyond the scope of IBP. We look to IBP to produce information and people who can contribute to action programs.

The concept of IBP and its research design were developed by scientists acting on their own initiative. The U.S. participants in IBP then solicited support from the National Science Foundation and from other appropriate agencies, public and private. The Foundation staff, and the staffs of other cooperating agencies, have played an important role in shaping the components of the program as they are funded but the initiative has come from the participating scientists themselves.

IBP has served as a focusing mechanism to get large-scale integrated ecological research started in this country. In the past, ecological research has typically been conducted through relatively small projects involving one or two senior scientists and a few assistants. A new dimension has been introduced with the advent of multi-investigator, multi-disciplinary attacks on significant ecological problems whose solution is beyond the competence of a single investigator working alone. These integrated projects cannot, of course, substitute for the innovative research of imaginative individual scientists. Both approaches must be allowed to flourish simultaneously, and the Foundation intends to continue support of individual ecologists, largely through its General Ecology Program.

IBP is also intended to focus attention on aspects of human adaptability to environmental stress, including the stresses of harsh climates and rapidly changing social conditions. As with the studies of ecological processes in nonhuman communities, IBP research in human ecology emphasizes an integrated attack on complex problems by teams of competent investigators from several disciplines.

The need for large-scale, integrated research on ecological problems will not disappear with the termination of IBP, whether that comes in 1972 or 1974. It is not expected, however, that IBP projects, once funded, will continue indefinitely. Some will be phased out as their principal objectives are attained; and all are planned to reach a terminal date when the accomplishments can be evaluated. It is noteworthy that the fixed cost of ecological research installations is less than in many fields of science. Even a large research program can be terminated when it ceases to be productive without excessive loss of investment in physical plant. We do, therefore, expect to evaluate progress as the research continues and at its termination. If such research is successful, we will certainly seek ways to continue it, and to use the IBP experience as a basis for future plans. We look

to both the National Academy of Sciences and the Interagency Coordinating Committee for IBP to play a role in this evaluation.

The National Science Foundation has been designated as the lead agency for Federal participation in IBP, and NSF is the only agency that has so far been given new funds specifically designated for support of IBP programs. Research already in progress under sponsorship of the Department of Agriculture, Department of Health, Education, and Welfare, Atomic Energy Commission, and other Federal agencies contributes in a significant way to the broad objectives of IBP and to specific IBP programs. We believe that the mission-related research of other Federal agencies will benefit substantially from the existence of IBP and its integrated research programs.

An Interagency Coordinating Committee serves to keep all agencies abreast of IBP activities and on occasion has been effective in developing joint funding of IBP projects which are clearly related to the mission objectives of two or more agencies. This joint funding has in some cases been achieved through interagency transfers of funds. Thus, in Fiscal Year 1968, AEC transferred \$50,000 of research grant funds to NSF. NSF then incorporated this amount in a larger award to Colorado State University in support of ecosystem research in the IBP Grasslands Project. This mechanism permitted one agency to assume responsibility for monitoring a project whose research objective was clearly in the interests of both agencies. Similarly, in Fiscal Year 1969, NSF transferred funds the other way, making \$186,400 available to AEC for support of IBP research at Oak Ridge National Laboratory. In addition, AEC, USDA, and the Smithsonian Institution have contributed to the support of the U.S. National Committee for IBP in each of the last two years. For convenience, this support has been provided through interagency transfer to NSF, which, in turn, contracts with the National Academy of Sciences—National Research Council for the services of the IBP National Committee secretariat. It is to be hoped that this type of cooperation can and will continue.

I would like to say a word about international aspects, since this is an International Biological Program. IBP is a program of international cooperation among scientists, not among governments. The U.S. National Committee for IBP is a non-governmental body of scientists, operating under the aegis of the National Academy of Sciences—National Research Council. The same is true of the IBP committees in most contributing countries. Each individual nation's efforts in IBP are financed by that nation. The U.S., like other participating nations, makes an annual contribution to the operation of the central IBP organization in London. Our dues assessment this year is \$25,000. Some parts of the US-IBP programs have involved work in foreign countries by U.S. scientists. This has been the case when work is required at a foreign site and where the manpower and resources in a foreign country are not adequate for U.S. objectives. In such cases, however, cooperating foreign nationals are financed by their own governments and there is a substantial foreign contribution of effort and facilities. It is noteworthy that so many nations, some with very limited resources, have resolved to devote so much to a cooperative international program dedicated to better understanding of the ecological processes that make life possible on our planet.

Mr. Chairman, my colleagues and I will be very happy to answer any questions you may have.

THE SALK INSTITUTE FOR BIOLOGICAL STUDIES,
San Diego, Calif., March 23, 1970.

HON. JACOB K. JAVITS,
U.S. Senate, Committee on Labor and Public Welfare,
Washington, D.C.

DEAR JACK: I regret that I have been away for the most part since your letter of 24 February arrived, and it is only now that am able to reply.

There is little that I can add by way of specific reasons why we should support the International Biological Program. It is self-evident that the problems with which man is now confronted stem from his successes and these have begun to have a negative effect upon the living universe of which he is a part, as well as upon himself. Inasmuch as there are no boundaries to the living universe on the face of the earth—not even those we can impose upon ourselves—it is essential that we enter into joint consideration with our fellow humans, wherever they may be, because of the common nature of the air we breathe and the organisms and resources upon which we depend for food and, in fact, for homeostasis.

These are but small steps in the right direction and should be made more than symbolic. Any leadership taken in this direction will have the same effect as the leadership that we have taken in the support of work and programs for the control of disease and in space exploration. Therefore, we should not hold back either in our activities at home or in our participation in international programs that concern life and man.

Sincerely,

JONAS SALK.

Senator EAGLETON. Doctor, I want to thank you and the other members of your panel for your attention, your interest and your presentation.

Apparently that concludes our witnesses this morning on Senate Joint Resolution 89 and House Joint Resolution 589. The subcommittee is adjourned.

(Whereupon, at 12:36 p.m. the subcommittee adjourned.)

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