Science's Role in the World Health Organization

Methods for amplifying the effects of scientific resources on global health problems are described.

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The World Health Organization (WHO) has a clear but unachievable mission consciously bestowed by its founders in 1947. According to the WHO Constitution that mission is "the attainment by all peoples of the highest possible level of health," with health defined as "a state of complete physical, mental, and social well-being and not merely the absence of disease or infirmity." The role of science in WHO, then, is to chart the shortest and most economical paths, in infinite progression, from a lower to a higher level of health toward a final goal which remains ever elusive but alluring.

WHO is now entering its 25th year of operations, the last 12 of which have seen a considerable intensification of research activities. This is a respectable enough period of time to afford some perspective on the successes, failures, and problems of the United Nations arm that is perhaps most broadly involved in research and the application of science and technology to worldwide problems.

Our involvement ranges the spectrum of the hard and soft sciences—physics, chemistry, biology, and sociology, and their components of mathematics, engineering, and economics—and applies them to problems of mental and physical health. Such problems are of immediate concern to peoples in all countries, but they assume special significance in the economically underdeveloped areas of the world where well over a half of the world's population dwells. These people are afflicted constantly by poverty, hunger, and disease and intermittently by earthquakes, storms, and floods; and some—in Vietnam, Bangladesh, Burundi, and the Middle East—face the additional burdens of war and its aftermath. The resultant scale of human suffering beggars description.

But this is the scene and backdrop of WHO's activities which are carried out with a total effective working budget that the sanitation services of many large cities in the United States would consider grossly inadequate, some 100 million dollars annually (*1*). About \$14 million, \$8 million of which represent voluntary funds supplementing regular budget, are spent each year by WHO in support of research. The remainder is spent on operational activities involving health assistance to member states.

Much of this article is devoted to the research component. Through some of the mechanisms used in WHO we are able to amplify our effect far beyond the reasonable expectations of our limited budget. Specifically, this has to do with our enlisting the collaboration of many laboratories and leading scientists who find great personal satisfaction and scientific interest in using all the world rather than a single country as an experimental and operative frame of reference.

Organization of WHO

First, a brief sketch of how WHO functions. The organizational charts (Figs. 1 and 2) give some idea of the functional units. WHO is a highly decentralized organization in which field operations are carried out through six regional offices located respectively in Washington (Pan American Sanitary Bureau, Regional Office for the Americas), Copenhagen for Europe, Alexandria for the Eastern Mediterranean, Brazzaville for Africa, New Delhi for Southeast Asia, and Manila for the Western Pacific.

Headquarters in Geneva is responsible for the formulation of technical principles and guidelines that govern operations carried out in the regions. Overall policy is determined by the World Health Assembly consisting of 137 (*2*) countries, usually represented by ministers of health or their chief public health officials together with technical staff, which meets annually to approve the budget. The executive board comprises health authorities from 24 countries who serve in an individual capacity; the board meets twice a year for in-depth examination of the program and budget and for preparation of a detailed set of recommendations to the Assembly.

By far the largest part of WHO's total resources is devoted to the application of currently available scientific knowledge and techniques, but in developing countries this is done under conditions of severe restraint having to do with economic unfeasibility and lack of trained manpower. Despite these constraints great gains have been registered, particularly in communicable disease control where success has been so notable that it has boomeranged: WHO has been accused of prime responsibility in the population explosion in economically underdeveloped countries!

Remarkable achievements in malaria control have resulted from the use of DDT, in tuberculosis through simplified chemotherapeutic regimes carried out in the home, in yaws from penicillin treatment, in major communicable disease because of improved vaccines, all abetted by improved maternal and child health practices.

These factors have contributed greatly to the marked increase in life span in most of the developing countries of the world. Considerably less progress has been seen in major diseases such as cancer, cardiovascular and other chronic degenerative diseases, and the mental disorders, which affect both economically developed and developing countries. But it must be emphasized, whatever gains have been registered in the poor countries, these represent only the smallest dent in the mountain of misery created by disease and the lack of even the most primitive amenities of life.

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Some Questions

In the face of such realities and the obvious need for direct relief in economically underdeveloped countries, where can science and technology be most effective? How can an organization like WHO justify the use of part of its budget for the direct support of research, not infrequently at the fundamental and theoretical level? The latter question raises a recurrent skirmish with budget-conscious governing bodies; nonetheless, the principle of research has become accepted in WHO over the years, made evident by the imperative need for knowledge and technology in the barren areas where progress has been at a virtual standstill, and justified by excellent yields on relatively small investments.

How WHO Works in Research

Collaborative research is the principal approach used in the WHO program. This approach is based on the premise that certain problems are best attacked through cooperative efforts of workers in various countries operating under different ecological conditions.

To this end we have developed a network of some 750 reference centers and collaborating laboratories. As a rule, research projects are initiated and designed by technical units in WHO aided by consultants. The research itself is usually carried out by established institutions, including the above network of laboratories, often with modest financial assistance by WHO in the form of "seed" grants to offset partially the much greater expenses borne by the laboratories themselves. As was indicated earlier, the major element in whatever successes have been achieved lies in the fund of goodwill, talent, and resources of collaborating scientists and their laboratories and institutes, to which we have ready access throughout the world in government services, universities, and sometimes in large or small commercial enterprises.

Small grants are also made by WHO to individual investigators working on subjects of interest to the organization, for training in research methodology, as well as to finance visits to other laboratories by scientists working on problems of mutual interest. When scientists bid for these grants, the applications are examined by technical units at WHO in consultation with outside referees, and by a special grants committee in WHO. (The organization, incidentally, also awards more than 3500 education and training fellowships each year.)

Special Bodies for Research

In 1959, an advisory committee on medical research was established consisting of 19 distinguished scientists in various disciplines from different parts of the world. This committee meets annually to review research programs and to advise the director-general on them.

Periodically, groups of experts are convened to review specific subjects from a purely scientific point of view, to identify gaps in knowledge, to recommend research approaches, and to establish technical principles and guides. Members of these groups are drawn from 44 expert advisory panels totaling more than 2600 scientists appointed by the director-general.

The International Agency for Research on Cancer is an autonomous body within WHO; it was established in 1965 to promote international collaboration in cancer research. It has a governing council and a scientific advisory body and operates on an annual budget of about $2.5 million from contributions of 10 participating countries. The agency, sited in Lyons (France), works in close collaboration with WHO headquarters and concentrates on epidemiological investigations in many parts of the world and on laboratory research in Lyons.

In recent years WHO headquarters has carried on direct research, for example, in epidemiology and communications science. In addition, scientists are employed by WHO and its regional office for the Americas (the Pan American Sanitary Bureau) to work in institutions largely financed from sources external to the regular budget of WHO. These include the Institute of Nutrition of Central America and Panama, the Pan American Zoonoses Center near Buenos Aires, the East African Virus Research Institute in Entebbe, and some of the WHO research and training centers for immunology.

Research Priorities

The major activities with priorities in research are communicable diseases; noncommunicable diseases including cancer and cardiovascular and other chronic diseases; environmental health; biology, including toxicology, biological standardization, and comparative medicine; strengthening of health services, including family health with its components of human genetics, reproduction, and nutrition; mental health; and organization of health services.

From the perspective of developing countries, questions of the total "prevention" and "cure" of cancer and cardiovascular disease do not assume the highest priority. Advances toward these goals, as now seen, might lengthen life by some 5 to 8 years, given man's present chromosomal endowments. On the other hand, successes in the control of communicable diseases have demonstrated a much more rapid method for reducing the great difference in lifespan between peoples in poor and in affluent countries. The organization will, of course, continue to play its part in cancer and cardiovascular disease studies through epidemiological investigations in different population groups and by helping to further research on any new insights gained in the process. We must leave to the advanced institutes in developed countries, however, most of the fundamental laboratory research required, for they have the needed resources. The same can be said of problems of central nervous system functioning and behavioral disorders.

Results and Present Programs in WHO-Supported Research

In 1958, thanks largely to the initiative of the United States, the WHO research program began a period of steady growth. It is now in order to ask ourselves the following question: What significant contributions to science and technology have been made by WHO through its research program which would otherwise not have been made or, at the least, have been appreciably delayed? I cite a few in which it can reasonably be claimed that WHO played a major role:

1) Evaluation of the effectiveness, or lack thereof, of recently developed biological products (vaccines and serums) for polio, measles, smallpox, rabies, typhoid, cholera, tuberculosis, brucellosis, leptospirosis, and cysticercosis.

2) Clarification of the epidemiology of the above group of diseases as well as of cancer, cardiovascular diseases,

influenza, dengue and other arbovirus infections, trachoma, and of parasitic diseases including malaria, toxoplasmosis, schistosomiasis, and hydatidosis among others.

3) Characterization of immune-complex nephritis in malaria and shock syndrome in dengue hemorrhagic fever.

4) Comparative studies in the chemotherapy of yaws, tuberculosis, leprosy, schistosomiasis, and brucellosis.

5) Insights into malnutrition, especially protein-calorie deficiencies and their relationship to infective agents.

6) Studies on the biology of many insect vectors and of their resistance to insecticides.

7) The development of nearly 300 biological standards and working preparations to provide baseline references for all countries.

8) Progress in international uniformity of diagnostic criteria and technical procedures for many of the major communicable and noncommunicable diseases (such as malnutrition, mental disorders, and the chronic degenerative diseases).

It should be noted that these contributions have been mainly in fields requiring comparative studies in differing economic, social, and ecological settings.

Research supported by WHO is continuing on most of the above items and on many others not mentioned. In addition, our present research program includes expanded activities in the biology of human reproduction and the development of contraceptive devices, comparative studies in schizophrenia, technological control of environmental pollution, human genetics, the immunological basis of disease, operational research for health care delivery, and systems analysis in health planning at national and local levels.

Lacks

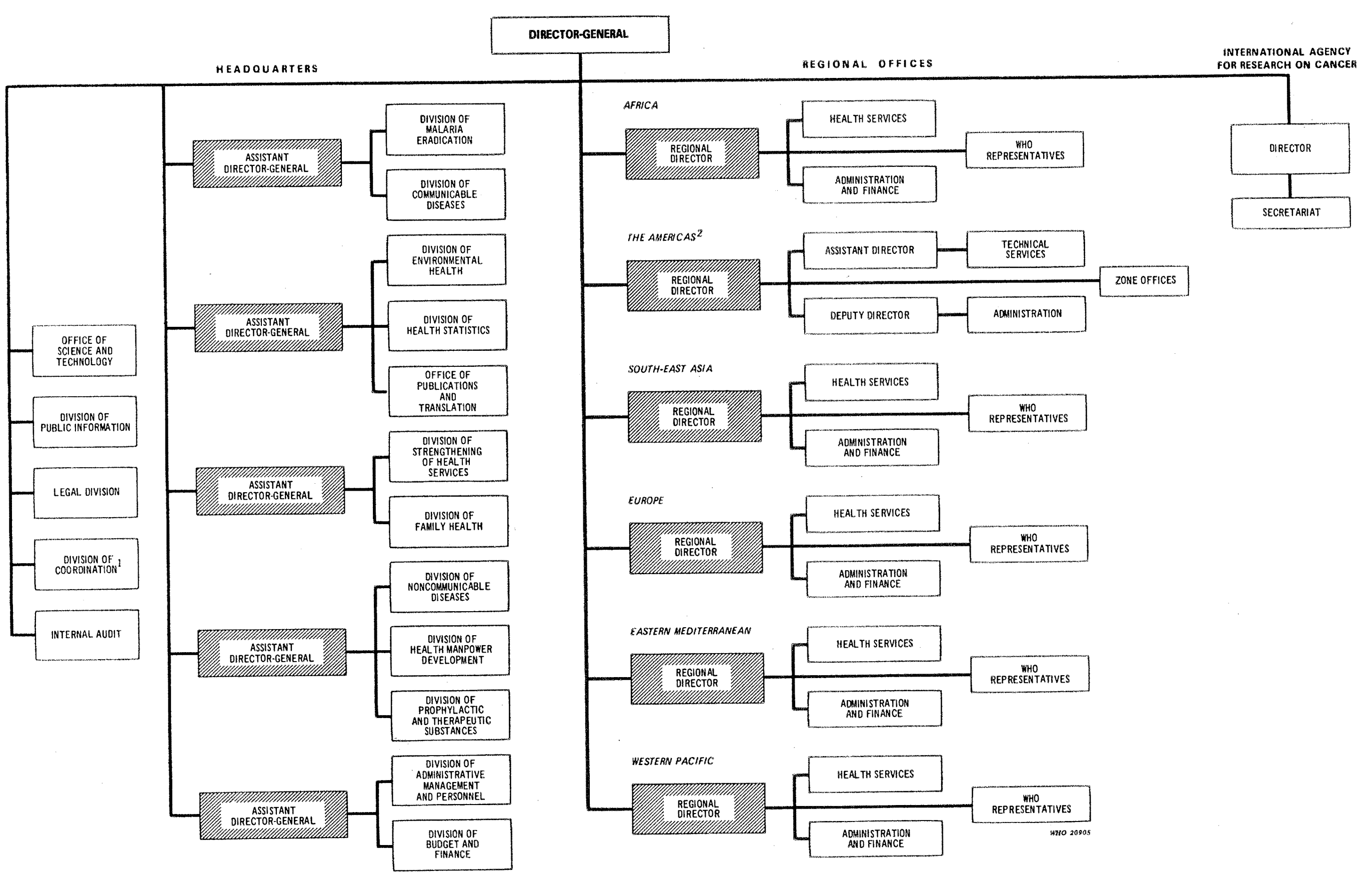
There remain, however, several largely unfulfilled priority areas of work in WHO where science and technology play a most important role.

1) *Development of a worldwide health information network.* There is great need for much more rapid development of a computerized health information network linking all countries to a centralized facility in Geneva. With present and foreseeable resources this may take decades to achieve.

As for now, we must confine ourselves to one component of such a network: simple early warning systems for communicable diseases, adverse reactions to medicines, and health hazards of the human environment. For these systems to be truly effective we must develop an adequate data base for epidemiological indices and a communications network to assess current hazards and to predict future ones. Important hardware components are required, as well as research in information theory in its widest sense. For WHO this means research in the mathematics of epidemiological theory, in technological assessment, in operations research, and in analytical techniques for extracting meaningful correlations from a large number of variables.

2) *Parasitic diseases.* A very great increase in fundamental and applied research on this group of diseases is urgently required, and will depend on the talents and resources of major institutions and from various disciplines in both economically advanced and developing countries.

3) *The biology of human reproduction.* Our ignorance of many basic features of the physiology and psychology of human reproduction is profound, and this impedes progress in the development of contraceptive techniques ap-



[1] The liaison offices with United Nations, ECA, ECAFE and IAEA, the WHO medical advisers to UNICEF and the WHO representative with UNRWA report to the Division of Coordination

[2] Regional Office for the Americas/Pan American Sanitary Bureau.

Fig. 1. Structure of the secretariat of the World Health Organization.

propriate for different economic and social conditions. WHO has expanded its program here and, although an appreciable amount of work is in progress in laboratories and institutes throughout the world, the magnitude and complexity of so extensive a goal call for a vastly increased effort. I scarcely need emphasize the urgency of this problem.

4) *Toxic chemicals.* An intensified attack on pharmacotoxicological problems, especially at the molecular level, is needed to clarify the actions of chemicals. We must also have large-scale animal toxicity studies on the carcinogenic, mutagenic, teratogenic, and other toxic potentials of the large number of chemicals, including medicines, to which man is increasingly exposed. In this sector particularly and in that of human reproduction, one can readily perceive the need and justification for establishing internationally operated institutes that would be linked to national, university, and other efforts. There is irony in the blighted hopes for a World Health Research Center, first proposed in 1963—well before environment alarm developed into a bandwagon—and rejected by the governments in 1965; for this was an entity especially designed to concentrate on these particular problems.

5) *Improved technological aids.* These include instrumentation for diagnostic and survey procedures in mass campaigns against communicable diseases, and for population studies in human genetics, nutrition, and metabolic disorders; and less expensive technological procedures for coping with environmental pollutants, improving sanitation, and designing prosthetic devices.

I should like to discuss briefly this aspect of technology to illustrate how we approach a specific set of problems in a rather specialized field.

WHO has special responsibilities toward the developing countries in helping them with respect not only to their basic health needs but also in the judicious introduction and use of modern technology. These countries find themselves under increasingly strong pressures, both internal and external, to import advanced technology. In health care systems one important field of such technology is automated biomedical instrumentation.

The benefits of bio-instrumentation are undisputable in the clinical domain: fetal monitoring, intensive care units, automated laboratory examinations, computer assisted diagnosis, and the use of artificial organs. However, these techniques are too costly for the developing countries and are irrelevant to their present needs. Manpower there is relatively inexpensive, and health assessment of the population is much more useful than refinement of clinical procedures.

The need therefore is to extend existing capabilities to handle mass procedures whether diagnostic, prophylactic, or therapeutic (for example, in campaigns for yaws control by means of penicillin inoculations). These procedures are usually concerned with "gross" pathology and do not necessarily require sophisticated machine assistance at the clinical care level. However, to cover the amount of basic work that has to

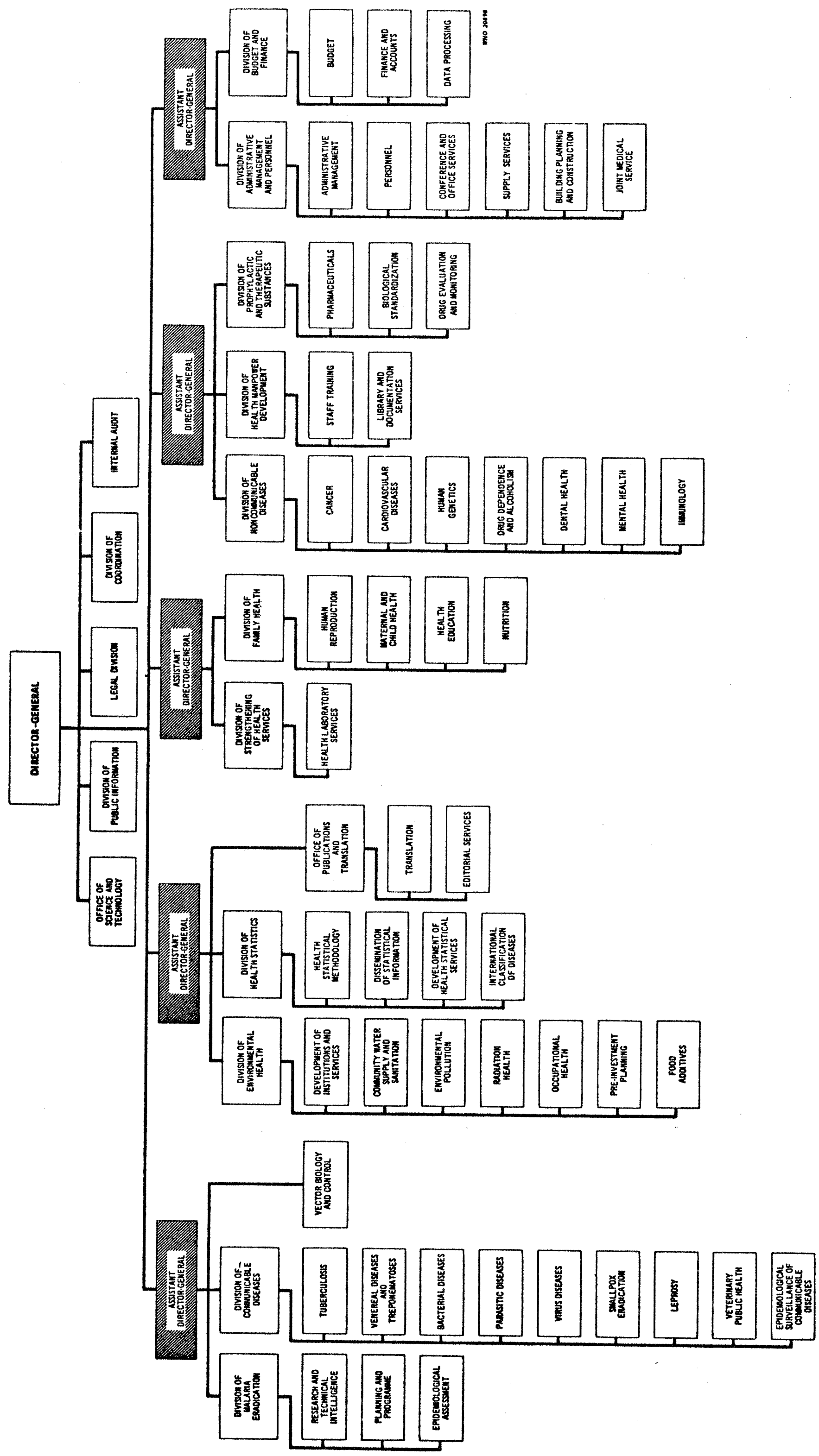


Fig. 2. Structure at headquarters as of 1 November 1972.

be done with very little skilled and semiskilled personnel, some degree of automation could have a substantial contribution to offer, as will be seen in the following.

As I have mentioned before, the main health problem of underdeveloped areas is that of infectious diseases, either endemic or epidemic. There are now active WHO programs in areas with a total population of 700 million for malaria, of almost as many for tuberculosis, and of 300 million for schistosomiasis. As an example, programs for malaria eradication call for blood-film examination of 1 percent of the population per month in an area, or about 15 percent per year. This means some 90 million examinations per year. A technician can read at most 50 films in a day, or about 10,000 per year; thus some 9000 field technicians are required. The cross-checking laboratories to examine about 10 million films per year require another 1000 laboratory technicians. Inevitably, an unpredictable margin of error results which can seriously compromise the effectiveness of a control program.

In such a situation it is possible to imagine well-equipped laboratories set up in the capital, or in a regional center, which could deal with such a flow of biological samples for examination. Therefore WHO has been encouraging high-level technological efforts in automated pattern recognition and image processing with potential application to such major problems as malaria and schistosomiasis.

With respect to other diseases the logistics of collecting, preserving, and transporting biological samples present unsurmountable difficulties in certain geographic areas, and local handling of samples becomes imperative. Since these areas are precisely those which suffer most from a lack of skilled staff, some sort of simple and cheap machine-assisted operation must be sought. Such an approach calls for the development of new devices that do not necessarily follow the conventional diagnostic procedures. One example is the possible use of mass spectrometry for the detection of acid-fast bacilli in samples for the purpose of tuberculosis and leprosy control campaigns. Another possibility is the use of inexpensive image digitization which, instead of identifying organisms by extensive computation exercises, relies on one or two criteria like differential staining or fluorescence. This requires that background noise is rejected either by prior chemical processing or by purely optical filtering.

The problem of mechanization in underdeveloped countries is a very controversial one because mechanical systems tend to be expensive, vulnerable, and difficult to maintain. It is desirable in such countries to encourage the implementation of simple manual operations by the use of the existing labor force.

To summarize, there is a great need for simple and robust technological devices to provide greatly increased accuracy and efficiency. The development of such devices for those diseases which are of little direct importance to developed countries must, nevertheless, depend on advanced technological knowledge and facilities in the wealthier countries. We therefore seek the assistance of specialized groups in places like the Massachusetts Institute of Technology, the University of London, and in other advanced institutions to help us in this task.

Future Prospects

The above five areas of needed research and development are all accessible to ready implementation, given certain requirements. One requirement is for greater participation of leading scientists and advanced laboratories in our efforts. Here we should have little difficulty. But of course the indispensable element is money. One can only deplore the lack of funds which so restricts us that we can exploit only a mere fraction of the potential help from collaborators. An increase of $10 million in the annual research budget of WHO would without doubt yield extraordinary returns, but we have reached the limit of funds available in the regular budget for support of research. Unless there is a radical change of attitude toward the United Nations on the part of member governments, we must look elsewhere for increased support. Unfortunately, nothing on the present scene gives reason for optimism concerning such a change.

The United Nations idea continues to battle for its life against ignorance, indifference, provincial hostility, and criticism which fails to take into account the lack of support, both financial and ideological, among the nations of its family. Such attitudes toward the United Nations, directed mainly at its political impotence, affect other components of the United Nations "system" as well. We are witnessing a bypassing of the United Nations, and the proliferation of bilateral and multilateral agreements in many fields of science and technology, stimulated largely by political expediency, and for which ample funds seem to be available.

Partial blessings on that; we should not cavil at support of science for peaceful purposes from whatever angle. But what about greater support for science within the United Nations "system"? Surely this approach combines most desirably the international ethic of science and the machinery for its implementation throughout the globe. After all, an effective United Nations is, in the long run, our best hope for a peaceful, reasonably healthy, and economically just world.

Addendum. One hears often of the financial contributions made by the United States to the support of activities within the U.N. system, but much less frequently about benefits obtained. A particular instance of the latter is worth citing.

An analysis was recently made by N. W. Axnick and J. M. Lane (*3*) of the costs associated with the protection of the United States against smallpox in 1968. This was estimated to be $153.8 million, of which $0.7 million was contributed to WHO specially earmarked for its smallpox eradication program, and $3 million in U.S. bilateral assistance to 19 countries in West Africa. The success of the WHO-directed smallpox eradication program throughout the world has resulted in a 1972 decision by U.S. authorities to discontinue routine vaccination of the general population and of smallpox vaccination requirements for international travel to smallpox-free countries, which was estimated to involve economic costs of $135.7 million during 1968. The total current U.S. contribution (1972) to all activities of WHO is $27.6 million. Thus it will be seen that very substantial savings, probably exceeding $100 million annually, will accrue to the United States from the work of WHO on smallpox alone.

References and Notes

1. It is rather sad that this modest annual budget figure of WHO represents the 5-year goal of the Environment Fund set up as a result of the United Nations Conference on the Human Environment held in Stockholm in June which aroused so much public interest and cooperation from scientists. Governmental representatives were inspired to unusual rhetorical heights, but the result was a very lean ration for the United Nations "system."
2. Member states, 135; associate member states, 2.
3. N. W. Axnick and J. M. Lane, *World Health Organization Report, WHO/SE/72* (1972).