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AMERICA'S SYSTEMATICS COLLECTIONS: A NATIONAL PLAN

Compiled and Edited

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for the

Belmont Writing Committee

Published

by

The Association of Systematics Collections

A report to the Association of Systematics Collections by a special committee of systematic biologists (the Belmont Writing Committee), convened 29-30 September and 1 October 1972, by the Smithsonian Institution at its Belmont Estate, Maryland.

December 1973

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*Duplication and publication of this report were made possible by a National
Museums Act Grant from the Smithsonian Institution to the Smithsonian
Research Foundation.*

ABSTRACT

“America’s Systematics Collections: A National Plan” is a report to the nation’s systematics collections community, and includes a National Plan for the recognition and development of systematics collections as an important national resource in the United States.

The report states the goals of the systematics collections community, and documents the importance of systematics collections to science, society and education. The problems of the systematics collections community are identified and discussed. Recommendations are presented that, if implemented, could permit the systematics collections community to achieve its goals; the recommendations are reiterated within a framework of priorities. Estimated new support required by the systematics collections community for the next five years is \$63,217,920.

The Association of Systematics Collections has been charged with distribution and implementation of the National Plan.

PREFACE

This report is addressed principally to systematists concerned with the nature and quality of America's systematics collections as a national resource. The report describes and recommends ways whereby systematists and others responsible for the care and management of systematics collections can develop their collections into a more effective resource responsive to the needs of science, applied science and society. As part of a national effort to this end by concerned systematists, appropriate steps should be taken to enlist the aid of the public and agencies of the public to bring about major improvements in financial support for collections.

During the past several years, there has been growing concern about systematics collections, their condition, their capacities to provide an increasingly diverse spectrum of services, and the quality of their essential partnership with systematic biology. This report is the outgrowth of a number of previous studies and reports concerning the present status of systematics collections and their prospects for the future.

The Committee on Environmental Quality of the Federal Council for Science and Technology, in October 1967, established the Panel on Systematics and Taxonomy (POST). The POST Report, *Systematic Biology: A Survey of Federal Programs and Needs* (9) presented sixteen recommendations to strengthen support for systematic programs in the federal government. *America's Museums: The Belmont Report* (2) addressed the status of the entire system of American museums, and led to increased funding for museum activities through the National Museums Act, the National Endowment for the Arts and the National Endowment for the Humanities. Also, in the early 1960's, an *ad hoc* committee of service-oriented systematists submitted a report to the National Research Council and National Academy of Sciences entitled "Statement of Need for an American Institute of Taxonomic Zoology for Biomedical Research." As a result, a Committee of the Division of Biology and Agriculture of the National Research Council, in January 1970, produced a report, *Systematics in Support of Biological Research* (6), recommending establishment of an American Institute of Applied Systematics which "... would take advantage of existing strengths in systematics at various institutions throughout the country." A book, entitled *The Life Sciences* (3), included the following recommendations: 1) a vigorous program for upgrading the key museums of natural history across the country; 2) development of a plan to identify a limited number of general museums and a group of specialized repositories.

With the support of the National Science Foundation, a com-

mittee of the Conference of Directors of Systematics Collections undertook a survey of the resources and needs of the major institutions that maintain systematics collections and in 1971 published the "Steere Report," *The Systematic Biology Collections of the United States: An Essential Resource. Part I. The Great Collections—Their Nature, Importance, Condition and Future* (4), which identifies the "... critical problems faced by the great systematics collections ..." and recommends "... a strategy for the future."

Richard S. Cowan and Frank A. Taylor in behalf of the Smithsonian Institution convened a meeting on September 29-30, 1971, which was attended by: Robert Brooks (Smithsonian Institution), David Challinor (Smithsonian Institution), Robert Farrell (Smithsonian Institution), Walter Hodge (National Science Foundation), Robert Inger (Field Museum of Natural History), Paul K. Knierim (National Museum of Natural History), George E. Lindsay (California Academy of Sciences), Thomas D. Nicholson (American Museum of Natural History), S. Dillon Ripley (Smithsonian Institution), Reed Rollins (Gray Herbarium, Harvard University), William Sievers (National Science Foundation), and William C. Steere (New York Botanical Garden). This group recommended initiation of studies whose conclusions would be reviewed in a conference on development of a national program for systematics collections and their management. Six committees were formed with the support of the National Museums Act and the Smithsonian Institution: *Relationships of Natural History Museums to Users*, Howard S. Irwin (Chairman); William L. Culberson, Terry L. Erwin, C. J. McCoy and David B. Wake. *National Resource Centers for Systematic Biology*, George E. Lindsay (Chairman); Willard Hartman, Robert J. Lavenberg, Willard W. Payne and George E. Watson. *Specimen Documentation: Data Recording, Retrieval and Exchange*, Richard S. Cowan (Chairman); David M. Bates, Theodore J. Crovello, James F. Mello and Richard G. Van Gelder. *Management of Collections: Curatorial Practices, Operating Procedures, Equipment*, Robert Inger (Chairman); A. W. Crompton, Paul D. Hurd, Jr., James L. Patton and John H. Thomas. *Growth of Collections and Libraries*, Reed Rollins (Chairman); Richard Alexander, Robert S. Hoffmann, Porter M. Kier and Alan Solem. *Present Trends and Future Prospects*, Peter H. Raven (Chairman); Richard S. Bordman, David M. Gates, Philip S. Humphrey and Jerome G. Rozen, Jr.

The resulting "six reports" were presented at the meeting of the Conference of Directors of Systematics Collections (27-28 April 1972) at the Florida State Museum, University of Florida, Gainesville, which was attended by the directors of the member institutions of the Conference and by most of the members of the "six

committees." The "six reports" were revised and presented at the Systematic Biology Symposium held 6-8 July 1972 by the Smithsonian Institution in collaboration with the National Academy of Sciences. The Symposium was attended by 177 representatives of the systematics community.

Following the several presentations, critiques and reviews of the "six reports," Frank A. Taylor and Richard S. Cowan organized the Belmont Writing Committee, which met at the Belmont Estate (Smithsonian Institution, 29 September-1 October 1972) to outline a final report including a national plan. This Committee comprised representatives of the original "six committees," representatives of the recently founded Association of Systematics Collections and others (see inside front cover).

America's Systematics Collections: A National Plan is the direct outgrowth of the Belmont Writing Conference.

At its September meeting, the Belmont Writing Committee agreed that the report should be prepared for submission to the President of the Association of Systematics Collections, who would arrange for its distribution to systematic biologists and other interested persons.

ACKNOWLEDGEMENTS

The year and a half entailed in preparation of the report has been characterized by productive interactions with the systematics community, and reduction in the numbers of committees (and people) actually responsible for preparing the final manuscript for publication. The subcommittee that compiled and reviewed all available materials and prepared this report was appointed by the Belmont Writing Committee as follows: Howard S. Irwin, Willard W. Payne and David M. Bates. Coordination of the review process and final editorial revisions of the manuscript were undertaken by Philip S. Humphrey and the staff of the Secretariat of the Association of Systematics Collections, Stephen R. Edwards and Suzann W. Barr.

The extensive discussions at the Systematic Biology Symposium were recorded and the typed transcripts used by the Belmont Writing Committee and its writing subcommittee in preparation of the final report. Also consulted by the Committee and the writing subcommittee were hundreds of letters concerning the "six reports" and the problems of systematics collections. To the authors (and typists) of these documents, we express our gratitude.

The prepublication draft of the report was reviewed by the Executive Committee of the Association of Systematics Collections and approved for distribution to all who have requested copies. All comments, suggestions and criticisms resulting from prepublication review of the report have been considered in preparation of the manuscript for final publication.

This report would not have been possible without the concern and efforts of many systematists. We are grateful for the special contributions of those who served on the various committees; we are equally grateful to the multitude of systematists who in one way or another provided thoughtful review, criticism and encouragement during the year and a half in which this report was produced.

Special acknowledgement is given to Richard S. Cowan, without whose foresight and leadership many of the necessary steps that led to the development of this document would not have taken place.

We wish to acknowledge S. Dillon Ripley and the Smithsonian Institution for the impetus and special encouragement provided through support of the several committees whose efforts culminated in this report. In addition, we are grateful to Porter M. Kier, Director of the National Museum of Natural History, for his support and encouragement during the final stages of preparation of the

report. Sally Yochelson provided thoughtful assistance with the distribution of the report.

Prepublication duplication and distribution of this report and final publication were made possible by a National Museums Act grant from the Smithsonian Institution to the Smithsonian Research Foundation.

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INTRODUCTION

"Systematics collections of plants and animals are the only permanent record of the earth's biota, and the specialized libraries attached to these collections are the written record of the earth's natural history" (3:354). Systematics collections are complex information acquisition, storage and retrieval systems comprising specimen samples of organisms and associated information about them.

Living collections of plants, animals, bacteria and viruses that are used for classification and identification are considered as part of the larger systematics collections community to which this report is addressed.

Libraries are essential elements of the systematics collections enterprise in that they provide: 1) a means of disseminating information derived from examination of specimens; 2) assistance in identification of specimens; 3) information on the taxonomy, distribution, variation and biology of plants and animals.

The National Plan presented in this report is designed to make systematics collections and their associated institutions a more effective national resource system, better able to serve the needs of systematic biologists and society. Although the problems addressed in this report are of an international character, they are discussed in reference to U.S. systematics collections. It is hoped that in the future these problems will be considered at the international level.

This report comprises: 1) a statement of the primary goals of the systematics collections community; 2) a description of the specific goals of the systematics collections community with respect to improving the condition of the collections and the services they provide; 3) a discussion of systematics in science and society today; 4) a discussion of the problems affecting the systematics collections community; 5) specific recommendations (the National Plan) that will move to resolve the problems and enable the systematics collections community to realize its goals; and 6) a statement of priorities and estimated costs of implementing them.

GOALS OF THE SYSTEMATICS COLLECTIONS COMMUNITY

The primary goals of the systematics collections community are:

1. To improve the condition of systematics collections as a national resource.
2. To improve the quality and efficiency of services associated with systematics collections resources.

The *specific goals* of the systematics collections community concern the quality of the whole information acquisition, storage and retrieval system of systematics collections, and express an ideal that perhaps has been achieved by a few individual collections, but which is far from having been achieved by the systematics collections community as a national, cooperative enterprise.

The quality of systematics collections as an information resource of national importance depends on the physical condition of the collections themselves, the conditions of their storage, management and associated documentation and the principles that are followed in adding new materials to the collections. With respect to these matters, the *specific goals* of the systematics collections community are:

1. Management of the specimen inventory and associated documentation to insure: a) permanent conservation of the specimens themselves; b) ready access to them and their documentation; and c) space, facilities and library resources enabling systematists to improve the information content of the collections through identification, classification and elaboration of the intrinsic information carried by each specimen.
2. Addition of new specimens and associated information that: a) reflect the goals and priorities of basic and applied science; and b) improve the quality and quantity of specimen- and taxon-related data, so that the information content of each specimen is enhanced.

The ultimate test of any information acquisition, storage and retrieval system is its capacity to provide prompt and accurate informational services to those who need them and in the form required. While many or most systematics collections can and do provide specialized informational services to taxonomists and applied biologists in various fields, the capacity of systematics collections as a national resource to provide sufficient information to basic and applied science and education falls short of both present and future needs. Thus, the *specific service-related goals* of the systematics collections community are to:

1. Make available upon demand specimen- or taxon-related information in a variety of useful forms.
2. Enable incorporation of specimens and associated data in the information management system.
3. Enable ready access to the specimens themselves, and to associated documentation and library materials.

Provision of these services depends on careful taxonomic work in relation to the collections; therefore increased participation of qualified taxonomists is essential in the information acquisition, storage and retrieval enterprise of the systematics collections community. Taxonomists provide definitive identifications and classifications that carry important information and permit predictions useful to biologists and applied biologists. The availability of voucher specimens insures that ecological, physiological, zoogeographical or other biological work will not be of reduced value due to questions about accuracy of identification of the organisms involved.

The capacity of systematics collections to provide services is contingent on continuing awareness of the special requirements of those who use or may need to use the services provided by systematics collections.

SYSTEMATICS IN SCIENCE AND SOCIETY

SYSTEMATICS AND SCIENCE

Systematics is one of the fundamental perspectives in biology. It involves integration of fields such as ecology and behavior with functional morphology, biochemistry, genetics and evolution. It seeks to determine the attributes of species, how current species relate to those of the past, what mechanisms account for their extinction and how the multitude of species cohabits our planet. Systematists also have the task of finding, observing, describing, cataloguing and ascertaining relationships among the kinds of organisms.

"Although . . . systematics is a field concerned with diversity, the wide applicability of certain unifying classificatory principles and procedures is becoming increasingly evident. . . . The importance of taxonomic classifications, not only for keeping track of information about organisms, but also for summarizing this information and predicting the characteristics of incompletely studied organisms . . . is increasingly clear. . . . Classifications based on large numbers of characters are essential for such predictions and such classifications are a major concern of systematic biology" (8:5).

Dessauer (5:348) commented that "Biochemists and biophysicists are finding that much molecular data 'makes sense' only when organized according to natural groupings and analyzed in the light of evolutionary theory." The principles of systematic biology apply to biological systems and processes at whatever level of organization or integration. Current trends in systematic biology, and in the rest of biology as well, lead inevitably to a reduction in the artificial compartmentalization of biology as a whole.

Modern systematic research combines the talents of the molecular, the genetic, the organismic and the population biologist. Kruckeberg (7:197), a biochemist, noted that "The biologist who dares to ignore the provincial boundaries can, with broad training and insight, approach any of the limitless interfaces between ecology, systematics, and evolution. Then he can confront effectively the most fascinating problems of all—why organisms are where they are, and why they do what they do. In a nutshell, super integration of the three fields of synthesis truly will give us a twentieth century natural history."

Our concepts of the living world are being changed profoundly by interactions among once discrete, even isolated areas of thought. Answers to some of the most significant and urgent questions being posed by society today increasingly demand data from systematics integrated with genetics, evolution, molecular biology, biochemistry and ecology. The availability of modern high-speed data

processing machinery and methodology enable use and manipulation of the staggering bulk of available information in ways never before possible. It is therefore reasonable to expect that highly significant ecological and ecosystematic generalizations will emerge, particularly in the broad interface between ecology and systematics. Such interpretive schemes will depend on the accessibility of large, well organized collections of organisms.

SYSTEMATICS AND SOCIETY

Historically, much of the early impetus for the development of collections of specimen examples of living things stemmed from interest in the nutritive and medicinal properties of plants and animals. Today, systematics applied to the solution of human problems is important in the health sciences (epidemiology, pharmacology), the study of human food resources (agriculture, fisheries, pest and disease control), the search for utilizable natural resources (minerals, energy, construction materials) and the rapidly growing concern for the quality of the environment (impact assessment, rare and endangered species, indicator species of pollution).

Many examples of the application of systematics to the study and solution of human problems have been presented in other reports (see PREFACE and REFERENCES CITED).

A persuasive expression of the application of systematics to ecology, a field of growing importance in the national concern for problems involving the environment, was made by E. O. Wilson (10): "Most of the central problems of ecology today can be solved only by reference to details of organic diversity. Even the most cursory ecosystem analyses have to be based on sound taxonomy. And after the first broad measurements of energy flow and geochemical cycling have yielded their important but limited information, what remains of intellectual challenge stems chiefly from details of the biology of a particular species. The food nets, the fluctuation of population numbers and biomasses, the diel and seasonal rhythms, the rates and patterns of dispersal, the colonization of empty habitats, microevolution, physiological adaptation, and most other basic topics of ecology, require a deep understanding of the biology of individual taxa. Progress depends not just on correct identification of species, but also on the mastery of larger taxonomic groups of the kind best achieved through deliberate specialization by taxonomists or taxonomically trained ecologists."

The identification and study of fossil organisms long has been an invaluable tool in stratigraphy. Stratigraphic studies, in conjunction with modern physical methods for determining geochronological age, are now being used to evaluate theories of plate tectonics. In combination, the biological, physical and geological in-

formation from these studies has led to profound revision of our concepts of the history of the earth—a subject of no small concern to petroleum, mining and other extractive industries, on whose success in finding the substances and energy resources of modern industry depends the continuation of civilization as we know it.

Technological means are now available to improve knowledge of the distribution of living things, to monitor the health of crop plants and to determine the effects of environmental modification on communities of organisms. No matter what technological achievements are brought to bear on these and related problems, the solutions ultimately will depend in part on data from systematics collections.

The application of systematic information to problems of human health, food resources, environmental quality and the location and utilization of natural resources will increase substantially, given the availability of systematics collections capable of providing services adequate to current and potential needs.

SYSTEMATICS AND EDUCATION

Systematics collections serve a multiplicity of educational purposes, including provision of: 1) identified specimens and related information for exhibits; 2) the basis for major natural history publications in great demand by the public; 3) an important resource for elementary, secondary and post-secondary curricula in the life sciences; and 4) a tangible record of organic evolution and the diversity of nature.

Educational services offered by institutions housing systematics collections include identification of organisms, formal lectures on every conceivable facet of systematic biology and access on a general level to highly technical information. Each institution, in the light of its own strengths and weaknesses, must chart a course for meeting the growing needs of the public for educational services that will increase public understanding of, and appreciation for, the living environment.

As systematics is one of the fundamental perspectives in biology, it is essential to an integrated undergraduate curriculum in the life sciences in colleges and universities. A background in systematics is prerequisite to a full understanding of many other fields of biology. And systematics collections form an integral part of this educational experience.

At the graduate level, the student of systematics is an apprentice scientist, actively engaged in original research as well as other academic pursuits. All of the facilities required to support research at a professional level must be supplied him, and many of the prerogatives accorded faculty or senior curatorial personnel become

his. Graduate programs in systematic biology require substantial support for collections, laboratories, libraries and faculty, not only from the institution of which the student is a part, but also from the discipline as a whole, for the graduate student, like other systematists, needs specimens, loans, information and other forms of assistance.

Systematics collections and their associated resources are vital to graduate programs in that they provide materials for research as well as give the student a synoptic view of the organisms in which he has an interest.

Improvement of the condition of systematics collections and the services they provide ultimately will depend on the quality and effectiveness of the education and training programs that will develop the required scientific, technical and service personnel.

PRESENT STATE AND PROBLEMS OF SYSTEMATICS COLLECTIONS

Systematics collections in the United States comprise approximately 200,000,000 specimens, cared for by more than 1200 institutions. Accurate information on the number, quality and kinds of systematics collections and the circumstances of the institutions caring for them has not been compiled. Nevertheless, on the basis of currently available information, annual growth of systematics collections is estimated at 1% to 2% per year, or an annual increment of approximately 2,000,000 to 4,000,000 specimens—the annual equivalent to the total holdings of a medium-sized museum. At the maximum rate it is estimated that U.S. systematics collections will double in size in 30 years. In short, U.S. systematics collections are not in a “steady state” condition. They are growing rapidly and, in large part, for reasons beyond the direct control of the systematics collections community. It is, however, essential to recognize that part of this growth results from research activities and is important to the “health” of the collections. Were the systematics collections in a “steady state” or “no growth situation,” the problems besetting them might not be so urgent. As it is, the problems attendant to expansion inevitably intensify year by year and the solutions become more difficult and expensive to implement.

Many of the more than twelve hundred institutions housing systematics collections have solved various of the problems discussed below. Nevertheless, achievement of the goals of the whole systematics collections community requires cooperative efforts to solve these problems at the national level.

The inadequacies and problems that must be recognized and solved before systematics collections and the services they provide can become a more efficient national resource fall into the following categories: A) Information; B) Standards; C) Resources; D) Management; E) Support.

INFORMATION

1. Correlative information concerning the distribution, condition, quality, rates of growth and needs of systematics collections has not been compiled.
2. More complete information on costs of facilities, personnel and management of systematics collections is needed.

Our ability to define the problems of systematics collections is hampered by inadequate information concerning the distribution, condition, quality and needs of systematics collections and their associated resources. Furthermore, information on costs of the resources needed for the support of systematics collections is limited.

The lack of statistical information concerning systematics collections makes it difficult to provide more than qualitative descriptions of problems affecting them.

- 3. Those who manage systematics collections are, for the most part, insufficiently aware of or not prepared to meet present and probable future needs of systematic biology, science and applied science for information, services and research support.**

Direct, almost commercial application of taxonomic knowledge is an emerging development that has major implications for systematics collections. The widespread and increasing need for identification of organisms of consequence to public health, agriculture and environmental assessment should be stimulus enough for more effective development of appropriate identification and other systematic services. Requirements of ecologists and oceanographers for identifications will increase sharply in relation to programs like the International Biological Program (IBP), the International Decade of Ocean Exploration (IDOE), and as yet unplanned but urgently needed efforts to sample changing and threatened environments.

The broadening nature of research in systematic biology results in changing demands on systematics collections. Acquisition policies of institutions holding collections should reflect or anticipate these changes. Curatorial procedures should be modified, if necessary, to accommodate new materials preserved in different ways than in the past.

The systematics collections community, lacking concise information concerning present and emerging needs of systematic biology, basic science and applied science, cannot plan effectively to meet the present and anticipated needs.

STANDARDS

- 1. Standards for acquisition of specimens, where existent, have arisen from internal priorities rather than national priorities. This has led to unplanned and uncontrolled growth of collections, and to many of the secondary problems that have resulted, such as shortages of space, personnel and equipment.**

An accurate census of specimens in systematics collections in the United States is impracticable; many collections either lack numerical catalogues or maintain records by lot instead of by individual specimen.

Plans and priorities cannot be fully established without an analysis of current specimen holdings on a national basis. Signifi-

cant gaps exist in the quality, depth and coverage of our collections. As new analytical techniques are developed and demands for new kinds of service emerge, many of our present collections will be unable to satisfy the new needs.

In view of limited resources and the high costs of collection growth, acquisitions policies must be formulated to support not only enlightened institutional goals, but new national goals as well.

Growth has been erratic in most systematics collections throughout their history. Acquisitions have been influenced more by the existing representation of particular groups of organisms at an institution than by any long-range plan. Generally, the most valuable specimens added to a collection have been those collected by a systematist in connection with his own research problem, although collecting not associated with specific kinds of biological research, when done by experts, can and often does result in highly significant new material. Also, collections similarly made of poorly known groups often are of great importance.

Nationally important collections are at present substandard, not just because they contain too few specimens or specimens from areas too limited, but more importantly because many specimens have been prepared poorly or improperly and lack sufficient accompanying data. The continued use of funds to purchase specimens of relatively low quality and of limited value to collections cannot be justified.

One of the ultimate consequences of unstructured growth of systematics collections is that available space is filled more rapidly than anticipated. In most museums the crowded condition of the collections inhibits integration of new materials, frequently intrudes into work space needed by specialists and students and diminishes the accessibility of specimens.

Some institutions have dealt with problems of collection maintenance and space by transferring their collections to other institutions. Such transfers are bad for systematic biology because they reduce the diversity among centers of systematic research and limit the potential for training systematists and performing service functions. Nevertheless, inevitably there will be situations in which an institution having important systematics collections is unable or unwilling to continue to support its collections at an adequate level. Under such circumstances, the collections should be transferred to another institution rather than be permitted to remain neglected to the point that irreplaceable materials are destroyed.

Given the current level of staffing for most of the largest systematics collections, growth in numbers of specimens is at a point where new additions reduce the research productivity of systematists in curatorial positions. Even when the curation of specimens is delegated to subordinates, loans, public service and administra-

tive and supervisory activities continue to be a drain on the systematist-curator's time. In many institutions, the service requests to a collection-based systematist grow more rapidly than the collection. One of the real problems involving collection growth is that the increase in the number of professional systematists is not sufficient to meet the continuing need for increased research in systematic biology. Further, there are no funds to employ additional systematists, even if they were available.

Even though electronic data processing can provide vastly improved access to specimen-related information, ultimate taxonomic validation of this information requires that the specimen itself be examined. This requires that the collection be in good order and readily accessible. Moreover, systematists, systematics collections and systematic library facilities are inextricably linked, and for proper and efficient collection-based activities they must be kept in close proximity.

Coping with the anticipated growth of systematics collections will require additional contiguous space, improved techniques of collection management and an increase in supporting staff commensurate with collection growth. Present staffing of collections is so inadequate that it cannot be used as a baseline for judging future needs. If major collecting efforts such as the International Decade of Ocean Exploration (IDOE) or the International Biological Program (IBP) are initiated in the future, provisions should be made to insure that the implications for collection growth are understood in advance and are provided for in relevant proposals for funding.

- 2. Standards for specimen documentation, preservation and storage are varied and uncoordinated. Thus present and probable future information and service needs of systematic biology, science and applied science in general cannot be satisfied effectively.**

As interest in and support of systematic biology increases, the questions asked by systematists become more sophisticated and require consideration of new kinds of information from specimens. For example, the needs of systematic mammalogists have expanded from the "skin and skull" to include karyotype and biochemical data. Specimens in old collections often cannot be used to answer new questions. For example, in mollusks the traditional "empty shell" preservation facilitates adequate study of some aspects of variation, the delimitation of geographic ranges and usually the identification of species. But studies of classification and phylogeny, and the initial delineation of species, require that entire organisms be preserved in alcohol for dissections, in formalin or Bouin's Fluid for histological examination, in osmium tetroxide for electron microscope examination of soft tissues and in other fixa-

tives for studies of chromosomes. For virtually every group of living organisms, similar additions to and extensions of the older techniques of preservation are required for modern research in systematics.

Universal standards are yet to be developed for the data recorded in the field when a specimen is collected, or in the laboratory when attributes of the specimen are studied and measured. The kinds of data associated with specimens and the ways in which specimens and data are gathered and preserved determine the scientific value of the material. These are aspects of collecting that necessarily vary from group to group and for which standards can only be determined by the specialists doing research on each group of organisms.

Questions asked by biogeographers, ecologists, agriculturists and public health officials require different arrangements for data storage than are customary in collections arranged by species. The types of data recorded and methods of storing, retrieving and correlating specimen data are inadequate to meet present and anticipated needs.

The extent to which such techniques as electron microscopy, chromosomal typing and biochemical analysis can extract data from specimens now in systematics collections is severely limited by the use of inadequate methods of specimen preparation and preservation. Innovation is needed in collection management to develop new and better ways to preserve organisms and to extract data from them both before and after preservation.

The pace at which habitats are being altered and organisms are becoming extinct is accelerating so rapidly that statements of the early 1950's, such as that predicting that undisturbed tropical rainforests would last only until 2000 AD, today seem incredibly optimistic. Whereas we should save samples of the world's biota for posterity, we must at the same time face the question of *how to maximize the future usefulness of the specimens we procure*. Many systematists find that material gathered in the course of "general collecting" does not measure up to the requirements of today's questions in systematics. Nevertheless, for some groups of organisms, the present level of knowledge is so limited that almost any specimen, even with limited data, will be of some value.

RESOURCES

1. The resources of systematics collections are not adequate for current service demands, nor for anticipated future service demands.
2. Space, personnel, supplies and equipment for systematics collections are not adequate to meet either present needs for collection storage or the needs that anticipated growth of the collections will impose.

3. Personnel, equipment, library and publications (information transfer) resources of systematics collections are inadequate for the needs of the systematic biological research on which the collections depend for their quality and usefulness.

"The kinds of facilities employed for institutional collections, whether federal, state, university-supported, or private, are largely similar: space for housing specimens; staff offices and work areas; associated research laboratories and libraries; and resources for the necessary functions of curation, service, and information exchange. Most of the taxonomic units [of the Federal facilities surveyed] do not now have sufficient space and storage equipment for research and collections care. . ." (9:33).

A survey of major U.S. systematics collections found widespread and critical deficiencies in the space, personnel, library and equipment resources needed for effective use of existing systematics collections (4:17). Most systematics collections are housed in physical facilities that are obsolete in design and inadequate in size, storage capacity and office space. Most major collections are located in metropolitan areas where space is limited and property values and construction costs are high, and the deficiencies of physical-plant features such as temperature and humidity control are destroying the specimens.

Shortage of trained personnel is one of the most critical problems affecting systematics collections. Inadequate staffing is the basic reason why many systematics collections are inadequately curated, difficult to access and incapable of providing effective services. Serious personnel shortages exist at all levels, from clerical and technical support and service personnel to research scientists.

"At present many investigations of plant and animal communities are limited by inadequate knowledge of classification for certain types of organisms and a severe shortage of systematists who can provide identification and reference services' (*Restoring the Quality of Our Environment*, PSAC Panel Report on Environmental Pollution, 1965). The multitude of service identifications for ecologists, amateurs, public health officials, and stream or forest surveys; the requests for lists of organisms to prepare impact studies; the needs of pollution monitoring—these and other economically oriented service needs have far outstripped the capacity of collection managers and systematists to cope with the flood of requests.

"Support personnel are used for a variety of assignments to free professional taxonomists from routine tasks and to make more effective use of their training and experience. Support skills range from repetitious work to tasks of highly skilled specialists: bottle

washers, research assistants, preparators, cataloguers, scientific illustrators, taxidermists, photographers, computer programmers, and, of course, clerical and secretarial help. Without adequate supportive assistance, the scientists themselves are forced to carry out these chores. . ." (9:28).

"... no agency approaches the 3-to-1 personnel ratio regarded by the Panel as desirable for Federal systematics laboratories. It is also evident that the average amount of assistance in all agencies, already below standards, decreased between FY-1967 and FY-1968. If there is one point that should be emphasized in this report, it is the lack of sufficient supportive personnel throughout the taxonomic programs. . ." (9:28).

"With but few exceptions, reliable and authoritative identification can be provided only by a small group of curator specialists staffing the few American museums with large, comprehensive reference collections and extensive libraries. These curators are at present invariably overworked, understaffed and unable to cope with the flood of demands on their time; thus the needs are often poorly served. Available comparative collections are frequently inadequately curated for proper study. . ." (6:8).

"Systematists at the Ph.D. level require years of training. Moreover, they rarely wish to devote full time to service aspects of systematics. Fully qualified, Ph.D. level research personnel should produce the tools (keys, monographs, computer programs, etc.) that enable others to do much of the routine work. An occasional misidentification would result, of course, but with research personnel available to check doubtful cases, such eventualities would be minimal. . ." (6:14).

Evidence suggests that increased specialization and more sophisticated demands require greater growth rates for the cadres of service personnel than for the collections with which they are associated, but no study of this important problem has been made.

Systematics collections do not have sufficient ancillary equipment for taking measurements, microscopy (phase-contrast, scanning electron microscopes), preparing skeletal material (dissecting equipment, dermestid colonies) and electrophoretic studies.

Library holdings provide an essential resource for research in systematic biology. The specialized systematics libraries that have grown with collections and research are not limited to bound books and periodicals; they may also include a variety of related aids: various card indices, catalogues, manuscripts, illustrations, microfiche records of historically important herbaria, cartographic information and bibliographical and biographical files.

Although the problems that libraries face and their prospects for the future closely parallel those that confront collections, libraries also have unique problems. The enormous proliferation of scien-

tific literature over the past few years has exceeded the acquisition capabilities of financially deficient institutions. Also, special funds are no longer available for needed maintenance and restoration of valuable reference books. Thus libraries must continually re-evaluate their own acquisition policies to reflect a budgetarily sustainable growth rate. Unnecessary duplication of effort, omission of important data from studies and the restriction of knowledge are all possible consequences of inadequate systematics library resources.

Publications provide the primary medium for the dissemination of information among those who use systematics collections. Existing support for publications is inadequate and there are insufficient publications to serve effectively audiences concerned with applied systematics.

4. Cataloguing, specimen storage and specimen related data management systems are not designed for the information and service needs of science and applied science.

Specimens often are collected for practical and authenticative purposes that exploit only a small portion of the data they contain. Long beyond the satisfaction of immediate needs, these specimens continue to be stored, and the collections they augment gradually become more valuable as a scientific resource. Our abilities to find and use effectively the data specimens can provide are limited by the enormous volume of material, its dispersion and the manual techniques for maintaining records and retrieving information from them.

The potential for manipulating and retrieving data could be greatly improved by application of electronic data processing (EDP) technology. EDP offers possibilities for automating data-file searches and for querying files through numerous subject-area entry points. Other advantages to application of EDP are found in the management of collections, e.g., the control of loans, restructuring of collections and production of documents such as labels, file cards and catalogues.

Although collections now exist primarily to serve systematic biology, other disciplines, such as ecology, physiology, anatomy and morphology, could benefit from increased access to living and preserved collections and the data they contain. This access, especially to preserved collections, is often difficult for those disciplines because most collections are arranged taxonomically, and the serial catalogues (when they exist) in which the information about the collection is recorded, are arranged chronologically. Thus, queries must be reduced to appropriate taxonomic or temporal terms or they cannot be answered efficiently.

Improved access to systematics resources is a key to encourag-

ing and upgrading specimen based research, and essential to improving the level of services provided to science and society by systematists.

5. Automated systems for cataloguing and managing specimen-related data are imperfectly designed and lack standardization. Difficulty in adopting automated systems in systematics collections relates principally to incompatibilities of hardware and software and inadequate attention to the needs of curators and cataloguers for a convenient and utilitarian system.

Although EDP systems and computers are recommended as solutions to the inadequate specimen and specimen-related data management systems of systematics collections, currently available EDP systems have a multiplicity of shortcomings that have impeded their acceptance and implementation in the vast majority of systematics collections.

Several EDP systems are designed for systematics collections, each having different characteristics and potentials for service. Most curators and systematists are reluctant even to select a given system for possible future use because of uncertainty as to which system ultimately will be the "best." Until recently little has been done to assist the systematics collections community in evaluating the available EDP systems.

Most, if not all, available systems are difficult to transfer from one institutional computer facility to another because of "language" problems and inadequate documentation of software. Moreover, implementation almost invariably requires the time and expense of programmers who must be employed to get the system "up" and going.

Finally, none of the available EDP systems has been described and documented in convenient, user-oriented manuals that would enable curators to adopt and implement EDP cataloguing conveniently and with a reasonable understanding of all associated costs.

MANAGEMENT

1. The heterogeneous administrative environments in which systematics collections are managed do not have reward systems designed to assist in achieving the goals of the systematics collections community.

"In universities and in government agencies promotion depends mostly upon research productivity. Moreover, a feeling of accomplishment and of doing something interesting characterizes research activity, whereas identification work is for the most part

considered repetitive and tedious—the common species turn up again and again. Thus it usually works out that the more active and original a [systematist] is as a researcher, the less service he provides as an identifier. For such practicing systematists, it is easy to see a conflict between professional advancement through research on the one hand and systematic service on the other. Unless personnel job descriptions clearly state the responsibility for identification work, there is a very human inclination to shun it" (6:13, 14).

The reward system for members of the systematics collections community is not geared to the problems that need to be solved; this is a complex management problem, the nature and complexity of which vary with the kind of institution in which a given systematist-curator is employed. For what and by whom is a systematist-curator being rewarded? Within the systematics collections community, the systematist-curator receives the reward of increased professional status for producing high quality research and such collection-related services as identifications and the loan of specimens. The monetary rewards of systematist-curators in colleges and universities are for teaching, service and research—with increasing recent emphasis on teaching and service to the school. There is a growing tendency for systematist-curators to find themselves stuck in a double reward system in which those things that improve their status in the profession *do not* bring in a larger pay check. Moreover, existing reward systems do not provide incentives for systematist-curators to improve standards of collection growth, standards for specimen related data, standards for service to systematic biology or to provide identifications and other services to those agencies that require them.

As most of the "status" rewards in systematic biology come to those who produce good research, systematists argue that funds should support the generation of more research rather than any improvement of the whole systematics collections system in terms of its standards, management and the services it can provide to the rest of science and society. Any diversion of funds away from research for activities that are not directly rewarded in the peer group system is looked upon with distrust and suspicion.

2. Most institutional administrators responsible for systematics collections have not planned for the future of their institutions with respect to making systematics collections a more effective national resource.

The field of collections management is largely cryptic and undefined, and only slightly and as yet haphazardly developed. Present and future demands for biological data, especially when coupled with problems of collection growth, require that collec-

tions be managed institutionally and collectively in ways that foster their more efficient utilization.

The great post-World War II influx of new specimens, increased use of collections for diverse purposes and spiralling maintenance costs lead to the inescapable conclusion that new approaches are needed to the management of systematics collections.

Depending on the degree of administrative responsibility within an institution, systematics collections may be plagued by annual uncertainties concerning the sources and amounts of budgets. Such uncertainties, coupled with the lack of apparent institutional commitment, do not encourage the planning efforts needed to make systematics collections a more effective national resource.

During the past hundred years, increasing numbers of institutions have been faced with the problem of what to do with systematics collections built up in the past by staff members who are no longer active, and that are of little current use to existing staff. This problem is especially acute for universities. A particular biologist during his lifetime may influence a university to invest many thousands of dollars in a systematics collection that may be irrelevant to the purposes of the university after he leaves. The point is, of course, that such collections are not irrelevant to the development of systematic biology as a whole.

It can be a distortion of the educational function of a university and a disservice to the proper development of the science of biology to use the mere presence of a collection as an excuse for making an appointment in a particular field of systematics. Faculty members should be chosen as potential contributors to the educational program of a university rather than as caretakers of specimens left behind by others.

In the long run, the development and maintenance of small and medium-sized departmental collections in universities depend on the continuing influence of the faculties of these universities. Individual systematists may feel that the presence of a collection of some kind in association with a university department is an essential factor in undergraduate or graduate education and, if so, then it is obligatory to influence the university to build or maintain such a collection. On the other hand, if the university is unwilling to maintain a particular collection, ways and means must be found to transfer the collection elsewhere so that it is not lost as a resource of systematic biology.

Probably fewer than ten universities in the United States have collections that are unquestionably of great national significance. At these universities, specialized kinds of graduate education can be conducted that are impossible elsewhere. In addition, these universities with major collections serve a dual function as educational institutions and systematics centers of national importance. It is

clearly in the national interest that large collections be maintained at some universities, but the maintenance of these collections poses special problems for the institutions in which they are housed.

3. Because of parochial institutional traditions, there has been little cooperation among those responsible for systematics collections.

Today the principal use of most systematics collections and their associated resources is research. The published and as yet unpublished results of this research are used, in turn, mostly within the systematics collections community. To a very great extent, the research enterprise is highly personal and appears to be affected principally by the peer group of systematists concerned with a given group of organisms. Educational use of systematics collections and associated resources appears to be dedicated largely to adding new members to the peer group of specialists concerned with studying particular groups of organisms. Little educational use of the system is made for the training of professional service personnel or for the training of professionals concerned with "applied research" uses of systematics collections and their associated resources.

Most members of the systematics collections community would argue that the problems associated with systematics collections and the services they can or should provide could be solved if there were adequate funds to improve the condition of the collections and their associated resources and to provide adequate professional service personnel to manage the collections and their services. This still would not solve what are probably the most important problems; that is, those associated with the systematics collections community as a *cooperative enterprise*.

There is not *one* systematics collections community, but many discipline-oriented ones, operating more or less independently. Our ability to solve common problems and achieve the goals of 1) improving the services of systematics collections and associated resources to science and applied science, and of 2) improving the condition of the collections themselves so they are a more effective national resource will continue to be limited until the systematics collections community begins to act as *one* community instead of many, independent discipline-oriented ones. Moreover, if the systematics collections community as a whole can improve itself as a cooperative enterprise, there will be much greater likelihood that it can generate the kinds of biological syntheses and generalizations that depend on a systematic approach to the great diversity of living things.

SUPPORT

- 1. The public and agencies of the public are insufficiently aware of the availability and usefulness of systematics collections and the services they provide or could provide.**

This is basically an information and public relations problem. Whereas many museums throughout the country have developed outstanding service and educational outreach programs in their local communities, the systematics collections community has done little at the national level to increase public awareness of systematics collections and their associated resources and the various services they can or could provide. Increased public use and support of the resources of systematics collections cannot take place if the public is unaware of the existence of these resources.

At the same time, according to the "POST Report" (9:28), federally sponsored service-oriented systematics collections have a very high demand for their services while inadequate personnel resources prevent them from providing the services fully and adequately.

- 2. The presently available services of systematics collections are not used as effectively as they might be in the larger public interest.**

"In the past, applied systematics has been inadequately utilized and inadequately coordinated for the best development of applied biology. . ." (6:3).

Systematists familiar with available systematics services usually are not involved in the planning of programs whose successful implementation depends ultimately on systematics services.

A number of museums have demonstrated that systematics collections are an important educational resource for elementary and secondary schools. At the national level, actual and potential educational services of systematics collections are neither widely recognized nor effectively utilized.

- 3. Financial resources needed to solve the immediate and most urgent problems of systematics collections have not been made available.**

It has been said that for both survival and aesthetic reasons society needs to know what organisms it is coexisting with and how to manage them. How well is the systematics collections community satisfying that "need to know" and how much is society willing to pay for this knowledge?

"... many . . . collections are in buildings that have not been overhauled in decades and may be almost a century old. The major systematic biology collections are national assets and should be

treated as such; many of them desperately need help now. . ." (3:356).

Solution of the general financial problems facing systematic collections and their associated libraries is critical to the implementation of any national effort. Increased levels of funding must be forthcoming for increases in numbers of professional and professional service personnel, for operating expenses and for the purchase of equipment. A second financial consideration is related to the formulation of any national effort. Planning and coordination imply the creation of councils and advisory committees to receive continuing communication from all segments of the systematics community. Such groups require budgets sufficient to implement the mandates given them. Justification for these expenditures may be found in increased quality, productivity and efficiency in the disciplines that, in turn, permit systematic biology to meet in a more meaningful way its societal and scientific obligations.

A technologically dependent firm that spends nothing on research and development soon becomes obsolete, if not bankrupt. Yet the financial squeeze affecting systematics collections has prevented adequate housekeeping, and has discouraged research into innovative techniques of specimen preparation, preservation, curation and data storage.

"The principal obstacle to developing appropriate numbers of technicians and service specialists in systematic biology has been economic; there are but few paid positions for such people. Yet they would greatly increase the potential for applied systematic work in the United States. . ." (6:14).

Financial problems facing the systematics collections community include the following:

- a. Inadequate federal and state assistance in solving immediate and critical problems of space, personnel, equipment and services.
- b. Little federal or state assistance in development of plans and mechanisms for the implementation of plans to improve systematics collections as a national resource.
- c. Little or no provision for the needs of systematics collections in the development of budgets in support of national, state or regional programs of various kinds (International Biological Program, environmental impact assessment, etc.). Costs imposed on systematics collections are not taken into account in the development of programs that depend, in part, on applied systematics services.
- d. Applied systematics services are not paid for by the recipient, and thus users of these services do not incorporate such costs into their budgets. There is no fee structure or

system whereby the user community could in part support applied systematics services.

4. Research in systematic biology receives inadequate public support.

"Today, the life sciences are poised to explore the most arcane mysteries of life and they can attempt to provide a foundation for the measures required to counteract some of the oldest enemies of man—the diseases to which he is subject—to protect the quality of the environment and the habitability of planet Earth, to assist in limiting the burden of an excessive human population, and to assure an adequate food supply for all.

"No guarantees can be offered in conscience. But should the effort fail, it should not be for lack of trying. Today, as yesterday, it is difficult to imagine more noble goals or more appropriate use of public funds. For much of the endeavor the pace of progress will be determined by the generosity of public support. But as, increasingly, the life sciences become 'big science,' then, as in the physical sciences, the magnitude of public funding will determine not merely the pace of progress but whether, indeed, there is to be progress" (3:356).

"While many museum scientists depend on specialized collections in conducting their investigations, an increasing number engage in field and laboratory experimental studies of living organisms, or of ecological problems in natural settings. Their collections provide the basis for taxonomic-classification services necessary to many other scientists and also provide a baseline for ecological studies" (3:275).

At a time when national needs for ecological and applied systematic information are being expressed in the most urgent terms, the basic research required to satisfy these needs is not receiving adequate public support. Whereas needs for more and better systematic and ecological research become increasingly evident, the funds required to train and support the systematists and applied systematists qualified to undertake the research are becoming decreasingly available.

There is inadequate provision for support of the systematic research urgently required to improve the quality of systematics collections as a basic data resource for science and applied science. Ultimately the quality and utility of the collections depend on the quality of the science utilizing the collections and thereby enhancing them.

THE NATIONAL PLAN

The National Plan comprises a series of recommendations that, when implemented, will solve the problems outlined in the previous section and, given appropriate funding, enable the systematics collections community to achieve its several primary and specific goals.

Many problems afflicting systematics collections in the United States ultimately can be traced to the fact that the people and institutions responsible for systematics collections have not behaved as a cooperative community responsive to the needs of science and society and capable of reaching common agreement concerning matters affecting the condition and use of systematics collections. In short, a high level of organization within the systematics collections community as such has not existed. Until it does, such resources as become available in support of systematics collections may be limited and inadequate to the challenge of the several goals articulated earlier in this report.

Thus, the first recommendation of the National Plan concerns support of an organization that enables the institutions responsible for systematics collections to function as a cooperative enterprise in the larger national interest.

Subsequent recommendations concern steps the systematics collections community should take—in concert with scientists, applied scientists and educators—to improve the condition of systematics collections as a national, service-oriented, scientific resource.

Systematists' discussion of mutual problems has resulted in efforts to solve, or at least alleviate, some of the problems cited in the preceding section. A major result of the discussions which led to the preparation of the present report was the establishment of the Association of Systematics Collections (ASC).

RECOMMENDATION 1: Support and strengthen the Association of Systematics Collections, an organization dedicated to improving the condition of systematics collections and their services (see Priorities A-1 and 2).

The Association of Systematics Collections (ASC) was established in July 1972 "... to foster care, management, preservation and improvement of systematics collections and to facilitate their utilization in science and society by:

1. Providing representation for institutions housing systematics collections;
2. Encouraging direct interaction among those concerned with systematics collections and their use;
3. Providing a forum for consideration of mutual problems;

4. Promoting the role of systematics collections in research, education, and public service through:
 - a. the coordination of information concerning needs of users,
 - b. the planning of advisory services,
 - c. the development and implementation of national goals and priorities;
5. Other means and devices which shall be determined from time to time by the membership" (1:1).

The ASC has taken the initiative and accepted the responsibility for coordinating development and implementation of plans relating to the condition and use of systematics collections as a national resource. Any institution housing collections, living or preserved, of systematic value is eligible for membership in the ASC. The Association is organized for purposes of promoting action at all levels, is constituted to be responsive to the concerns of any appropriate organization, discipline or individual and is expected to have a membership of 200 or more institutions. The ASC is administered by representatives designated by the director or chief executive officer of each member institution. Coordination of activities of the ASC is accomplished through the Board of Directors and a permanent Secretariat.

Through establishment of a series of ASC Councils (see Recommendation 2) and Advisory Committees representing various segments of the systematics community (see Recommendation 3), a mechanism of communication, coordination and action will emerge to the ultimate benefit of systematics collections and those who use them.

Further development of systematics collections as a national resource requires establishment of a strong working collaboration between those responsible for systematics collections and those who use them. The ASC by itself cannot bring this about; what is required is the active participation of the scientific community through professional societies and the community of applied scientists working in the public interest through various federal, state and local agencies. This participation will be encouraged through a system of professional society Advisory Committees and ASC Councils.

RECOMMENDATION 2: Establish a series of ASC Councils to study specific problems relating to systematics collections (see Priority A-3).

Provision for the establishment of the recommended system of Councils exists in the Constitution and By-Laws of the ASC (Article XII, p. 8):

In the pursuit of its objectives, the Association shall seek advice and recommendations from the communities of science and society that are users of systematics collections and the knowledge derived therefrom. To this end, the Association shall appoint and support action groups, to be known as . . . Councils, to study specific problems relating to the care, management and use of collections, and other matters relating to the objectives of the Association, and to recommend to the Association policies, procedures, or solutions with respect to the problems under study. Such . . . Councils may be temporary or permanent, and may be changed from time to time as the needs and priorities require.

To insure adequate representation on each Council, nominations for Council membership will be solicited from:

1. Designated representatives of ASC member institutions.
2. Advisory Committees of professional societies and other groups.
3. Organizations or agencies concerned with applied systematics, and employing service-oriented personnel.
4. Persons or organizations able to provide expertise pertaining to accomplishment of the goals of a given Council.
5. Appointed Council chairmen.

Each Council will be representative of the concerns of those responsible for systematics collections and those who use them. The proposed Councils are:

1. Council on National Systematics Collections Resources.
2. Council on Standards for Systematics Collections: Specimen Documentation, Collection Growth, Specimen Acquisition, Specimen Storage, Data Acquisition and Inter-institutional Loans.
3. Council on Electronic Data Processing.
4. Council on Personnel Needs of Systematics Collections.
5. Council on Systematics Collections and Environmental Quality.
6. Council on Research and Graduate Education in Systematics.
7. Council on Libraries and Publications.
8. Council on Improving Public Awareness of Systematics Collections.

Additional Councils may be established as needed.

ASC Councils will have policy, planning and administrative responsibilities within the areas stated or implied in their titles. They will be responsible for identifying national resources and determining national needs. Councils will be charged with responsibility to answer questions posed about national resource matters by federal agencies or by the ASC. They will seek to implement suggestions coming from Advisory Committees. They will request and collate

information from Advisory Committees, and will pass to them appropriate assignments from the ASC. ASC Councils will present the results of their deliberations to the ASC for action, or may be charged by the ASC to take action themselves.

The President of the ASC will limit membership on a Council to 12-15 members, including the chairman; initial appointments will be staggered for terms of 1, 2 and 3 years to insure full opportunity for representatives from all areas to participate in Council activities. The Board of Directors of the ASC will determine the term of each Council member.

The procedure for selection of Council members is as follows:

1. The ASC Secretariate receives nominations and forwards them to the appropriate Council chairman.
2. Each Council chairman reviews all nominations and submits his recommendations to the ASC Secretary, who distributes them to the Board of Directors.
3. The Board of Directors reviews all nominees, and recommends to the President the membership of each Council.
4. With the consent of the Board of Directors, the President of the ASC appoints members to the proposed Councils.

Each Council chairman will be expected to make periodic progress reports to the ASC Board of Directors and at the annual meetings of the ASC.

Establishment of a Council requires approval by majority vote of the membership of the ASC.

Councils on National Systematics Collections Resources, Standards for Systematics Collections and Systematics Collections and Environmental Quality were established in January 1974 by the ASC.

RECOMMENDATION 3: Establish Advisory Committees representing those elements of the scientific community concerned with systematics collections (see Priority A-4).

ASC Councils will be advised by and responsible to discipline-oriented Advisory Committees established by professional societies and other groups. These Advisory Committees will be formed within the various disciplines concerned with systematics collections, and may interact with any ASC Council as appropriate.

Establishment of Advisory Committees is the responsibility of the appropriate professional societies. Where no professional society exists, Advisory Committees should be developed—perhaps at the instigation of the ASC—by as large a body of professionals as can be organized.

Advisory Committees from disciplines concerned with systematics collections are key elements in making the National Plan a national enterprise. They will seek out and organize the interested individuals in their respective disciplines, assign duties to *ad hoc* committees formed from these constituencies, and serve as a means of communication among individuals, disciplines and the ASC in matters involving resources and the National Plan. The Advisory Committees will collect data concerning resources in the disciplines, develop criteria for distinguishing National Resources, recommend recognition of appropriate collections as National Resource Centers, and stimulate discipline-wide studies of ways to improve the condition and services of systematics collections. With adequate interplay among the committees, societies and individuals, Advisory Committees will become strengthening forces within the disciplines, and provide forums for consideration of many matters of intradisciplinary concern.

Several Advisory Committees already have been established:

1. Committee on Collections (American Ornithologists' Union).
2. Advisory Committee for Systematic Resources in Botany (American Society of Plant Taxonomists).
3. Advisory Committee for Systematic Resources in Invertebrate Paleontology (Paleontological Society).
4. Steering Committee (Council of Systematic Malacologists).
5. Advisory Committee for Systematic Resources in Mammalogy (American Society of Mammalogists).
6. Advisory Committee on Invertebrate Collections (American Society of Zoologists).
7. Advisory Committee for Systematic Resources in Entomology (Entomological Society of America).
8. Advisory Committee on Systematic Resources in Vertebrate Paleontology (The Society of Vertebrate Paleontology).
9. Advisory Committee for the Development of a National Plan for Ichthyology (American Society of Ichthyologists and Herpetologists).
10. Joint Committee on Systematics Resources in Herpetology (American Society of Ichthyologists and Herpetologists; Society for the Study of Amphibians and Reptiles; Herpetologists' League).
11. Advisory Committee on Culture Collections (American Society for Microbiology).

No limit to the number of Advisory Committees that should be established is recommended. As new Advisory Committees are formed, they should develop appropriate working relationships with ASC Councils and with other Advisory Committees.

Each Advisory Committee will have the opportunity to seek representation on the membership of a given ASC Council by submitting one or more nominations. Since memberships of ASC Councils are limited to 12-15, not all Advisory Committees will be represented on a given ASC Council, and no one Advisory Committee will have a representative on each ASC Council.

The system of Advisory Committees should include, as soon as possible, appropriate representation of those concerned with the relation of systematics collections and systematics to the solution of human problems. This might occur through existing "group-of-organism" related Advisory Committees, or through the establishment of appropriate new "problem" related Advisory Committees.

RECOMMENDATION 4: Identify systematics collections of importance as national resources and designate National Resource Centers (see Priority B-1).

Identification of national resource collections of a particular group of organisms must be the responsibility of systematists in disciplines dealing with those collections. *When agreement is reached that a collection is indeed a vital national resource, a means must be found to develop, support and maintain it at an appropriate level.*

The maintenance and preservation of a collection of importance as a national resource requires that it be housed at an institution where continued commitment is reasonably assured. For some institutions now housing national resource collections, the commitment may change with time and with changing research interests and personnel. Such institutions cannot and should not be expected to accept permanent responsibility for guardianship of those collections. Other institutions, especially scientifically active museums and collections, both large and small, have accepted and will continue to discharge such responsibilities. *Institutions with continuing long-term commitment to preservation of national resource collections must be recognized as National Resource Centers, and must be charged with the responsibility not only to maintain their resources but also to provide service from them. In addition, National Resource Centers must be prepared to accept additional resources that become jeopardized elsewhere. The effective discharge of these national responsibilities will be possible only with improved support and additional and diversified personnel.*

Small collections must be recognized for their important contributions to the systematics collections community. Many, if not most, of the smaller systematics collections are associated with small colleges or universities. While most small systematics collections (in terms of their taxonomic holdings) may not be important at the national or international level, they are extremely important on a regional or local basis. The systematists associated with small collections usually are more familiar with problems of the local flora and/or fauna and therefore could provide expertise available from no other source. Also, small collections associated with teaching institutions must be recognized for the extremely important contributions they provide in stimulating students to go into systematic biology and other fields that enhance the systematics collections community.

One approach to enhancing the value and contribution of small systematics collections, where feasible and appropriate, is for the systematists responsible for them to develop collaborative relationships with major systematics collections.

It is essential that the institutions housing small collections make clear long-term commitments to support them.

Criteria for the recognition of National Resource Centers may vary somewhat, particularly from one kind of institution to another—as with private museums versus public educational institutions. However, any such assessment necessarily will involve consideration of:

1. The size and quality of the collections held.
2. The historical importance of the collections, especially in terms of type and documented material.
3. Evidence of institutional commitment and ability to continue appropriate care, research and service functions.
4. The institution's location and its role in graduate education.
5. The nature and activity of its professional staff.

To implement the recommendation, professional society Advisory Committees will survey the collection resources of their disciplines and forward their findings and recommendations to the ASC Council on National Systematics Collections Resources. The Council in turn will develop criteria for the identification of collections of national importance and a mechanism for designating collections and institutions according to a classification system and supporting criteria. Such a classification system might include:

1. National Systematics Resource Centers,
2. Regional Systematics Resource Centers,
3. Research and Educational Resource Centers,
4. Systematics Service Centers.

Systematics Service Centers would include at least the following types of facilities:

1. Sorting Centers—these would provide preliminary sorting for massive collections, especially those acquired in large ecological programs, biome studies, biomedical surveys and the like;
2. Identification Centers—to provide routine identifications and coordinate identification services by specialists for more difficult groups;
3. Specialized Service Centers—including electron microscope facilities maintained to serve broad needs, specialized genetic and chemical services, data banking centers and so on;
4. Natural History Information Centers—these would be staffed by education specialists to screen inquiries and provide information to schools and the general public. A primary responsibility would be to produce leaflets to answer the kinds of questions most frequently asked of curators in natural history museums.

The Council will review data provided by Advisory Committees and on the basis of criteria it develops will recommend appropriate designation of collections and institutions. As its work progresses, the Council will interact with the membership of the ASC through the Board of Directors to develop mechanisms for formal designation of Centers. The ASC by appropriate means will assist designated Centers in seeking support from federal, state and other agencies.

With the assistance of the ASC, the Council will prepare and publish a handbook of systematics collections, their holdings, areas of emphasis, current research activities, services, major users, etc.

RECOMMENDATION 5: Develop standards for systematics collections: physical facilities, collection storage, preservation, specimen and data acquisition and documentation, collection growth, interinstitutional loans (see Priority B-2).

It is most important that we re-examine the nature of our collections and the rationales for their growth and development. What are the requirements for additional collections of specimens? How can we most appropriately expand existing collections or inaugurate new ones? What elements of the disappearing world biota are most crucial for future research and for the well-being of society—that is, of the still salvageable biota, what will be of greatest value for the world of tomorrow? What are the limits we must accept

for growth of systematics collections, and how are we to set them?

Exploitation of the data of systematics collections for service and research purposes increasingly will demand better methods of acquiring, storing and retrieving data. Electronic data processing (EDP) will become increasingly important in this enterprise. The continued growth of collections will demand use of EDP for many aspects of collection management, including efficient document production, label duplication, record keeping and taxon and specimen location. *It is important now to plan for the information needs of tomorrow, and to promote development of standards for acquiring, recording, storing and retrieving information about specimens.*

Implementation of this recommendation will require cooperative efforts on the parts of the ASC Council on Standards for Systematics Collections, the various Advisory Committees and representatives of agencies concerned with applied systematics.

It is proposed that the Council on Standards and the several Advisory Committees collaborate to:

1. Establish minimal standards for physical facilities in which collections are maintained.
2. Prepare guidelines for developing and improving physical facilities, for estimating costs and for establishing priorities in this area.
3. Establish minimal standards for management of systematics collections.
4. Continue efforts to standardize equipment, materials and procedures.
5. Develop standards for collection growth and specimen acquisition.
6. Develop standards for specimen preservation in various groups of organisms.
7. Develop standards for the acquisition and storage of specimen-related data.
8. Prepare concise instructions for collection and preservation of as many groups of organisms and for as many types of study as possible.
9. Consider mechanisms for redistribution of specimens to improve the quality of storage and conservation and to increase accessibility.

Only those collections meeting certain minimum standards should be eligible for certification as National Resource Centers. The standards should concern continuing care of collections, labeling and data preservation, accessibility, etc. Thus, the Advisory Committees and this ASC Council should function to communicate advances in curating, to discuss problems of acquisition and distri-

bution of specimens, to deal with questions of accessibility of collections and to provide continuing review of standards and procedures and their application to systematics collections. In its work, this ASC Council should recognize that the "standards" it develops are a prerequisite to the development of any EDP system for the management of systematics collections.

A National Plan for management of systematic resources implies a degree of predictability from institution to institution that can be achieved only through reasonable standardization. Further, if one of the results of such a plan should be support of these national resources by public funds, minimum standards of management must be set and maintained to assure responsible administrators that their funds will be used to advance the purposes for which they were appropriated.

RECOMMENDATION 6: Implement electronic data processing in collection management procedures (see Priority B-3).

The ASC Council on Electronic Data Processing, with the assistance of a data processing consultant and in collaboration with the Advisory Committees, will:

1. Develop standards and techniques for acquisition, storage and retrieval of data using available EDP technology (hardware, programs, etc.).
2. Develop mechanisms to assist institutions housing systematics collections in implementation of EDP systems for their collections, including cost information.
3. Develop priorities for:
 - a. Retrospective data capture by institution, taxonomic group and geographic area;
 - b. Data capture on new specimen acquisitions by institution, taxonomic group and geographic area;
 - c. Identifying compatible software;
 - d. Preparing guidelines for hardware acquisition;
 - e. Preparing user-oriented handbooks for managers of systematics collections.

The work of the Council on EDP ultimately will depend on the development by the Council on Standards of appropriate and widely accepted standards for specimen- or taxon-related data.

EDP offers the only realistic mechanism, now and in the future, by which the enormous data resources of systematics collections may be acquired, stored and queried.

RECOMMENDATION 7: Develop mechanisms whereby the resources of systematics collections can be used more effectively in studying and resolving problems affecting the quality of the environment, and develop programs for improving public awareness of the importance of correct identification of species to indicate environmental changes and their effects on human welfare (see Priority B-4).

One of the most important aspects of the National Plan is to improve systematics collections so that they can be better used in the identification of species. Such identifications are an essential component of the biological measurement of environmental changes and the prediction of their effects on human welfare.

The ASC Council on Systematics Collections and Environmental Quality, in collaboration with Advisory Committees, will:

1. Ascertain the needs of agencies concerned with environmental quality for services uniquely available from systematics collections.
2. Determine the capacity of systematics collections to provide these services.
3. Develop mechanisms to permit development of the required services.
4. Establish policies and mechanisms whereby the required services can be provided on a reimbursable basis.
5. Develop a plan for an information center, or centers, to enable those requiring the services to request them from the appropriate systematics collections.
6. Develop and implement programs to improve public awareness of the fact that environmental changes can be detected only with correct identification of species, and thus that authoritative taxonomic identifications bear directly on human welfare.

RECOMMENDATION 8: Address the problems of libraries and publications associated with systematics collections (see Priority B-5).

The ASC Council on Libraries and Publications in collaboration with Advisory Committees should:

1. Collect current information about systematics libraries, their services and their needs.

2. Recommend standards to be met by designated National Systematics Library Centers.
3. Review problems of dissemination of systematic information (data, syntheses, concepts, standards, methods) by formal publication and other means.
4. Determine the needs of library resources and centers and prepare proposals to satisfy them.

RECOMMENDATION 9: Develop and implement programs for improving public awareness and use of systematics collections as a national resource important to science and to the solution of problems affecting human welfare (see Priority C-1).

The National Plan is designed to improve systematics collections as a national resource. The Plan is concerned with the development of improved approaches to the management of systematics collections and the services they provide. For this reason, the Plan presents recommendations, the implementation of which must depend chiefly on the systematics community. Given existing resources, much can be accomplished to make the systematics collections community a more effective instrument for improvement of systematics collections as a national resource.

There is a limit to what can be accomplished without vastly increased public understanding, support and use of systematics collections. Therefore, a special Council should be established to develop a coordinated program designed to improve understanding and support of systematics collections by the public and agencies of the public. Such a program might include:

1. Special popular and semipopular publications.
2. Popular and semipopular films for use by schools, civic organizations and the like.
3. Collaboration with elementary and secondary schools in career education programs.
4. Development of special resources and services designed to improve public understanding of problems whose solutions depend in part on research based on systematics collections.
5. Development of more accurate methods of measuring the financial needs of the systematics collections community and relating these to improved satisfaction of public and scientific needs for the services of systematics collections.
6. Preparation and publication of handbooks of U.S. systematics resources, services and technical and scientific expertise, cross-referenced by taxonomic group, geographic

region, research and applied research emphasis and service.

7. Establishment of an information center and clearinghouse concerning the resources and services of systematics collections.
8. Development of improved communications with and services to public agencies concerned with law enforcement and other problems that depend on identification of plants and animals.

RECOMMENDATION 10: Study financial resources available and potentially available to the systematics collections community and seek means to implement priorities (see Priority C-2).

The Association of Systematics Collections, by whatever means determined appropriate by the systematics collections community, should undertake the following:

1. Study of the sources and utilization of funds currently supporting systematics collections and their associated resources and services.
2. Studies that will lead to development of improved procedures for budget planning and management, more accurate estimates of costs and better measures of performance.
3. Survey public and private agencies to determine actual or potential availability of resources to: a) support systematics collections and their associated resources and services; b) contract for specific services; c) subsidize training programs; d) support activities of Advisory Committees, the ASC Secretariat and Councils; and e) improve awareness of the public and agencies of the public concerning systematics collections as a national resource.
4. Seek funds—and, as appropriate, assist elements of the systematics collections community in seeking funds—to implement the priorities of the National Plan.
5. Make available to the systematics collections community by means of reports and services of the ASC Secretariat the results of studies 1-3 above.

RECOMMENDATION 11: Improve the services and other contributions of systematics collections to graduate education in systematic biology (see Priority D-1).

This recommendation concerns: a) ways of increasing availability of systematics collections to those who wish to use them for graduate education; b) increasing the quality and effectiveness of use of collections and the resources associated with them for graduate education; and c) increasing the quality and quantity of opportunities for graduate education in association with systematics collections.

To implement this recommendation, a Council on Research and Graduate Education, in collaboration with Advisory Committees, and as appropriate, with the Council on National Systematics Resources, will:

1. Identify those institutions that emphasize graduate education and research in systematic biology and that have systematics collections and associated equipment, library and other resources most appropriate to modern research in systematics.
2. Prepare handbooks on opportunities for research and graduate education available in relation to systematics collections, citing institutions, their research emphases, collections and associated research and graduate educational resources (fellowship and predoctoral employment opportunities should be listed). Handbooks might include advice to prospective graduate students concerning preparation for careers in systematic biology.
3. Seek ways to improve financial support for pre- and post-doctoral research and education. In particular, support should be sought for pre- and post-doctoral research fellowships, travel grants, special equipment grants and special service grants (scanning electron microscopy, data processing, geochronological dating, etc.).
4. Develop mechanisms that insure that the added financial burdens associated with 1-3 above are supported at the institutions and make recommendations as to appropriate funding.
5. Prepare and publish a report on groups of organisms that are of importance to science and society and in systematic research.
6. Develop appropriate information services for graduate students and prospective graduate students to assist in:
a) locating opportunities for graduate training and research, b) finding financial support, and c) seeking employment.

RECOMMENDATION 12: Develop technical training programs for professional service personnel

and establish mechanisms for personnel placement (see Priority D-2).

To realize the goal of improved service, systematics collections will require additional personnel trained for activities other than basic research. Advisory Committees and the ASC Council on Personnel Needs must assess present and future needs for professional service personnel and develop appropriate technical training programs and placement services.

At realistic staffing levels, trained professional service personnel could:

1. Assume greater responsibility for the routine care of collections.
2. Improve handling of loan shipments, refiling of specimens returned from loan and other aspects of specimen handling.
3. Assume responsibility for satisfying the growing demands for identification services.
4. Expedite various processes of extracting and recording data needed for many kinds of special studies.

PRIORITIES

In the 18 months since the first steps were taken to formulate a National Plan to improve the condition of systematics collections and the effectiveness of their services, certain elements of the emerging National Plan have been implemented—and some now are in the process of being implemented. The Association of Systematics Collections, an organization dedicated to improving the condition of systematics collections and their services, has been established. Three ASC Councils have been formed to address specific recommendations of the National Plan. Several Advisory Committees, representing professional societies and other groups, are studying and evaluating the systematics collections of their groups of organisms, have begun to develop standards for their collections and are considering ways to implement electronic data processing.

The priorities for implementation of the National Plan are predicated on the following:

1. Those managing and using systematics collections must work together as a concerned and cooperative community in order to improve systematics collections as a national resource.
2. The systematics collections community must develop and implement standards for the quality and management of systematics collections and their associated resources and services.
3. The systematics collections community must devote itself vigorously to improving awareness, understanding and support of the public and agencies of the public.

Present public support for systematics collections is limited at best, and there is reason to believe that it will not improve perceptibly without convincing, positive moves on the part of the systematics collections community itself. For this reason, many of the member institutions of the Association of Systematics Collections already have dedicated substantial resources to the business of the Association and to the establishment of a Secretariat. To generate new and strong support from the public and agencies of the public, the systematics collections community must make a significant initial investment of its own energy and resources. No breakthrough in public support ever will be forthcoming if the systematics collections community withholds its own positive action until there is promise of an immediate increase in funding for systematics collections. For agencies of the public to invest further in systematics collections there must be better public understanding of the significance and quality of systematics collections.

Funds for the systematics collections community are needed at three levels. 1) Those necessary to support the ASC, its Secretariat and Councils. These funds will further enhance communications, improve cooperation and facilitate participation by the systematics collections community and user groups (see Table 2). 2) Those necessary to support professional society Advisory Committees. These funds will further enhance communications and cooperation within the systematics collections community (see Table 10). 3) Those needed to solve many of the larger problems of the total systematics collections community, with respect to facilities and personnel (see Table 11).

Estimated budgets, provided in Appendix I, reflect the financial needs at these three levels, and are summarized in Table 1.

A. ESTABLISH A NATIONAL, COOPERATIVE APPROACH TO THE PROBLEMS OF SYSTEMATICS COLLECTIONS

1. Strengthen the Association of Systematics Collections by increasing the size and representation of its membership (see Recommendation 1).

During its first year (July 1972-June 1973), the Association of Systematics Collections committed \$1400 of its funds (including contributions-in-kind) to increasing membership. These funds have been used to support the Membership Committee (\$300) and associated expenses of the Secretariat (\$1100). In addition, various contributions-in-kind (ca. \$2500, including travel, per diem and time) have been provided by members of the Membership Committee and the Board of Directors. As a result of activities of the Membership Committee and the Secretariat, 18 institutions were approved and subsequently elected to membership in May 1973. During 1974, the Association will commit \$4700 of its anticipated resources to increasing membership. Table 3 presents a budget summary of the ASC resources that have been, or will be, committed to increasing the membership through 1978.

2. Obtain improved support for the permanent ASC Secretariat so that it can provide optimal communications with and services to Advisory Committees, Councils, the systematics collections community, those who use systematics collections and the public (see Recommendation 1).

The ASC Secretariat was established in February 1973, and was budgeted for \$20,000 for the calendar year 1973. The ASC membership has pledged \$21,500 in support of the organization and the Secretariat. In addition, the University of Kansas has provided \$9,450 in contributions-in-kind (salaries, office space and maintenance). In 1973, income from membership dues (43 institutions)

was \$6,850; the balance carried over from the previous year was \$2,900. Total income for calendar year 1973 was \$9,750. The difference between annual dues income and annual operating expenses has been covered from the pledged support from the ASC membership.

It is hoped that 20 to 30 additional institutions will join the Association each year for the next four years.

The Secretariat will seek outside support for the next four years, at the end of which time the membership should exceed 120 institutions and income generated through dues and anticipated special grants and contracts will cover annual operating expenses. The estimated budget of the ASC Secretariat for calendar years 1973-1978 is shown in Table 4.

3. Develop basic support for ASC Councils (see Recommendation 2).

Basic support includes travel and per diem for attending meetings; special support is for the cost of high priority activities peculiar to each Council. Special support may include implementation of recommendations resulting from studies by a given Council.

Basic support for the Councils is estimated on the basis of the following: a) each Council will have fifteen members; b) each Council will be active for three years; c) each Council will meet twice the first year and once each during the second and third years; d) each Council meeting will last four days; e) two or three subcommittees of each Council, consisting of three or four members, will meet once during the first year and three times each during the second year; f) transportation costs are estimated at \$150.00 per individual per trip; g) per diem is calculated at \$25.00.

Although support for each Council is estimated on the basis of three years of great activity, some, if not all Councils should continue to function indefinitely at a lower level of activity and cost. Each Council should provide a continuing forum of interaction with, and services to, the systematics collections community and those who use systematics collections.

The estimated cost for basic support for one ASC Council is shown in Table 9.

4. Establish additional Advisory Committees, representing professional societies and other groups, and develop increased support for Advisory Committees (see Recommendation 3).

As of December 1973, eleven Advisory Committees have been established by professional societies and other groups. Of the eleven existing Advisory Committees, four have received support

through the National Science Foundation for one year, averaging \$8,600 per Committee. The remaining Advisory Committees are (or have been) supported through their respective professional societies and contributions-in-kind provided by the members or their home institutions. The cost of maintaining one active Advisory Committee of 10-15 members is estimated to be \$8,600 per year. A typical budget for an Advisory Committee is shown in Table 10.

The ASC and its Secretariat will assist Advisory Committees by providing communications, advice, data, aid in seeking funds and assistance in publishing reports.

B. IMPLEMENT PLANS FOR SURVEYING NATIONAL SYSTEMATICS RESOURCES AND IMPROVING THE CONDITION OF COLLECTIONS AND THEIR ASSOCIATED RESOURCES AND SERVICES

1. Obtain support for the work of the ASC Council on National Systematics Collections Resources (see Recommendation 4).

The special support needed for the Council on National Systematics Collections Resources can be divided into three categories. Estimated support for this Council is presented in Table 5.

- a. *Data Collection*.—The Council will: 1) develop criteria for evaluating systematics collections; 2) design and distribute questionnaires; 3) develop a nomenclature that reflects the status of collections and their capacities to provide various needed services; and 4) accumulate and tabulate data from returned questionnaires.
- b. *Data Analysis*.—The Council will use objective methods (computerized statistical programs, etc.) to analyze the data.
- c. *Data Dissemination*.—The Council will prepare and publish a handbook that will serve as a "guide to systematists and systematics research and service centers". Further, it will publish a report on the status of America's systematics collections. Finally, this Council will collaborate with the Council on Standards and the ASC in establishing criteria for National Systematics Resource Centers.

Variation among estimates of the financial needs of the systematics collections community reinforces the necessity of a complete survey. The "Steere Report" has estimated that the major systematics collections will require \$48.7 million for new space, \$7.4 million for rehabilitation and renovation and \$4.4 million for equipment over the next 10 years (4:27). *The Life Sciences* (3:356) estimates that "... new buildings for all systematics facilities in the nation could cost \$120 million over perhaps the next ten years". See Table 13.

2. Obtain support for the work of the ASC Council on Standards for Systematics Collections (see Recommendation 5).

The Council on Standards for Systematics Collections will require special support to:

- a. Develop and circulate questionnaires to determine present (and needed) standards among institutions housing systematics collections.
- b. Analyze data from returned questionnaires and in collaboration with Advisory Committees develop appropriate sets of standards.
- c. Publish user-oriented manuals on standards for acquisition of specimens and associated data, specimen storage, loan procedures, etc.

Estimated support for this Council is provided in Table 6.

The *highest priority* of this Council is to develop appropriate standards for collecting and recording specimen-related data. Without such standards, work of the Council on Electronic Data Processing cannot go forward. Development of standards for specimen storage, loan procedures, containers, etc. will be deferred until the Council on Standards has accomplished what is needed for the work of the Council on Electronic Data Processing to proceed.

The Council on Standards, in collaboration with the Council on Electronic Data Processing, will standardize data storage techniques and define standardized data fields to insure compatibility with EDP systems at different institutions.

3. Establish and obtain support for an ASC Council on Electronic Data Processing (see Recommendation 6).

The Council on Electronic Data Processing will require special support for the following activities: a) investigation and evaluation of the various EDP systems now available for use by the systematics collections community; b) preparation of guidelines describing the most suitable system for a particular institution; c) preparation of user-oriented handbooks that will provide systematist-curators with the knowledge required to implement EDP; d) implementation of trial EDP programs in one or two institutions that support a variety of plant and animal collections. In the planning stages of these projects, the Council on EDP will work in collaboration with the ASC Council on Standards for Systematics Collections. Data have been developed by the Committee on Specimen Documentation: Data Recording, Retrieval and Exchange for several courses of action ranging from minimal advisement, evaluation and experimentation (\$1,600 to \$43,000 annually). Assuming

that an appropriate beginning for the Council on Electronic Data Processing should include the capability for communication, advisement and evaluation, and would require the service of two full-time employees (user-oriented EDP experts fully familiar with systematics collections), the annual cost for salary and supplies is estimated at \$31,500. Table 7 summarizes the estimated support required by this Council.

4. Obtain support for the work of the ASC Council on Systematics Collections and Environmental Quality (see Recommendation 7).

The ASC Council on Systematics Collections and Environmental Quality, in conjunction with the ASC Council on National Systematics Collections Resources, will determine the kinds of data that can be provided by systematics collections to aid in environmental impact assessment. The Council will prepare and publish guidelines for use by systematist-curators contributing to the preparation of the systematic sections of environmental impact statements. Further, the Council will establish guidelines for payment of services rendered by systematics collections in contributing to, or in preparing, the sections of environmental impact statements that depend on information from systematics collections. Publication costs and miscellaneous expenses are estimated at \$3,000 per year for the three years that this Council is at a high level of activity. Table 8 summarizes the estimated support needed by this Council.

5. Establish and obtain support for an ASC Council on Libraries and Publications (see Recommendation 8).

The Council on Libraries and Publications will require special support for: a) establishing criteria for designating National Systematics Library Centers; b) preparing and publishing guidelines for selective funding of systematics libraries; c) developing standards for the maintenance and conservation of library resources; d) developing guidelines for dissemination of various classes of systematic information, e.g., range extensions, specimen- and taxon-related data, statistical tables, by formal publication and other means, and investigating new, more economical (in terms of funds and space) methods of publishing (or duplicating already published) systematic information. The special support required for accomplishing these activities is estimated at \$3,000 per year for three years, and includes publication costs, data analysis and miscellaneous expenses. Table 8 summarizes the estimated support needed by this Council.

**C. INCREASE PUBLIC AWARENESS OF AND SUPPORT FOR
SYSTEMATICS COLLECTIONS AS A NATIONAL RESOURCE**

- 1. Establish a Council to develop a coordinated program designed to improve understanding and support of systematics collections by the public and agencies of the public (see Recommendation 9).**
- 2. Develop accurate methods of measuring the financial needs of the systematics collections community and improve public awareness of the costs of satisfying the need for services provided by systematics collections (see Recommendation 10).**

The relevance of systematics collections must be conveyed to the public and agencies of the public—the primary supporters of systematics collections. A Council must be established to improve public understanding and support of systematics collections. This Council will address the problems of coordinating and distributing information about systematics collections to the public.

Support for this Council will be needed to publish semipopular brochures and films for school classes, civic groups, etc. A pilot public education program regarding career opportunities in the field of systematics should be designed and funded.

Special support costs for this Council are estimated at \$3,000 per year for three years. Table 8 summarizes the estimated support needed by this Council.

The capacity of the systematics collections community to provide accurate and credible means of measuring its financial needs depends in part on the accomplishments of the Council on National Systematics Collections Resources. It is through the Council of National Systematics Collections Resources that the systematics collections community will gain, for the first time, an accurate index to the extent, diversity, emphases, quality, size and needs of the systematics collections in the United States. Once this information is available, the Council on Public Awareness, in conjunction with the ASC and the various professional societies, can relate the financial needs of these collections to the services in highest demand by the public.

Coordination between the two Councils will result in the development of criteria for estimating more accurately the funds needed for space, equipment and personnel that when provided can improve the capacity of the systematics collections community to provide the needed services. The Council on Public Awareness will then need to identify those agencies and foundations that are willing to contribute to the support of systematics collections.

D. IMPROVE QUALITY AND QUANTITY OF PROFESSIONAL AND PROFESSIONAL SERVICE PERSONNEL ASSOCIATED WITH SYSTEMATICS COLLECTIONS

1. Establish and obtain support for an ASC Council on Research and Graduate Education in Systematics (see Recommendation 11).

The ASC Council on Research and Graduate Education will require support for the following endeavors: a) preparation of a handbook that will describe and list the various graduate education programs for professionals in systematic biology in the United States; the handbook also will describe employment opportunities in systematic biology; b) development of a curriculum for training professionals in modern collection management techniques for maintaining (curating) systematics collections in conjunction with the Council on Standards; c) development of a fellowship program for research in systematic biology, with an emphasis on applied systematics.

Specialized support for this Council is estimated at \$3,000 per year for three years. Estimated support for the activities of this Council are presented in Table 8.

This Council also will make inquiries as to possible sources for funding the proposed fellowship program, i.e., Atomic Energy Commission, Corps of Engineers, National Science Foundation, etc. In addition, the Council will develop criteria for selecting recipients of the research fellowships in systematic biology.

2. Establish and obtain support for an ASC Council on Personnel Needs of Systematics Collections (see Recommendation 12).

The ASC Council on Personnel Needs of Systematics Collections will require support for three major projects: a) survey institutions housing systematics collections to determine those institutions with the greatest need for service-oriented personnel—an activity that is basic to subsequent efforts of the Council; b) establish criteria for designating training centers that can offer programs for service-oriented personnel; c) establish a pilot training program for service-oriented personnel. The cost for the surveys, publications and miscellaneous expenses is estimated at \$3,000 per year for three years. Estimated support for this Council, exclusive of the Training Program, is presented in Table 8.

The budget for the service-oriented personnel training program is based on: a) two-year training period for each trainee; b) trainee stipends of \$6,000 the first year, \$6,500 the second year; c) part-time supervisors selected from the staff at designated train-

ing centers; d) ratio of one part-time supervisor for three trainees; e) supervisors are salaried at \$6,000 per year; f) twenty trainees would begin training the first and second years, and thirty trainees would begin training in the third and fourth years; g) each trainee would be supported for three years after he completes the program; h) graduate trainees would be salaried at \$8,000 the first year and would receive 5% increases in the second and third years. The estimated support for the service-oriented personnel training program is presented in Table 12.

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FIGURE 1. Relationships of Budget Tables 1-13.

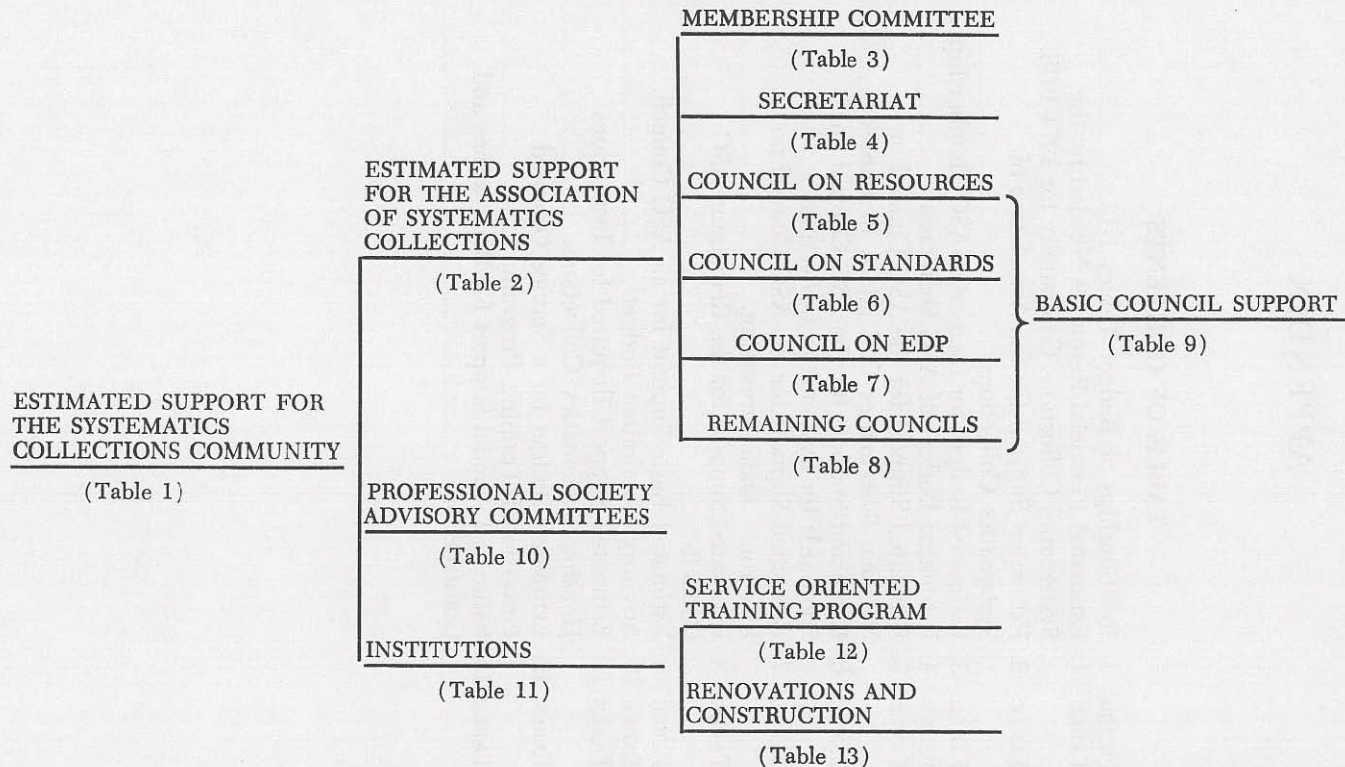


TABLE 1. Estimated Financial Resources Needed by the Systematics Collections Community for 1974-1978.

	1974	1975	1976	1977	1978	Total
ASC ¹	\$ 171,550	\$ 217,750	\$ 213,600	\$ 103,200	\$ 79,100	\$ 785,200
Advisory Committees ²	86,000	86,000	86,000	86,000	86,000	430,000
Institutions ³	12,000,000	12,159,960	13,329,920	12,609,920	12,902,920	62,002,720
TOTAL	\$ 12,257,550	\$ 12,463,710	\$ 12,629,520	\$ 12,799,120	\$ 13,068,020	\$ 63,217,920

¹ See Table 2.² See Table 10.³ See Table 11.

TABLE 2. Estimated Support for the Association of Systematics Collections.

	1973	1974	1975	1976	1977	1978	Total
Membership Committee ¹	\$ 4,400	\$ 4,700	\$ 5,000	\$ 5,300	\$ 5,600	\$ 5,900	\$ 30,900
Secretariat ²	24,500	31,500	38,400	45,500	52,600	59,700	252,200
Council on Resources ³		16,350	16,800	6,050			39,200
Council on Standards ⁴		13,500	19,050	4,750			37,300
Council on EDP ⁵		92,000	95,750	86,750			274,500
Remaining Councils ⁶		13,500	42,750	65,250	45,000	13,500	180,000
Total	\$ 28,900	\$ 171,550	\$ 217,750	\$ 213,600	\$ 103,200	\$ 79,100	\$ 814,100

¹ See Table 3.
² See Table 4.
³ See Table 5.
⁴ See Table 6.
⁵ See Table 7.
⁶ See Table 8.

TABLE 3. Estimated Budget for Increasing ASC Membership.

	1973	1974	1975	1976	1977	1978	Total
ASC Budget ¹	\$ 1,900	\$ 2,200	\$ 2,500	\$ 2,800	\$ 3,100	\$ 3,400	\$ 15,900
Contributions-in-kind	2,500	2,500	2,500	2,500	2,500	2,500	15,000
Total	\$ 4,400	\$ 4,700	\$ 5,000	\$ 5,300	\$ 5,600	\$ 5,900	\$ 30,900

¹ Includes direct support of Membership Committee plus associated expenses in the Secretariat.

TABLE 4. Estimated Budget of ASC Secretariat.

	1973	1974	1975	1976	1977	1978	Total
Income:							
Balance	\$ 2,900	\$ 18,300	\$ 18,800	\$ 19,350	\$ 15,700	\$ 15,850	
Dues	6,850	12,000	16,000	20,000	24,000	28,000	
Pledges	21,500						
Contributions-in-kind	11,550	10,000	10,950	11,850	12,750	13,650	
Grants and Contracts ¹		10,000	12,000	10,000	16,000	18,000	
TOTAL	\$ 42,800	\$ 50,300	\$ 57,750	\$ 61,200	\$ 68,450	\$ 75,500	
Expenses: ²							
Communications ³	\$ 2,800	\$ 5,200	\$ 6,000	\$ 6,800	\$ 7,600	\$ 8,400	
Board of Directors	5,100	5,800	6,500	7,200	7,900	8,600	
Councils ⁴	2,700	3,800	4,900	6,000	7,100	8,200	
Annual Meeting	1,600	2,700	4,000	5,500	7,000	8,500	
Office	10,300 ⁵	11,000	13,000	15,000	17,000	19,000	
Grant Preparation	2,000	3,000	4,000	5,000	6,000	7,000	
TOTAL	\$ 24,500	\$ 31,500	\$ 38,400	\$ 45,500	\$ 52,600	\$ 59,700	\$ 252,200

¹ Expected support from grants and contracts for Council activities, and special grants in support of the Secretariat.

² Figures represent salaries, equipment, and miscellaneous expenses.

³ Newsletter, etc.

⁴ Secretariat personnel and miscellaneous expenses, postage, printing, etc.

⁵ Includes start-up costs.

TABLE 5. Estimated Support for the ASC Council on National Systematics Collections Resources.

Activity	1974	1975	1976	Total
Data Collection	\$ 3,200			
Data Analysis	2,650	4,050		
Data Dissemination			\$ 2,300	
Basic Support ¹	10,500	12,750	3,750	
TOTAL	\$ 16,350	\$ 16,800	\$ 6,050	\$ 39,200

¹ See Table 9.

TABLE 6. Estimated Support for the ASC Council on Standards for Systematics Collections.

Activity	1974	1975	1976	Total
Questionnaires	\$ 1,500	\$ 300		
Data Analysis	1,500	2,000		
Publications		2,000		
EDP Compatibility		2,000	\$ 1,000	
Basic Support ¹	10,500	12,750	3,750	
TOTAL	\$ 13,500	\$ 19,050	\$ 4,750	\$ 37,300

¹ See Table 9.

TABLE 7. Estimated Support for the ASC Council on Electronic Data Processing.

Activity	1974	1975	1976	Total
Program Evaluation	\$ 30,000	\$ 31,500	\$ 33,000	
Publications/Communications ..	1,500	1,500		
Trial EDP Programs ¹	50,000	50,000	50,000	
Basic Support ²	10,500	12,750	3,750	
TOTAL	\$ 92,000	\$ 95,750	\$ 86,750	\$ 274,500

¹ Estimated costs to transform conventional to EDP cataloguing at two institutions and maintain a modest level of activity at each institution for two years. Selection of appropriate institutions will be made by the Council and will involve evaluation of local computer resources, "importance" of the collections, and interest of curators and staff. Final determination of funds required by each institution will be made by the Council in relation to local financial circumstances and willingness of a given institution to commit itself to continued support of EDP in management of its collections.

² See Table 9.

TABLE 8. Estimated Support for the Remaining ASC Councils.

Council	1974		1975		1976		1977		1978		Total
	Amount	Sub-total	Amount	Sub-total	Amount	Sub-total	Amount	Sub-total	Amount	Sub-total	
Environmental Quality											
Special support	\$ 3,000		\$ 3,000		\$ 3,000						
Basic support ¹	10,500		12,750		3,750						
Subtotal	<u>\$13,500</u>	\$13,500	<u>\$15,750</u>	\$15,750	<u>\$ 6,750</u>	\$ 6,750					
Libraries and Publications											
Special support			\$ 3,000		\$ 3,000		\$ 3,000				
Basic support ¹			10,500		12,750		3,750				
Subtotal			<u>\$13,500</u>	13,500	<u>\$15,750</u>	15,750	<u>\$ 6,750</u>	\$ 6,750			
Public Awareness											
Special support			\$ 3,000		\$ 3,000		\$ 3,000				
Basic support ¹			10,500		12,750		3,750				
Subtotal			<u>\$13,500</u>	13,500	<u>\$15,750</u>	15,750	<u>\$ 6,750</u>	6,750			
Research and Graduate Studies											
Special support					\$ 3,000		\$ 3,000		\$3,000		
Basic support ¹					10,500		12,750		3,750		
Subtotal					<u>\$13,500</u>	13,500	<u>\$15,750</u>	15,750	<u>\$6,750</u>	<u>\$ 6,750</u>	
Personnel Needs											
Special support					\$ 3,000		\$ 3,000		\$3,000		
Basic support ¹					10,500		12,750		3,750		
Subtotal					<u>\$13,500</u>	13,500	<u>\$15,750</u>	15,750	<u>\$6,750</u>	<u>6,750</u>	
TOTAL		<u>\$13,500</u>		<u>\$42,750</u>		<u>\$65,250</u>		<u>\$45,000</u>		<u>\$13,500</u>	<u>\$180,000</u>

¹ See Table 9.

TABLE 9. Estimated Basic Support for an ASC Council.

Year	Activity	Number of Participants	Number of Meetings	Number of Days	1	Year 2	3
Full Council:							
1	transportation ¹	15	2		\$ 4,500		
	per diem ²	15	2	4	3,000		
2	transportation	15	1			\$ 2,250	
	per diem	15	1	4		1,500	
3	transportation	15	1				\$2,250
	per diem	15	1	4			1,500
Subcommittees: ³							
1	transportation	4	1		1,800		
	per diem	4	1	4	1,200		
2	transportation	4	3			5,400	
	per diem	4	3	4		3,600	
TOTAL					<u>\$10,500</u>	<u>\$12,750</u>	<u>\$3,750</u>

¹ Calculated on the basis of \$150 round trip jet economy air fare per individual per trip.² Calculated on the basis of \$25 per day per individual.³ Based on three subcommittees per Council.

TABLE 10. Advisory Committee Budget.

Air Fare:	
Ten committee members for three meetings at \$150.00 per individual per meeting	\$4,500
Five committee members for one meeting at \$150.00 per individual	750
Ground Transportation:	
Ten individuals for three meetings each at \$10.00 per individual per meeting	300
Five individuals for one meeting at \$20.00 per individual	100
Per Diem:	
Ten individuals for two days at \$25.00 per day per meeting	1,500
Five individuals for four days at \$25.00 per day	500
Miscellaneous:	
Postage	150
Telephone	200
Supplies, xerox copying, miscellany	150
Secretarial assistance	450
TOTAL	<u>\$8,600¹</u>

¹ Given 10 active Advisory Committees, the cost would be \$86,000 per year.

TABLE 11. Estimated Support Required for Institutions Housing Systematics Collections.

	1974	1975	1976	1977	1978	Total
Service Oriented Training Program ¹		\$ 159,960	\$ 329,920	\$ 609,920	\$ 902,920	\$ 2,002,720
Construction and Renovations ²	\$12,000,000	12,000,000	12,000,000	12,000,000	12,000,000	60,000,000
TOTAL	\$12,000,000	\$12,159,960	\$12,329,920	\$12,609,920	\$12,902,920	\$62,002,720

¹ See Table 12.² See Table 13.

TABLE 12. Estimated Budget for a Service Oriented Professional Training Program.

	1975	1976	1977	1978	1979	1980	1981	1982	Total
Trainees:									
Twenty ¹	\$120,000	\$130,000	\$160,000	\$168,000	\$176,400				\$ 754,400
Twenty		120,000	130,000	160,000	168,000	\$176,400			754,400
Thirty			180,000	195,000	240,000	252,000	\$264,600		1,131,600
Thirty				180,000	195,000	240,000	252,000	\$264,600	1,131,600
Supervisors: ²	39,960	79,920	139,920	199,920	199,920				659,640
TOTAL	\$159,960	\$329,920	\$609,920	\$902,920	\$979,320	\$668,400	\$516,600	\$264,600	\$4,431,640

¹ Including post-training salary.² 6.6 supervisors at \$6,000 per year per supervisor.

TABLE 13. Estimated Annual Support for Renovations and Construction.¹

Expense	Amount
New Space	\$ 9,720,000
Renovations and Rehabilitations	1,440,000
New Equipment	840,000
TOTAL	<u>\$12,000,000</u>

¹ The Conference of Directors of Systematics Collections estimated that the member institutions needed \$60,511,000 [\$48,732,000 for new space (81%); \$7,379,000 for renovations and rehabilitations (12%); and \$4,400,000 for new equipment (7%)] over the next ten years (4:27). The National Research Council Committee on Research in the Life Sciences, however, stated that \$12,000,000 per year for the next ten years was needed for all of the systematics collections in the U.S. The figures cited above in Table 13 are based on \$12,000,000 pro-rated by type of expense as determined by the percentages calculated for the estimates provided by the Conference.