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About the Institute
The Hunt Institute for Botanical Documentation, a research division of Carnegie Mellon University, specializes in the history of botany and all aspects of plant science and serves the international scientific community through research and documentation. To this end, the Institute acquires and maintains authoritative collections of books, plant images, manuscripts, portraits and data files, and provides publications and other modes of information service. The Institute meets the reference needs of botanists, biologists, historians, conservationists, librarians, bibliographers and the public at large, especially those concerned with any aspect of the North American flora.

Hunt Institute was dedicated in 1961 as the Rachel McMasters Miller Hunt Botanical Library, an international center for bibliographical research and service in the interests of botany and horticulture, as well as a center for the study of all aspects of the history of the plant sciences. By 1971 the Library's activities had so diversified that the name was changed to Hunt Institute for Botanical Documentation. Growth in collections and research projects led to the establishment of four programmatic departments: Archives, Art, Bibliography and the Library.

Hotel Genova
Londres

My office: Londres 40 - 1

Telf. 11-22-12 and 11-24-18

Busco de Quiroga Londres

SMITHSONIAN INSTITUTION
UNITED STATES NATIONAL MUSEUM
WASHINGTON, D.C. 20560

MAR 8 1968

March 4, 1968

AIR MAIL

Dr. D. J. Rogers
Department of Taximetrics
University of Colorado
Boulder, Colorado 80302

Dear ~~Dr. Rogers:~~ Dave

We are planning to issue the abstracts of the Symposium on Information Problems in the Natural Sciences as a small brochure in response to numerous requests for the information. We have the abstract you prepared prior to the Symposium but if you would like to enlarge or change it would you please do so, sending me a copy not later than March 21. Please include bibliographic citations, particularly when your work has been published, in whole or in part, elsewhere. We are hopeful that the abstracts will not exceed one typewritten page in length, including the references.

Because the abstracts will be retyped, either in their revised form or from the originals, it is not nccessary to submit a clean copy.

Thank you for your cooperation in making the Symposium the success that it was.

Sincerely yours,

Donald F. Squires
Deputy Director
Museum of Natural History

11 March 1968

Dr. Donald F. Squires
Museum of Natural History
Smithsonian Institution
Washington, D. C. 20560

Dear Don,

The abstract as I presented it is satisfactory for publication. Extra copies are enclosed in case you need them.

Write me when you have a minute and tell me about the Stony Brook deal. Do you really want to go to such a notorious institution?

Sincerely,

David J. Rogers
Professor of Biology

DJR:gm

SMITHSONIAN INSTITUTION
UNITED STATES NATIONAL MUSEUM
WASHINGTON, D.C. 20560

March 4, 1968

AIR MAIL

Mr. R. Brill
Department of Taximetrics
University of Colorado
Boulder, Colorado 80302

Dear Mr. Brill:

We are planning to issue the abstracts of the Symposium on Information Problems in the Natural Sciences as a small brochure in response to numerous requests for the information. We have the abstract you prepared prior to the Symposium but if you would like to enlarge or change it would you please do so, sending me a copy not later than March 21. Please include bibliographic citations, particularly when your work has been published, in whole or in part, elsewhere. We are hopeful that the abstracts will not exceed one typewritten page in length, including the references.

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Thank you for your cooperation in making the Symposium the success that it was.

Sincerely yours,

Donald F. Squires
Deputy Director
Museum of Natural History

SYMPOSIUM ON INFORMATION PROBLEMS IN NATURAL SCIENCES

ABSTRACT

David J. Rogers

The taxonomic information retrieval system depends on (at least) two important features:

1.- A set of techniques as close to the methodology of taxonomy as possible;

2.- A computer system with sufficient flexibility to -- store and retrieve the data rapidly and economically.

This paper addresses the first of the two features and a paper by Robert Brill addresses the second.

The important attributes of the techniques for the -- taxonomist to be considered are: the use of the system as a record-keeper and/or as an aid in his scientific data recording. Curatorial work requires much record-keeping and data processing. Classificatory problems require other slightly different techniques. Both may be -- considered as information retrieval. Since this is the case the design for introducing data into the computer and for querying the data bank are kept within the taxonomist's frame of reference. Taxonomic ---- characters are used to structure and convey information to the ---- computer. Characters are constructed in a way which makes searching and retrieving data efficient. Brill will speak to efficient methods to store these data.

An example of the structuring of characters for information retrieval will be given.

SYMPOSIUM ON INFORMATION PROBLEMS IN NATURAL SCIENCES

ABSTRACT

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1.- A set of techniques as close to the methodology of taxonomy as possible;

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An example of the structuring of characters for information retrieval will be given.

Our system assumes no needed differentiation between curatorial, research, or bibliographic info. We consider the museum collection as the primary, or master file. The data about these primary files is, in the terms of IR miliu, the inverted file. This inverted file must be searchable in many different types of query.

The description of the file is by the most nearly user oriented system - characters and attributes.

Curatorial and research efforts are but two variations of the same type of description.

DEC 1 1 1967

UNIVERSIDAD NACIONAL AUTÓNOMA

SYMPOSIUM ON INFORMATION PROBLEMS IN NATURAL SCIENCES

Apartado Postal 70-233
México 20, D.F.
MEXICO

Dr. David J. Rogers
Professor of Biology
Department of Biology
University of Colorado
Boulder, Colorado 80302

Dear Dr. Rogers:

I am sending you an official invitation to the Symposium on Information Problems in Natural Sciences, to be celebrated in the Universidad Nacional Autónoma de México on December 18-20, 1967; it will be a pleasure to us if you could attend to this meeting.

Hoping to see you in Mexico next December, I remain.

Sincerely yours

Ramón Riba y Nava Esparza
Executive Secretary

RR/yal.

Rogers

SYMPOSIUM ON INFORMATION IN
NATURAL SCIENCES
December 18-20,1967 México DF.

In order to facilitate the organiza tion of activities during the Symposium, We would appreciate the remitance of your regis tration fee.

Before December 1st	US $20.00
After December 1st	US $25.00
Sponse	US $ 8.00

Sincerely

Biól. Javier Valdés Gutiérrez
Treasurer of the Symposium

Check for $48
mailed 20 Nov
Rogers + "sponse"
Bull

Please mail to:

Biól. Javier Valdés G.
Jardín Botánico, U.N.A.M.
Ciudad Universitaria,
México 20, D.F.

val

20 November 1967

Biol. Javier Valdes G.
Jardin Botanico, U. N. A. M.
Ciud Universitaria
Mexico 20, D. F.

Dear Sir:

Enclosed is a check for the registration fee for me and Mrs. Rogers; and for Mr. Robert C. Brill, a colleague who has been asked by Dr. Donald Squires to present a paper.

Sincerely yours,

David J. Rogers
Professor of Biology

DJR:gm
End. check for $48.00

Cia. Turistica Mexicana, S. A.

PASEO DE LA REFORMA 185 PRIMER PISO (CABLE COMTURMEX) MEXICO 5, D. F.

TELEFONOS:
46-75-49 46-76-32
46-76-98 46-77-29

NOVEMBER 1ST. 1967

Mr. David J. Rogers also one to R Bell
Univ of Colorado, Dept. of Biology
Boulder, Colo.
U. S. A.

Dear Sir:

This will acknowledge with thanks receipt of your application for hotel reservations in Mexico City during the "Symposium on Natural Science" next December.

Following your instructions, we have booked accommodations as mentioned in the attached confirmation sheet.

As December is one of the high tourist seasons in Mexico the hotels require one night's deposit. Therefore, we would appreciate your remitting to us the indicated amount before the 5th. December 1967.

On the other hand, if you have requested transfers, kindly state the exact date, airline and flight of arrival and departure, in order to be able to provide this service.

Also, please let us know of any changes in your travel plans, in order to make all necessary corrections, as well as to avoid cancellation charges, and/or failure to provide transfer service.

Looking forward to hearing from you, we beg to remain

yours faithfully

CIA.TURISTICA MEXICANA, S.A.

Miguel Fdez. de la Regata B.
General Manager

MFR:em

Cia. Turistica Mexicana, S. A.

PASEO DE LA REFORMA 185 PRIMER PISO (CABLE COMTURMEX) MEXICO 5, D. F.

TELEFONOS:
46-75-49 46-76-35
46-76-98 46-77-29

CONFIRMATION

TO: Mr. David J. Rogers
2 Persons

HOTEL: MARIA ISABEL
ACCOMMODATIONS: 1 twin
DAILY RATE: US$ 18.00

ARR: Dec. 17/67
DEP: Dec. 23/67
TOTAL STAY: 4 nights
6

IF REQUESTED: NO
Transfer Service will be provided as follows:

Arrival Date: _____ /67 Day: _____ Airline _____ Flight # _____

Departure Date: 23 Dec /67 Day: Sunday Airline Braniff Flight # 4 (08.25 hrs)

DEPOSIT REQUESTED:

For Hotel US$ 18.00
240 x 2 480
~~For Transfers 2 x 40 x 8 = US$ 5.60~~
22.80
TOTAL..... US$ ~~23.60~~

(Kindly draw checks to the order of: CIA.TURISTICA MEXICANA, S.A., to be received not later than December 5th., 1967.)

Yours very truly

CIA.TURISTICA MEXICANA, S.A.

Miguel Fdez. de la Regata
General Manager

November 1st., 1967.

Cía. Turística Mexicana, S. A.

PASEO DE LA REFORMA 185 PRIMER PISO (CABLE COMTURMEX) MEXICO 5, D. F.

TELEFONOS:
46-75-49 46-76-32
46-76-98 46-77-29

CONFIRMATION

TO: Mr. Robert C. Brill
1 Person

HOTEL:	MARIA ISABEL
ACCOMMODATIONS:	1 single
DAILY RATE:	US$ 16.00
ARR:	Dec 17/67
DEP:	Dec 21/67
TOTAL STAY:	4 nights

IF REQUESTED:
Transfer Service will be provided as follows:

Arrival Date: Dec. 17 /67 Day: Sunday Airline Braniff Flight # 3 2235 hours

Departure Date: /67 Day: Airline Flight #

DEPOSIT REQUESTED:

For Hotel		US$ 16.00
For Transfers	3.50 x 4	US$ ~~14.00~~ 3.50
TOTAL.....		US$ ~~30.00~~ 19.50

(Kindly draw checks to the order of: CIA.TURISTICA MEXICANA, S.A., to be received not later than December 5th., 1967.)

Yours very truly

CIA.TURISTICA MEXICANA, S.A.

Miguel Fdez. de la Regata
General Manager

November 1st., 1967.

16

- Taximetrics Laboratory

June 21, 1967

Dr. Donald F. Squires
Deputy Director
Museum of Natural History
Smithsonian Institution
United States National Museum
Washington, D.C. 20560

Dear Don:

A title for Bob Brill's paper for the forthcoming conference in Mexico is: "A generalized approach to information retrieval: the BIRD and TAXIR systems."

I hope this is all you need at the moment.

You will be hearing from us shortly concerning our desired collaboration on the development of the IR project.

Sincerely,

David J. Rogers
Professor of Botany

DJR/ch

SMITHSONIAN INSTITUTION
UNITED STATES NATIONAL MUSEUM
WASHINGTON, D. C. 20560

June 2, 1967

Dr. David J. Rogers
Department of Botany and
Plant Pathology, Taximetrics Laboratory
Colorado State University
Fort Collins, Colorado 80521

Dear Dave:

I think it would be quite appropriate to have Bob Brill participate in a technical session at the Mexico City symposium if one eventuates. Could you send me a title for his contribution so that we may propose it for the agenda?

I, too, very much hope that our sessions will be sufficiently informal to permit discussion rather than simply being lectured to. I agree entirely that we will make much more progress if we can actually thrash out some of the problems.

With best regards,

Sincerely,

Donald F. Squires
Deputy Director
Museum of Natural History

A generalized approach to I R: the BIRD + TAXIR systems.

SMITHSONIAN INSTITUTION
UNITED STATES NATIONAL MUSEUM
WASHINGTON, D. C. 20560

May 1, 1967

Dr. David J. Rogers
Department of Botany
Colorado State University
Fort Collins, Colorado 80521

Dear Dave:

Thank you for your very prompt response and your offer to present a paper at the symposium. I think that the general title you have selected will do quite admirably. Dr. Gomez Pompa will be writing you with regards to costs, etc. for the meeting.

With best regards,

Sincerely yours,

Donald F. Squires
Deputy Director
Museum of Natural History

Enclosure
cc: Dr. Gomez Pompa

P.S. Would any others of your group wish to participate. Nicki Suszynski will probably be chairing a technical session.

- Taximetrics Laboratory

April 11, 1967

Dr. Donald F. Squires
Deputy Director
Museum of Natural History
Smithsonian Institution
United States National Museum
Washington, D.C. 20560

Dear Don:

At the moment, I see no conflict for the dates of your meetings in Mexico December 16th through the 20th and accept your kind invitation to present a paper suitable to the occasion. If you are looking for a tentative title, I suggest something along the following lines "A Computerized IR System for Taxonomy." I look forward to getting information about costs and so forth later.

Sincerely,

David J. Rogers
Professor of Botany

DJR/ch

SMITHSONIAN INSTITUTION
UNITED STATES NATIONAL MUSEUM
WASHINGTON, D. C. 20560

March 30, 1967

Dr. David Rogers
Department of Botany
Colorado State University
Fort Collins, Colorado 80521

Dear Dr. ~~Rogers~~ Dave:

The Smithsonian Institution is honored to join with the University of Mexico in sponsoring a symposium in Mexico City, December 18 through 20, on "Information Problems in Natural Sciences." We believe this is one of the most important areas for future development in the museum field, particularly among research museums and large repositories. Although we, at the Smithsonian, are making progress in development of data processing for the Museum of Natural History and such diverse areas as the National Portrait Gallery, there are many other significant and important developments afoot in the museum community.

Dr. Arturo Gomez Pompa, the originator of the conference, and I will be co-chairmen during the sessions, which we hope will have a truly international flavor. We have issued a call for papers through correspondence and are now engaged in establishing a program. Further details about the conference may be obtained as they develop from either Dr. Gomez Pompa or me.

Your activities in data processing would form an appropriate basis for a report to this symposium. Dr. Gomez Pompa and I hope that you will plan to attend and that you will be able to contribute a paper. I would appreciate your confirmation of your participation as early as possible so that we may plan the program.

Sincerely yours,

Donald F. Squires
Deputy Director
Museum of Natural History

OCT 3 0 1967

INSTITUTO INTERAMERICANO DE CIENCIAS AGRICOLAS DE LA OEA

Año del 25 Aniversario

ZONA NORTE

El Instituto es un organismo especializado de la Organización de los Estados Americanos. Fue establecido por los Gobiernos de las Repúblicas Americanas en 1942 para promover su desarrollo económico y social a través de la educación y la investigación.

OFICINA EN MEXICO
Londres 40, 1er. Piso México 6, D. F.
Teléfonos: 11-22-12 ,y 11-24-18 Cables: IICAGROEA MEXICOOF

ZN/HR/508
October 27, 1967

Dr. David J. Rogers
Professor of Biology
University of Colorado
Armory 101
Boulder, Colorado 80302
U. S. A.

Dear Dr. Rogers:

In reply to your letter of October 18, I would like to assure you that I will be able to accompany you to Veracruz on December 15 and 16 and that I will take care of the Hotel reservations and provide transportation in the office station wagon.

I will be glad to receive any equipment you may wish to send to my office in advance.

I look forward to seeing you in December.

Sincerely yours,

Luis A. Montoya

Luis A. Montoya
Official Representative
IICA in Mexico.

vc

PREPARATION OF IDENTIFICATION KEYS BY COMPUTER FOR FLORA NORTH AMERICA

Larry E. Morse [1], John H. Beaman [2], and Stanwyn G. Shetler [3]

Preliminary work on the Flora North America Project is indicating the practicality of using computers to process and store the kinds of botanical information that will be accumulated during the 15-year project. In particular, the computer appears to hold much promise as a tool for preparing, editing, and storing identification keys. The objective of the FNA Project is to produce a much-needed concise diagnostic manual to the vascular plants of the continental United States, Canada, and Greenland, to serve as both a systematic conspectus and an identification guide to this flora (Shetler, 1966). This compendium, anticipated to fill four to six volumes, will include dichotomous identification keys to all the 15-20,000 species treated.

The Flora Project has only begun, and our paper is simply a progress

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[1] Undergraduate botany major, Michigan State University, East Lansing, Michigan.

[2] Associate Professor of Botany, Michigan State University.

[3] Associate Curator, Smithsonian Institution, Washington, D. C. Beaman and Shetler are members of the Editorial Committee of Flora North America, of which Shetler is Secretary.

EXAMPLES OF COMPUTER-PRINTED IDENTIFICATION KEYS

KEY TO SPECIES OF SPIRAEA IN THE NORTHEASTERN UNITED STATES (FROM FERNALD, 1950, P.755)

1A. INFLORESCENCE AN ELONGATE PANICLE,
  2A. LEAVES GREEN BOTH SIDES,
    3A. BRANCHLETS OF PANICLE PUBERULENT OR TOMENTULOSE.
      . . . . . SPIRAEA ALBA DU ROI
    3B. BRANCHLETS OF PANICLE GLABROUS. . . . . SPIRAEA LATIFOLIA (AIT.) BORKH.
  2B. LEAVES CLOSELY FELTED BENEATH WITH WHITE OR TAWNY TOMENTUM.
      . . . . . SPIRAEA TOMENTOSA L.
1B. INFLORESCENCE A COMPOUND CORYMB,
  4A. CALYX DENSELY PUBESCENT; PETALS PINK; LEAVES LONG-ACUMINATE.
      . . . . . SPIRAEA JAPONICA L.F.
  4B. CALYX GLABROUS; PETALS WHITE; LEAVES OBTUSE OR MERELY ACUTE OR MUCRONATE.
    5A. LEAVES BROADLY OBLONG, COARSELY TOOTHED, NOT GLAUCOUS, THE LARGER
        2-5 CM. BROAD. . . . . SPIRAEA CORYMBOSA RAF.
    5B. LEAVES NARROWLY OBLONG OR OBLANCEOLATE, ENTIRE OR NEARLY SO, MUCRONATE,
        GLAUCOUS BENEATH, 1-1.5 CM. BROAD. . . . . SPIRAEA VIRGINIANA BRITT.

KEY TO SPECIES OF SPIRAEA IN SOUTHERN OHIO, ABSTRACTED FROM ABOVE KEY

1A. INFLORESCENCE AN ELONGATE PANICLE,
  2A. LEAVES GREEN BOTH SIDES, ... SPIRAEA ALBA DU ROI
  2B. LEAVES CLOSELY FELTED BENEATH WITH WHITE OR TAWNY TOMENTUM.
      . . . . . SPIRAEA TOMENTOSA L.
1B. INFLORESCENCE A COMPOUND CORYMB, ... SPIRAEA JAPONICA L.F.

PREPARED BY L. E. MORSE ET AL., DECEMBER, 1967;
PRINTED BY MICHIGAN STATE UNIVERSITY CDC 3600 COMPUTER;
DATA FROM GRAYS MANUAL USED BY PERMISSION OF AMERICAN BOOK COMPANY.

report on some applications of computers to botanical keys. Many of the possibilities we mention are as yet untested, and may never be implemented as a routine part of the Flora Project. However, one of us (L.E.M.) has written and successfully tested computer programs demonstrating most of the basic applications here outlined. We realize that others have recently developed experimental programs applicable to identification keys, and our primary purpose for giving this otherwise premature and relatively hypothetical report is to notarize our interest, as a Flora Project, in the application of computers to such problems as key preparation, and thereby to invite advice and criticism from others during our developmental phase.

The preparation and use of keys has long been a feature of systematic botany (Voss, 1952), and today among natural scientists the purpose, principles, and usefulness of identification keys can be taken for granted. The key has been defined as "an artificial methods for discovering with certainty the natural order [group, taxon] to which a given plant belongs" (Lindley, n.d.). Most modern keys are dichotomous, presenting one pair or couplet of contrasting statements (choices) at a time. Usually they take one of two printed forms, the indented style (Fig. 1) or the bracketed style (Fig. 2), each with its own merits. Sokal and Sneath (1966) have recently said that the "physical form" of identification keys "can be adapted to electronic data processing"; yet the two traditional formats serve their purposes well, so there is no need to introduce a new style if computers are capable of producing conventional keys, which indeed they are.

We anticipate at least three applications of computers to plant identification, namely: (1) for key editing; (2) for key construction; and (3) in facilitating identification when use of a conventional key may be difficult or impossible.

Key Editing

For Flora North America the keys will be prepared by many specialists who will contribute the taxonomic revisions comprising the completed treatise. Each key will go through about three stages of revision and editing before acceptance for publication, and will be tested by 25-50 or more regional specialists throughout North America. This process will give rise to many minor improvements which must be incorporated into a revised draft with ease and flexibility and without introducing new errors. Even relatively minor revisions to a dichotomous key often require substantial restructuring and renumbering of the couplets, usually requiring that the whole key be retyped. For editorial purposes it would be highly desirable to have a means available for reproducing conventional keys from data free of numbering and indenting specifics, thus permitting rapid revision without recopying of the acceptable portions.

Our program for printing indented keys from punched cards satisfies this need. The original key is punched onto cards. A control card is added after each statement to identify it as either a lead which implies continuation to the following lead or as one which makes the ultimate identification of a taxon. Since the pattern of identifications and continuations determines uniquely the indentation and numbering of a key,

the computer can quickly print indented keys from such a deck. Revisions are made (Fig. 1) by correcting or deleting affected cards or by inserting new ones, leaving the remaining data intact, thus greatly reducing the possibility of introducing new errors in revising a key. The cards to be changed are readily located in the deck, since they occur in the same sequence as the lines of the printed key. Bracketed keys could be edited and printed similarly, although we have used a different approach, described below.

Since editing involves only replacing or rearranging selected card records with these programs, the actual work could be done within the computer itself, following the requests of the user. Of the many possibilities, we have tested only that for deleting unwanted taxa, but other editorial changes would not be difficult. For computer editing we have found numerical condensations of the keys most convenient. For either bracketed or indented keys we first prepare a numbered list of taxa, and a similar list of the descriptive statements which will form the couplets. Thus the information contained in the key can be represented in purely numeric forms, perhaps as one card per taxon for indented keys and as one card per couplet for bracketed keys, as in our programs. Besides deleting taxa, we have used programs for preparing these numeric keys from the indented-key decks mentioned above, for interconverting the two kinds of keys, and for printing conventional bracketed keys as well as indented keys directly from the numeric decks. It is likely that similar programs will soon be developed for on-line use from teletype terminals so taxonomists may make rapid revisions in existing keys.

Or they may submit an original key by typing it in conventional form on the teletype and then request any of a variety of editing routines, obtaining a revised version within seconds.

Key Construction

The numeric keys lead naturally into the actual construction of dichotomous keys by computer, either on-line or by batch processing. This possibility has been suggested occasionally, but to our knowledge ours is the first working program for this. Although superficially similar to numerical taxonomy, key construction differs in that taxa rather than specimens are the fundamental working unit, and proper identification rather than classification is the goal. Constructing a useful key is one of the greatest challenges a taxonomist faces in presenting his conclusions, for the number of possible ways of differentiating a group of taxa is almost endless, but the precise ways are few. Many biologists have used punched cards and similar techniques in their key construction, yet a computer would be a far better tool if a program could be written permitting the taxonomist to remain in full control of the process. Such a program would be a tremendous aid to Flora North America authors dealing with large genera.

Constructing a key, with or without a computer, involves the successive division of groups of taxa into pairs of subgroups by an appropriately chosen couplet of characters. Although individual specimens express characters exactly, taxa may be composed of individuals which vary in their expression of a given character. Thus, a particular

character applies to a given taxon in one of four ways: the character either (1) does not apply to all included material, (2) is constantly expressed or (3) not expressed, or (4) varies within the taxon. Before a key can be constructed, information of this nature must be prepared, and for this purpose computer methods could also be used (Hill, 1959; Pohja, 1960; Sneath, 1962; Sokal and Sneath, 1963). Several factors are involved in selection of the best character for dividing a group of taxa into subgroups, and we have been unable to define a fully objective criterion for this decision. The use of inconspicuous or poorly defined characters detracts greatly from a key's usefulness, as does reliance upon features rarely observable in the average specimen. Since the user of a key seldom encounters all included taxa with equal frequency, the commonly encountered taxa should be identified in the fewest steps. Variable taxa offer the choice of lengthening the key by placing them in both subgroups, or of reducing the usefulness of the key by selecting a character which is in general less effective.

An application of probability to the theory of keys has shown that the best key to a given set of taxa is almost always that which forms equivalent subgroups at each dichotomy (Osborne, 1963); this provides a basic principle for writing a computer program for key construction. Our present limited program selects characters solely upon their ability to form subgroups containing nearly equal numbers of taxa, preparing numeric output for our editing and printing systems. We plan to add other parameters soon, thus giving from one data deck an assortment of slightly different keys from which the best could be selected. Programs for key

construction could be adapted for use with on-line systems, allowing the taxonomist to change the character-selection criterion anywhere in the process. Also, the program could be incorporated into the editing system so an entirely new key could be produced after significant alterations, such as major deletions of taxa, were made.

Identification

Computers can also be helpful in the actual identification of problem specimens. The most serious difficulty encountered in the use of conventional keys occurs when the character requested cannot be readily determined from the specimen being identified. Several systems have been devised which permit the user to employ only observable characters, in whatever order he chooses, while making an identification. These include numeric approaches (Ogden, 1943, 1953; Jacobs, 1966) as well as mechanical methods such as edge-punched cards or overlay sheets (Duke, 1965). The computer can provide a powerful extension of such techniques, especially valuable in the case of fragmentary specimens or missing data.

In our approach, which we have tested successfully off-line but not yet perfected as an on-line technique, the computer makes an internal list of all the possible identifications, and then crosses out those eliminated by the descriptive data the user submits. On-line, he could give a small list of easily observed characters, and the computer could reply with the numer of possible identifications remaining. The user could then request a list of these taxa, or continue the identification process by submitting more characters. The possible applications and modifications of such identification programs are almost unlimited. For

example, the conversational capabilities of time-sharing computers could be emphasized, resulting in a system for easy plant identification by the inexperienced. Also, special-use subprograms could be added to permit, for example, on-line construction of conventional keys to selected taxa using the stored information, or printing of critical descriptive information contrasting specified taxa.

Conclusion

In conclusion, it is evident that the computer can free the taxonomist from much of the tedious labor necessary in key construction and editing. Teletype systems, in particular, can now bring computers into the laboratory and herbarium. The idea that effective use of the computer cannot be made by a taxonomist untrained in computer methods is no longer tenable. Computer applications to the Flora North America Project may serve as a primary example of the role of automatic data processing in taxonomic research.

LITERATURE CITED

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A WORLD PLANT GERM PLASM RECORD SYSTEM[1]

C. F. Konzak, K. W. Finlay,
B. Sigurbjörnsson and G. Delhove[2]

Two-thirds of the world's population today is in want of an adequate and assured supply of food. By 1980, even with a beginning influence of family planning programs, world population, now over three billion, is expected to increase by another billion. Worse yet, more than three-quarters of this increase will occur in those areas of the world already short of food[1]. This morning, for example, India had at least another 30,000 mouths to feed[2]. Even the United States (as of November 20, 1967) joined the ranks of nations with populations above 200 million[3].

With agriculture unable to meet the needs of today's world, the problem can only become increasingly serious. Agriculture and biology, in general, face a challenge staggering to the imagination. There can be little doubt that a more massive and integrated world scale effort in food production-oriented research is urgently needed.

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[2]Professor of Agronomy and Genetics and Agronomist, Washington State University, Pullman, Washington; Reader, The University of Adelaide, Glen Osmond, South Australia; Head, Plant Breeding and Genetics Section, International Atomic Energy Agency, Vienna, Austria; and Seed Exchange Officer, Plant Production and Protection, FAO, Rome, Italy.

Because plants, especially the cereals, are among the most efficient and immediately usable and widely acceptable sources of food, considerable emphasis must be given to research in plant improvement. Plant improvement is in fact basic to success in increasing both plant and animal production, but an increase of research in plant improvement is not enough. Ways must be found to speed the exchange of the vital information and materials and to manage the increase of information resulting from increased research. An information explosion, exceeding in all proportion the already impossible situation existing today, must somehow be managed. Moreover, attention must be focused on improving the usefulness of the information. The life blood of plant improvement programs throughout the world depends on the exchange of information and, equally important, the exchange of materials.

The available information on the world's most important crop varieties is not only inadequate, it is highly variable as well as widely scattered. Much of the most valuable practical information is considered unpublishable. Germ plasm stocks in collections seldom are adequately documented. Because of identification synonomy, some of the existing materials in collections are often confused and duplicated. Retrieval of information from which to identify useful resources from large collections is already getting to be a hopeless task. As a result, alternative approaches to the systematic evaluation and use of germ plasm collections in breeding have come into practice. These practices involve the screening of mixtures of germ plasm stocks. The methods are proving to be an efficient plant breeding scheme as a temporary solution to a modern dilemma. However, if carried to the extreme, they invariably add to the existing confusion and offer a danger to the whole foundation of breeding because the specific identity of the resource is lost.

A. The Concept of a World Plant Germ Plasm Record System

The establishment of data banks or central information files would do much to alleviate this critical situation, to speed the progress of research and to place into action the products of that research. An international network connecting standardized record files of research stations with those of regional and national information banks, and the international information center to be established at FAO, Rome are envisaged. (Figure 1) The size and complexity of the files at the information centers would vary greatly from rather simple files of some individual scientists and integrated files at national centers to the complete files at the international coordination center. An effort is now in progress to develop such a system[4]. This program is being developed through the close collaboration of FAO staff. It involves cooperation of scientists through national and international projects in the International Biological Program and is being conducted under the guidance of the FAO-IAEA Working Group on International Standardization in Crop Research Data Recording.*

Studies in this program are aimed at the development of a model system for the keeping of standardized station records on active collections of plant germ plasm stocks. To accomplish this aim, it will be necessary to

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*Members of this independent working group are: T. T. Chang, Geneticist, International Rice Research Institute, Manila, Philippines; K. W. Finlay, Reader, Waite Agricultural Research Institute, Glen Osmond, S. Australia; E. G. Heyne, Professor of Agronomy, Kansas State University, Manhattan, Kansas; A. F. Kelly, National Institute of Agricultural Botany, Cambridge, U. K.; C. F. Krull, Agronomist, Rockefeller Foundation Programme, Mexico City, Mexico; and C. F. Konzak, Washington State University, Pullman, Washington as coordinator.

The group was established on recommendation of an international group of experts called by the Directors General of FAO and IAEA to Vienna, Austria in December 1965 to provide advice on the 'international standardization, integration and mechanization of crop data recording and processing'.

devise a system that (a) will permit, but not require computer storage and retrieval of the information, (b) is sufficiently adaptable to allow for the inevitable variations of detail required to describe biological material, and (c) should be properly documented to encourage and aid universal adoption.

The objectives of the proposed system are as follows:

1. To aid in standardizing the terminology, methods and procedures used by scientists for recording the history of plants, describing their characteristics and for evaluating their responses under experimental tests.
2. To stimulate cooperation among scientists within and between disciplines.
3. To provide an information service for staff of FAO, other international agencies and member countries.
4. To serve as an aid to international, national, regional and local coordination of projects in:
   a. Collection of new germ plasm via: (1) plant exploration, (2) induced mutation, and (3) hybridization (sharing of plant breeders' collections and introductions).
   b. Maintenance and distribution of available germ plasm stocks via: (1) sharing of maintenance and distribution services, (2) reducing unnecessary duplication of services, and (3) reducing the waste of valuable stocks.
   c. Evaluation of germ plasm stocks for plant improvement via: (1) tests of certain attributes such as disease resistance, adaptability, etc., and (2) integration, analysis and comparison of

performance records.

5. To provide plant breeders and other scientists with information on which to classify, evaluate and better utilize germ plasm stocks for plant improvement and other biological research[5].

B. Nature and Description of the System

A standard information recording format is in the final stages of design for use in a world scale test application on wheat and rice in connection with an IBP project on plant adaptation. This format is designed for application to records on a wide variety of biological materials maintained in collections. The records are divided into two main sections to facilitate information and data processing and research.

The basic record - The first section of the record includes specified identification and historical information, as well as unformatted text. Accessions are identified according to family, genus, species, species group, lifespan, population and use. The country and maintenance station, the year of accession and date of recording are included to aid in the interchange as well as the integration and up-dating of records. Information on the origin of the accession as well as synonymous designations and vernacular names is included. The complete pedigree of an accession is to be retrievable. In the developmental stages of the system, genetic and reference information as well as notable features and other special information will be included as unformatted open-ended text. A part of the identification section of this record format is designed so that the information carried can be accommodated on an 80-column computer punch card. This has been done to facilitate a tie-in with other applications for which the information is needed as a working master record. These

applications include the production of record books and lists for laboratory and field experiments, identification cards for attachment to samples that are stored, used for tests or exchanged, etc. Mechanical sorting and direct read-out of computer cards carrying identifying information on stocks have proved not only efficient and inexpensive, but they also allow for the flexibility and machine independence necessary for many applications in the field and laboratory.

Genus specific records - Descriptive features and attributes of an accession are to be entered on a separate form. This second part of the record includes information specific to the genus of material recorded. This design also is intended for broad application. For economic reasons, including the speeding of retrieval time and the concentration of large numbers of similar records, the descriptive data are to be coded using single unit number or letter codes. The information will be decoded during retrieval. This design will also serve as an aid to universal intelligibility of the information recorded. The standard format design will facilitate the orderly and systematic accumulation of information from a wide variety of sources.

As now planned, this section will accommodate sufficient information to describe the more important features of an accession. More complete and uniform descriptions, particularly of the most useful world cultivars, induced mutants, and breeding and genetic stocks, should eventually be achieved via a coordinated and systematic effort. While the ultimate aim is to accumulate in an open central file complete records of the many recognized attributes of accessions, obviously that goal is impractical. However, the aim will be to accumulate as much valuable information as

possible from as many sources as possible.

Other records - To complete the system it will be essential that associated record files be developed which describe in some detail the climate and soil at experimental station locations. This information could then be used to aid in predicting the usefulness of specific varieties or breeding stocks in regions served by those stations. Records on the occurrence of pests and diseases in relation to station agroclimates would add further to the usefulness of the plant germ plasm records.

C. Standardization of Procedures

Universal intelligibility of the information recorded is vital to the system. Handbooks containing standardized recording methods and guides are being developed through the cooperation of experts for recommendation by FAO. The standard recording methods to be recommended generally are modifications of methods having a history of use. As mentioned earlier, these methods have been designed to permit computer processing, but their use does not require computers.

For the genus specific records, handbooks of instructions on the recording of descriptive information and classified evaluations must be prepared by experts for each crop, although similar approaches are suggested. Standardization of recording will be achieved by relating code numbers or letters to diagrams and other guides to circumvent difficulties encountered in translating descriptive terms from one language to another. (Figure 2)

Retrieval - Preliminary tests of these concepts were made at IAEA headquarters in Vienna during February, 1967 using an IBM 1401. However, computer programs and equipment employed are considered independent of the concept. One or another of the available information, storage and retrieval

systems probably can be adapted for immediate use for records at least at some of the information centers. Several modern systems for use on IBM 360 equipment have been described by E. R. Lannon[6]. One of these is being used by the U. S. Food and Drug Administration.

Plans for action - Implementation of the recommended methods is planned via their application in internationally coordinated programs, in the associated IBP projects and through the voluntary cooperation of scientists over the world. The handbooks of procedures and guides for the system will be made available through FAO and other sources. A world scale test involving the voluntary cooperation of holders of the world's larger collections of germ plasm stocks of wheat and rice is planned for 1968. Preparations already are in progress for cataloging in accordance with the new system, the USDA wheat collection, a new Australian National Wheat Collection, the IRRI Rice Collection and several others. Detailed plans and progress reports will be routinely published in the FAO Plant Introduction Newsletter.

Studies on the development of a central file for wheat at FAO headquarters and for rice at the International Rice Research Institute are already in progress. As now planned these central files will become current sources of information on stocks in existence or available throughout the world. There will be periodic and continuous addition of information on new materials and removal to archives of information on entries no longer maintained. The central record file will accept records from all holders of collections willing to make samples of stocks available to scientists on the basis of requests processed and coordinated through FAO.

Once a sufficient quantity of records becomes available, summaries of

the information will be reported in the FAO Plant Introduction Newsletter along with instructions for making a request of the central system.

Some special problems - On the computer side, procedures, machine and programming language standardization would greatly facilitate information storage and retrieval in an international network.

1. Mechanics - The system design needs an efficient mechanism for bringing information into the central files and to encourage future cooperation. The organization of records into a standard form and the transfer to a regional, national or international center should involve a minimum of complication and effort. Virtual machine independence is desirable if the system is to have most ready acceptance. How can this be accomplished? Assuming that suitable information retrieval systems are available for a wide variety of machines, punch cards might be the medium for exchange of stored information. Even so, there is a conflict for punched paper tape machines. Is this the best the industry can offer? Can the computing industry provide complete interchangeability of magnetic tape reels? Is magnetic to paper tape compatibility available?
2. Computer program language - An internationally standardized computer programming language would be ideal. Machine intercompatibility by way of standard languages or other means would do much to encourage wide acceptance and participation in the system. Is there any possibility that this could be achieved? Is there even a reasonable alternative at the present time?

These problems like those posed by the world food situation may also be opportunities. To meet them will require even greater international

cooperation, not only among scientists, but also industry. The rewards may not only be greater freedom from want, but also the opening of new vistas for both science and industry.

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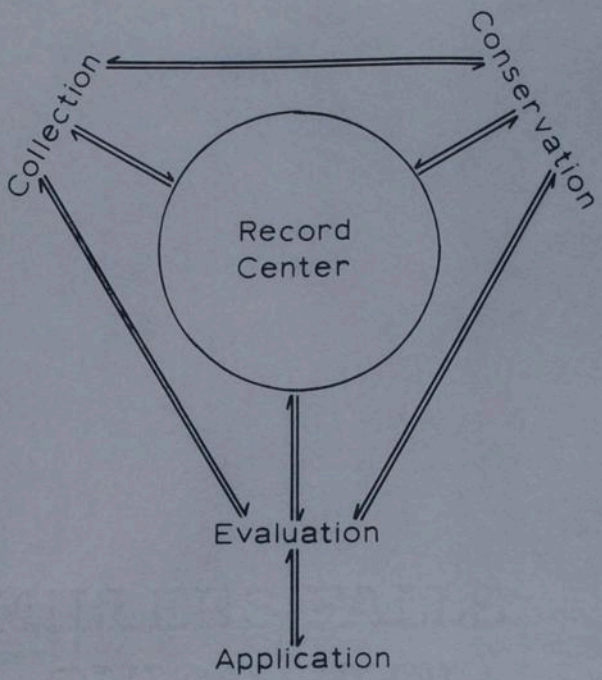
1. World Plant Germ Plasm
Record System



2. Spike density

Enter code number which best describes spike density.
Rachis internode length of some classes is given as a guide.

Code		Guide
0	dense	(2·5mm)
1		
2		
3		
4	mid-dense	(5·0mm)
5		
6		
7	lax	(10·0mm)
8		
9		

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Programa

Program

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Resúmenes

Abstracts

El Jardín Botánico

DE LA UNIVERSIDAD NACIONAL AUTÓNOMA DE MÉXICO fue creado con los tres siguientes objetivos:

a) Participar en forma activa en las labores de difusión cultural de la UNAM., a través de su contacto directo con el público, tanto nacional como extranjero.

b) Colaborar y participar en la enseñanza y divulgación de la Botánica.

c) Facilitar y fomentar la investigación botánica.

Sucintas explicaciones en forma de rótulos ponen en conocimiento del público los nombres científicos de las plantas en exhibición, su valor económico u ornamental y sus relaciones ecológicas (factores del medio en que se desarrollan) al indicar su área geográfica de distribución.

El Jardín Botánico de la Ciudad Universitaria, tiene varios tipos de instalaciones que incluyen dos grandes invernaderos en los que se cultivan plantas que requieren una temperatura más elevada y mayor humedad que las propias de la Ciudad de México.

El mayor de ellos es el Invernadero Faustino Miranda que se encuentra situado dentro de la zona escolar de la Ciudad Universitaria; el otro está localizado dentro del Jardín Botánico exterior y está dedicado principalmente a orquídeas mexicanas.

El Jardín Botánico exterior es la parte más extensa de nuestra Institución, en donde se encuentran agrupaciones de plantas de zonas áridas, de zonas templadas y flora silvestre del Pedregal de San Ángel.

Dasylirion longissimum

VISITE

EL JARDÍN BOTÁNICO

DE LA UNIVERSIDAD NACIONAL

CIUDAD UNIVERSITARIA

Dioon spinulosum

SIMPOSIO SOBRE PROBLEMAS DE INFORMACION EN CIENCIAS NATURALES

Symposium on Information Problems in Natural Sciences

auspiciado por la

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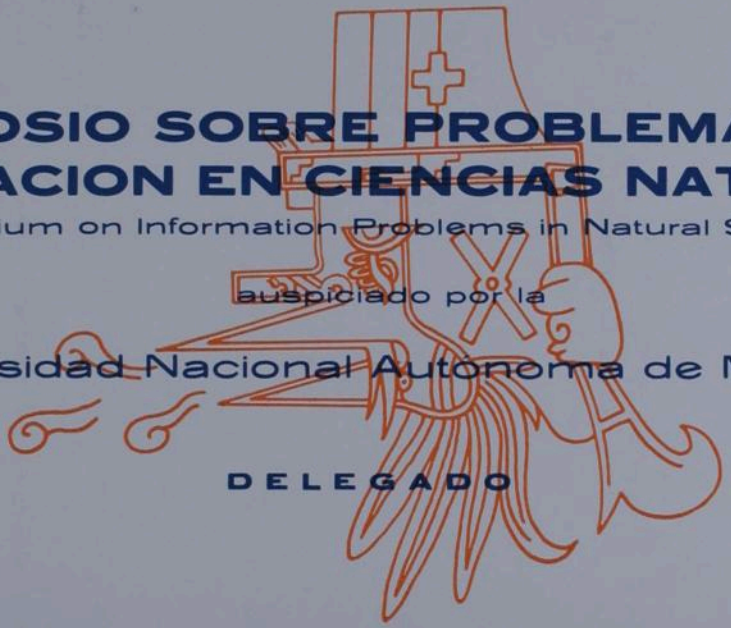

DELEGADO

DR. DAVID J. ROGERS, UNIVERSITY OF COLORADO, BOULDER, COLORADO .

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