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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.

July 27, 1966

Dr. P. F. Knowles
Agronomy Department
University of California
Davis, California 95616

Dear Paul:

When I returned I found a letter that you had written suggesting places to stay at Pullman, etc. I had left the Friday before the Tuesday meeting at Pullman, as I had wanted to stop off at Montana State University which was on the way, but thanks for your thoughts.

Enclosed is a copy of our M. esculenta coding. You will notice a total of 15 characters, K^1 , K^2 , K^3 , etc. The majority of the characters have states which are mutually exclusive. In other words, we can record a simple "yes" or "no", "present" or "absent" for at least one state of a particular character for each specimen. All characters in the M. esculenta list that have no value given for N and k or are not accompanied by a matrix such as character K^5 are of this type. The character "leaf color" in your C. t., which just off hand I would divide into (1) grey-green and (2) dark green, or the character "early inflorescence color" (1) yellow or (2) yellow orange, I should consider as of this type.

Those characters that have a value to the right of the states given to k and N are characters in which the states are not considered as mutually exclusive. In character K^2 , "color of stem", the value, $K = 1$, signifies that specimens possessing states that are adjacent in the coding will not be considered as completely dissimilar. In the instance of K^2 , a plant that has a silver stem will be considered slightly more than half similar to a plant with a silver-brown stem but will be completely dissimilar to a plant that has a brown or yellow stem. You will notice that states 3 and 4 have no assigned state. One of these states is redundant at the moment and was included for private reasons which do not concern us at the moment. One null state, state 3, is sufficient so that a specimen which has silver-brown stems will not be considered at all similar to a specimen with brown stems. Your character "spinyess of leaves" could qualify for this type of coding. My feeling is that plants with only an apical spine should be separated from those with few spines or moderately spined. Thus:

1. apical spine
 2. 0
 3. few spines
 4. moderately spined
 - etc.
- K = 1

In other words, I suppose I hypothesize that the apical spine is under different genetic control than the other spines.

The symbol, N, refers to the number of states that are to be considered as ordered. Notice character K⁰. The symbol k = 1 means that neighboring states are to reflect some similarity and N = 2 will restrict the states that can exhibit this similarity to the first two states. Namely, those plants that have slightly or moderately raised scars will be considered as somewhat similar, but plants with smooth or very large scars will be completely different from these slightly or moderately raised scars plants and also completely different from each other.

The third type of modification possible is for characters that are not composed of states that are continuous or orderable. They can be called reticulate characters. Character K⁹ of *M. esculenta* is of this type. The matrix gives the computer (as a look-up table) the degree of similarity to be assigned to plants with particular states. A plant that is unbranched (state 16) is half similar (.500) to a plant that is branched at the top (state 1) but completely unsimilar to a plant that is branched at top, 3/4, 1/2, 1/4 (state 15), and so forth. I am not suggesting that your character in *Q. t.* be set up in this fashion. That is a decision that you will have to make. As a matter of fact, I did not get an intuitive feeling for the justification for setting your plants up in 1/5s but again it must be considered that I do not know your material.

Note characters in *M. esculenta*, K⁹ and K¹⁰. State 4 in both of these characters is titled "logical." The logical state is used in those characters in which the character is applicable to some specimens in the collection and not to other specimens. The latter specimen would be coded as not logical. A simple example: Some plants have sepals and some plants do not. Those plants that have sepals have an additional character that describes the shape of the sepals. This character must contain a logical state for the coding of plants that do not have sepals. It is meaningful information that we cannot assign a state of shape to those plants lacking sepals and it is consequently, important to assign a state for the containment of this information. I consider that the coloring of the matured flowers of your plants might qualify for this type of treatment. In other words, in a character concerned with faded flowers, the colors of those plants coded for in a previous character "color of fresh inflorescence", yellow flowers, should have a logical state for coding those plants that have yellow-orange flowers when fresh.

At all events, if any of the above seems confusing, we will go over it when you visit us in August. We can also inform you about the theoretical basis for what we are doing and the nature of the computer output.

Dr. P. F. Knowles

- 3 -

July 27, 1966

The important consideration at the moment is to have a list of the characters and probable states to talk over. We will do the card punching for you from data sheets which we will supply and inform you how to fill out.

If you write us when you expect to arrive, we can make a reservation at a number of local motels for you. At all events we will see that you have a place to lay your head. As I told you in Pullman, the Monday (Aug. 29) following the weekend you expect to arrive, we have a visitor so you may be a bit neglected.

Sincerely,

Henry S. Fleming
Assoc. Prof. of Botany

HSF:ch

Enc.

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SANTA BARBARA • SANTA CRUZ

AGRONOMY DEPARTMENT
COLLEGE OF AGRICULTURE
AGRICULTURAL EXPERIMENT STATION

DAVIS, CALIFORNIA 95616

July 13, 1966

JUL 15 1966

Mr. Henry Fleming
Dept. of Botany and Plant Pathology
Taxonomy Laboratory
Colorado State University
Fort Collins, Colorado 80521

Dear Mr. Fleming:

In Dr. Rogers' letter of June 13, he mentioned that you would be visiting Pullman, Washington in July when I was there. I presume that you still plan to make this visit.

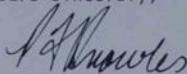
My plan is to drive up to Pullman, arriving there probably early on the morning of July 18th. I plan to take my wife with me and we shall stay in the Student Union. I choose the Union because it is on campus and convenient for my purposes.

If you would prefer to stay in motels, there are a number of good ones in Pullman. I am sure that you will have no difficulty getting reservations when you arrive. Apparently their busy season is during the winter.

My headquarters will be the Regional Plant Introduction Station, Johnson Hall 59, Washington State University, Pullman, Washington 99163. Dr. Sam Dietz is in charge of the station. Please let him or me know when you plan to arrive. He or I could drive to the airport near Pullman to meet you.

With best regards.

Yours sincerely,


P. F. Knowles
Professor of Agronomy

PFK:hc

- Taxonomy Laboratory

June 13, 1966

Dr. P. F. Knowles
Agronomy Department
University of California
Davis, California 95616

Dear Paul:

I have had to shift my work around because I had to be in Mexico to coincide with rains as they occur in the northwestern part of that country. This precludes any possibility of my coming to Pullman to be with you during that particular time.

However, Mr. Henry Fleming, my assistant, will be in Pullman on that date, and he and I will go over in detail whatever I know already about the project such that he will be able to assist you, perhaps in even more detail than I would be able to. I trust this is satisfactory to you.

Sincerely,

David J. Rogers
Professor of Botany

DJR:ch

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AGRONOMY DEPARTMENT
COLLEGE OF AGRICULTURE
AGRICULTURAL EXPERIMENT STATION

DAVIS, CALIFORNIA 95616

June 3, 1966

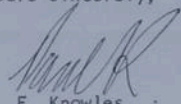
Dr. David J. Rogers
Dept. of Botany and Plant Pathology
Taxonomy Laboratory
Colorado State University
Fort Collins, Colorado 80521

Dear Dave:

As suggested in your letter of May 23 I shall plan to meet you on July 18 in Pullman. Schedules from here to Pullman are so terrible that I cannot tell you at this moment when or how I shall arrive there. When I make my visit to Pullman the end of this month I shall check in detail on the arrivals of planes and will let you know what I learn. I hope by that time to have assembled some data which I collected here during the last winter. The data I refer to were taken from some wild species studied here some years ago.

With best regards,

Yours sincerely,


P. F. Knowles
Professor of Agronomy

PFK:hc

- Taxonomy Laboratory

May 23, 1966

Dr. P. F. Knowles
Agronomy Department
College of Agriculture
Agricultural Experiment Station
University of California
Davis, California

Dear Paul:

Let's arrange to meet in Pullman on Monday, July 18. Tell me where I should go when I get there. I'll stick around with you long enough to aid in setting up the data for computing. This might give us a chance also to talk to S. M. Dietz on his retrieval system.

Looking forward to seeing you then.

Sincerely,

David J. Rogers
Professor of Botany

DJR:ch

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AGRONOMY DEPARTMENT
COLLEGE OF AGRICULTURE
AGRICULTURAL EXPERIMENT STATION

DAVIS, CALIFORNIA 95616

May 17, 1966 MAY 19 1966

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

Dear Dave:

I am sorry that I have been so slow in writing to you. As I probably told you in Berkeley, I have been finishing up a textbook on plant breeding which the late Dean Briggs and I started some years ago. This has kept me busy almost every evening of the fall and spring semesters. I am finishing up the last chapters now and should have much more free time for other things in about ten days.

I have collected some data on wild species which were grown here a few years ago and will try to assemble it as soon as I have a bit of free time.

But to answer the question of your recent card, I would say that I plan to visit Pullman the end of June to attend meetings of the Western Society of Crop Science. These meetings will be held the last three days of June. After the meetings I plan to take a day or two to look over the safflower nursery there in some detail.

Probably the best time to visit the nursery will be in mid-July, and with this in mind I am scheduling now a visit which will take me there by plane on Monday, July 18. I should be able to complete most of my notes in a couple of days and plan to return on Thursday, July 21. Once I see the nursery the end of June I shall have a better idea of the timing of future visits.

I hope to make a visit about the first week in August but will not plan that visit definitely now.

Trusting that this is the information you desire.

Yours sincerely,

P. F. Knowles
Professor of Agronomy

PFK:hc

- Taxonomy Laboratory

February 9, 1966

Dr. Paul F. Knowles
Department of Agronomy
University of California
Davis, California

Dear Paul:

You asked me to give my judgment of the proposed uniform format for information retrieval given by S. M. Dietz. About all I can do is give my general impressions, for without knowing the philosophy behind the methods and without knowing what is intended or what is expected from the information retrieval system, I cannot make useful judgments.

I would have to know in some detail or have explained to me what was intended, who will use the system, who will want to know "what" from it, what is the size of the problem. Knowledge of this type of question precedes any ability to make any meaningful responses to it. Clearly what is needed is a well thought out set of objectives from the biological standpoint. Once these objectives have been established then some consensus can be reached on how to best utilize some piece of equipment of other to handle the problem.

In reading the Memorandum from Dietz, dated July 27, 1965, I get the impression that a considerable amount of time has been devoted to the set up of the data on the computer cards. I would consider the set up of the cards as the last problem that the biologist should have to worry himself about. Beyond the actual details of card punching described in the Memorandum there is very sketchy or no description of the program the computer is to follow. Without this program I cannot make any heads or tails of what's coming out and how it will be used.

In our own experience with one limited activity, namely classification, we have discovered that the most work is involved in setting up such a program, and is done long before one con-

siders anything about card punching or otherwise. It is usually the case, as it was with us, that the biologist begins in a very naive way to approach the use of the computer and, only after having his head banged against the wall does he discover that the computer does only that which it is instructed to do. All biologists should realize that they need very strong assistance from people in the computer milieu. But, getting the right assistance from people in the computer milieu is dependent upon the ability of the biologist to search out and discover the right person. You can find all kinds of computer salesmen and others interested in the machinery or hardware aspects who are willing to do anything as long as their computer is spinning, and this is a very serious failure for the biologist. In other words, it comes down to two real problems: one, the biologist himself and his willingness to think through his problem, and two, the right individuals knowledgeable of the computers to carry out his wishes.

I'm sorry to be so negative about this, but I will have to discuss with Dietz himself or with others exactly what he intends and I suspect that he cannot really give me the full intent of his methodologies.

Sincerely,

David J. Rogers
Professor of Botany

DJR/pam

MEMORANDUM

TO: All interested in quick retrieval of information for Plant Introductions

FROM: S. M. Dietz, Regional Plant Introduction Station, Washington State University, Johnson Hall 59, Pullman, Washington 99163

DATE: July 27, 1965

SUBJECT: Proposed uniform format for information retrieval.

PROGRAMMING THE COMPUTER FOR USE OF MULTIPLE CARDS.

W-6 is presently programming the computer for retrieval of information in order to eliminate the restriction of 80 columns (one card). Information for 354 bean lines was already punched on IBM cards and these were used as a pilot run. The cost of programming the computer will be about \$150.00 for the first crop programmed (each additional crop will be considerably less), but the benefits gained are worth the additional expense. The information from each card is stored on 0.4 inch of tape. Since the tape is open ended, it is possible to add backup cards as required. By "open-ended", we mean data may be recorded on many cards, rather than being limited to 80 columns on one card. Information on all these cards is transferred to tape and the system is then theoretically as open-ended as the tape is long. This eliminates the restriction of attempting to get all data into 80 columns of one card, and the computer can correlate information contained on separate cards. The use of backup cards means a little more storage space is required. For this, a standard "Steelcase" cabinet is available with each drawer holding 3,500 IBM cards, so a 20-drawer cabinet will hold 70,000 cards. This 20-drawer cabinet is the same height and depth as a 4-drawer standard letter filing cabinet, but is about 4 inches wider. A 10-inch reel of 1/2-inch tape for the computer will hold information for at least 25,000 cards and can be "read" at the rate of 15,000 characters per second by some machines presently in use. Newer machines are faster.

Before presenting the proposed uniform card format, a few comments seem apropos for the following: (1) Punching IBM cards, (2) Use of zero in ratings and statistical analysis, (3) Comments on uniformity of ratings using 0 through 9, (4) Precise or exact measurements in the field, and (5) Arrangement of field cards for ease in punching.

PUNCHING IBM CARDS.

On an IBM card, there are 80 columns in which punching may take place, as shown on the first card of the enclosed card pack. In each column there are twelve punching positions, one each for the digits 1 to 9, and one each for the zones 0, 11, and 12. The 11 zone is immediately above the zero zone and the 12 zone is the uppermost zone just above the 11 zone. These zone punches are sometimes referred to as 0, X, and 12. A zero (0) punch is indicated by a small rectangular hole punched in the 0 zone of the card. When the 0 is punched alone

in a column, it represents the digit zero. As seen on the cards, digits are recorded by punching a single hole in the corresponding digit (or zero) position in the desired column. A letter of the alphabet is recorded by the use of two punches in a single column; one in the zone and one in the digit areas of the card. The alphabet is divided into approximate thirds. The first 9 letters are recorded by a punch in the 12 zone (uppermost punch in the card) and the proper digit, as shown in the columns printed with letters A to I along the top margin of the card. The next 9 letters are recorded by a punch in the 11 zone together with the proper digit, as shown by the letters J to R. The last 8 letters of the alphabet are recorded by punches in the zero zone together with the digits 2 to 9. For example, "A" is recorded by holes in the 12 zone and the digit 1 position, N by punches in the 11 (X) zone and the digit 5 position, and Z by punches in the 0 (zero) zone and the digit 9 position.

Special characters are recorded as one, two, or three holes in the desired column. Key-punch machines can be equipped with desired symbols as found on typewriters; in this case: equals, plus, minus, quote, dollar, slash, parentheses, comma, asterisk, and period signs.

USE OF 0 (zero) IN RATINGS AND STATISTICAL TREATMENT.

Dr. Skrdla received a reply from Nevada concerning alfalfa evaluations stating, "I note a '0' rating has been used in several places. This may cause difficulty in interpretation since many computers print a '0' if no information is punched in a column. The sorter would reject any unpunched column, but print out of rejected cards would show a zero." A July 1 memo from Dr. Oakes to Dr. Langford carries a similar statement quoted from DRL-128.

Discussions with programmers here were as follows: The 709, 1401, 1620 and new 360 IBM machines all can differentiate between a blank and a zero, and the 407 unit-record print-out machine can also. A blank in the 709 machine language is a minus zero, and a plain zero is a zero. Proper programming will differentiate blanks from zeros and print them as such. If programs in current use by others are not doing this, it is the fault of the program as set up, because most computers, sorters, and print-out machines can separate blanks and zeros when properly instructed to do so. On the sorter, cards are separated into ten categories, 0 through 9. Blanks are shuffled into a reject pile. If blanks mean no information, why have them printed out? A complete listing of all accessions for an accumulative inventory for a particular crop can be handled by the computer-attached print-out, and with proper instructions the blanks are left blank, and the zeros printed as zeros. In fact the enclosed print-out of the ratings for 27 variables (bean characteristics) shows the frequency of blanks and zero through 9 as actually punched on the cards.

Secondly, we discussed the statement that zero is not adapted to statistical analysis. A zero should mean zero, and it is just as good a number as any other from the statistical point of view. Please consult your local statisticians and obtain their opinions.

COMMENTS ON UNIFORMITY OF RATING (0 through 9).

It would be best if we all could agree on a uniform rating system in the use of 0 through 9. It is preferable to have 0 be zero, 1 as low, 5 as intermediate, and 9 as the most of whatever characteristic is rated.

Dr. Skrdla in previous correspondence and over the phone indicated many agronomists use "1" as best and "9" as least desirable. Other agronomists reverse this rating system. The rating system suggested at a recent alfalfa breeders conference is an example of the former. However, most horticulturists, pathologists, and botanists are following a system like percentages, or money, where 90% or \$9.00 is more than 10% or \$1.00. Examples follow: Lodging could be rated 0-9 with zero being upright and 1 through 9 indicating 10 to 90 degrees incline from the vertical plane. In other words a 9 would be 90 degrees from vertical, or flat on the ground, and would also be the most or greatest amount of lodging. If we rated straw strength (which is probably unnecessary in our preliminary evaluations) a 9 rating would indicate straw with the greatest strength and thus in all probability the least lodging, and a 1 would be weak-strawed and probably result in much lodging.

We must be very careful to rate the exact characteristic designated and not the inference as to which is best plant type. In the case of lodging a 9 is the greatest amount of lodging, so a 1 or 0 would also be the best plants from the breeders' point of view. In the case of straw-strength, a 9 is the greatest strength, so a 1 here would be the poorest plant for the breeder. We must be careful to rate specifically only the characteristic heading the column, and not get our readings muddled or confused with inferred ratings for something else. In some instances, by picking proper headings we can also have the best plants with a lower rating; such as rating the degrees of lodging from the vertical. This can not always be followed however. In rating vigor, the most vigorous types would be rated 9 and these would also be the best types for breeding. To rate lack of vigor would make the best plants have a rating of 0 or 1. However, this rates a negative characteristic; a trap we all must avoid.

PRECISE OR EXACT MEASUREMENTS IN THE FIELD.

The use of rulers and other instruments for exact or precise measurements should be kept to a minimum. For example: the use of rulers to measure leaf width of grasses to the nearest 1/10 of an inch appears to be impractical to us. Which leaves are measured: basal, cauline, or both; and at what stage in plant development? How many leaves must be measured for each plant, and for how many plants in each P.I. accession? Such measurements would more than double the field work to obtain something which is probably beyond preliminary evaluation anyway.

W-6 holds perennials for 3 years. Leaf widths may exhibit as much variation on the same plant over this 3-year period as found in comparisons between different accessions of the same species in any one year. Leaf width will also vary with fertilizer, irrigation, weeding, etc. Therefore, to be meaningful these measurements would have to be replicated, converted into averages or means and analyzed statistically. In fact, the exact measurements are meaningless unless compared to some standard. A standard variety can be grown, and a visual comparison coded: 1 - much narrower, 5 - average or the same as the standard, and 9 - much wider. This will give the information required in preliminary evaluation without greatly increasing the field workload. In other words, the use of rulers and other devices for exact measurements should be dispensed with and, wherever possible, visual observations recorded.

A possible exception is the use of the hand refractometer to measure total soluble solids in melons. Here it is impossible to see any differences, and a taste test is unreliable.

ARRANGEMENT OF FIELD CARDS FOR EASE IN PUNCHING.

Once the card format and resulting computer program is finalized for a priority crop, W-6 plans to print special field cards. These field cards would list the card column number together with its proper heading. Below each heading would be a zero through nine numerical breakdown, each with an accompanying description. The technician then only needs to circle the appropriate rating and give the completed field cards to the key-punch operator for punching and verification.

UNIFORM CARD FORMAT FOR REGIONAL STATIONS.

We would like your comments on the following proposed layout, which, as is or with appropriate modifications, can serve as a uniform card format for the Plant Introduction information retrieval system. Programming the computer for retrieval of information, as presented here, is essentially only an open-ended modification of the original proposal; permitting much greater flexibility.

First 8 columns: will be reserved for the letters P.I. and a six-digit number (all cards). We have included the letters P.I. to differentiate our numbers from C.I., state, or other numbers. This is necessary because we are integrating our retrieval system with that of breeders for cereals and other crops (here at W.S.U. and elsewhere) so we may search their records and obtain valuable information concerning the use of P.I. lines in their respective programs. Thus we must be able to separate P.I. from C.I. and other numbers. What has been done with cereals is also being done with other crops such as tomatoes and beans.

10 columns (9-19 on all cards) will be used for plant classification: 4 for genus, 4 for species, and 2 for variety names. Alphabetic abbreviations of the binomial or trinomial can be used and those set up by Dr. Oakes serve as a fine example. Dr. Sidney W. Gould is preparing an International Plant Index which, in 10 columns, numerically codes all plant names. He has completed coding at the family and higher levels and hopes to have the genera completed in 6 months. We may wish to continue with alphabetic abbreviations since these are more easily read than numbers, enabling us to recognize mistakes more easily. There is no objection to the use of alphabetic characters, rather than numeric, when used for identification purposes.

5 columns (19-23 on all cards): will show the origin as indicated by a uniform 5-letter abbreviation of the countries listed in the State Department Foreign Service List (suggested by Mr. Winters).

5 columns (24-28 on all cards) will use the Zip Code to identify locality reporting: Our local Post Office officials are actively working with the Computing Center, and Data Processing Units at Washington State University. As all of you know, a unique five-digit number has been assigned each post office. The Post Office Department has just issued a new and more complete book which lists the

Zip Code for all post offices in the United States and its possessions. This edition is cross-indexed; i.e., alphabetically by state and city and also in a numerical sequence by zip code number. This new edition has been printed and should be available in local post offices within two months. Our post office stated they are instructed to give free copies to institutions and other public agencies. I have already requested one for our regional station. Additional copies are available through the Superintendent of Documents in Washington, D.C. If 5 columns are reserved on the card, then the location anywhere in the United States and its possessions can be pinpointed to the nearest post office. We are already using zip code numbers in correspondence such as 99163 for Pullman, Washington, and 50010 for Ames, Iowa, etc.

The post office has also adopted a universal two-letter abbreviation for states and possessions. Since these differ in 11 instances from the list composed by Dr. Oakes, I have included a tabulation of the official post office abbreviations. (see following page)

2 columns (29-30 on all cards) will be used to code Year data taken at each respective station. The last two digits of the year would be used. It would be 100 years before a duplication would appear.

SUMMARY OF IDENTIFICATION INFORMATION - (30 column field - all cards, regardless of crop):

It takes 30 columns for identification: 3 for the initials P.I. and a six-digit number, 10 for the plant name, 5 for origin, 5 for locality grown (zip code) and 2 for the year data taken. This information would appear in the first 30 columns of all regional station cards, regardless of the crop rated.

REMAINING 50 COLUMNS OF THE CARD (31-80).

Column 31 will be used to indicate the type of information rated on each card, i.e., a card with a "B" in this column would be a Bacterial disease card, card "C" for rating plant Characteristics, "D" for Data Comments, "F" for Fungi, "G" for Genetic data, "H" for Parasitic HIGHER Plants, "I" for Insects, "M" for Mites, "N" for Nematodes, "P" for Physiologic data (other than temperature and water relationships), "S" for Soil type, "T" for Temperature effects such as heat causing blossom drop or winter hardiness, "V" for Virus diseases, and "W" for Water relationships such as drought resistance. This uses 14 letters of the alphabet to categorize the type of information rated in the 40 columns (38 through 77), and leaves 12 additional letters for further expansion.

Columns 32 through 34 would be used to numerically list 999 possible backup cards for each of the categories listed in column 31. This is essentially the card number Dr. Langford suggested, but is more open ended by using 3 columns. Columns 35 through 37 are reserved for numerically coding 999 possible races of an organism associated with a particular disease. Columns 38 through 77 (40 columns) would be used to record ratings on whatever is recorded in column 31, i.e., plant characteristics, diseases, etc. Those wishing to use the 40 column mark-sense cards for field notes, as suggested by Dr. Sowell, could have the information transferred directly to this 40 column field.

TWO-LETTER STATE ABBREVIATIONS*

Alabama	AL	Montana	MT
Alaska	AK	Nebraska	NB
Arizona	AZ	Nevada	NV
Arkansas	AR	New Hampshire	NH
California	CA	New Jersey	NJ
Canal Zone	CZ	New Mexico	NM
Colorado	CO	New York	NY
Connecticut	CT	North Carolina	NC
Delaware	DE	North Dakota	ND
District of Columbia	DC	Ohio	OH
Florida	FL	Oklahoma	OK
Georgia	GA	Oregon	OR
Hawaii	HI	Pennsylvania	PA
Idaho	ID	Puerto Rico	PR
Illinois	IL	Rhode Island	RI
Indiana	IN	South Carolina	SC
Iowa	IA	South Dakota	SD
Kansas	KS	Tennessee	TN
Kentucky	KY	Texas	TX
Louisiana	LA	Utah	UT
Maine	ME	Vermont	VT
Maryland	MD	Virginia	VA
Massachusetts	MA	Virgin Islands	VI
Michigan	MI	Washington	WA
Minnesota	MN	West Virginia	WV
Mississippi	MS	Wisconsin	WI
Missouri	MO	Wyoming	WY

CI = USDA Cereal Investigations Numbers
 PI = USDA Plant Introduction Numbers
 UN = Reserved for FAO accessions
 RL = Canada R.L. Numbers
 CN = Canada CAN Numbers

* Canal Zone, District of Columbia, Puerto Rico, and Virgin Islands also included.
 Codes assigned by U. S. Post Office Zip Code.

Column 78 is used for a Systems Identification. Our system code letter in column 78 would always be "I" for Introductions. Other program systems used by breeders etc., would also have information on P.I. lines, but recorded on different card formats. They would have some letter other than "I", for example "B" for breeders cards etc., in column 78. In other words the letter "I" in column 78 means that the card format used is according to the Plant Introduction system. Column 79 will identify the retrieval system by using letters A through Z to designate the proper program control cards which instruct the machine what to do. Column 80 can be used to record desirability, as indicated by Dr. Langford, or left open as discussed later.

THE FOLLOWING IS A TABULAR PRESENTATION OF A PROPOSED UNIFORM CARD FORMAT

Columns 1-30	Col. 31	Cols. 32-34	Cols. 35-37	Columns 38 thru 77 (40)	Col. 78	Col. 79	Col. 80
This 30 column field is reserved for identification information on <u>all</u> cards regardless of crop. Includes: P.I. and number, Plant name, Origin, Locality grown, and the Year data taken.	B	999 possible backup cards.	Identification of 999 possible races.	Bacterial diseases	Systems Identification - always "I" for Introductions	Program control cards for machine instruction.	Desirability rating or left open for future expansion.
	C			Plant Characteristics			
	D			Data Comments			
	F			Fungal diseases			
	G			Genetic data			
	H			Parasitic Higher plants			
	I			Insects			
	M			Mites			
	N			Nematodes			
	P			Physiologic data			
	S			Soil type			
	T			Temperature effects			
	V			Virus diseases			
	W			Water relationships			

Enclosed are cards filled out as examples. The third card in the enclosed card pack, marked "C" in column 31, is the plant characteristic card. Listed along the top margin of the first columns of the card we find PI 123456 Phas vulgar Turkey 99163 65. This means this purely hypothetical line of beans from Turkey was grown at Pullman, Washington and the data for plant characteristics taken in 1965. Columns 38 through 77 (40 columns) would be used to rate

40 or fewer plant characteristics. If more columns are required to rate characteristics we have 999 backup cards (columns 32 through 34) containing 39,600 additional columns for rating plant characteristics alone. Each of the remaining letters B through Z in column 31 also have 999 backup cards.

Setting up a priority listing of characteristics is of little importance, except where there is need to make a decision as to whether a particular characteristic should be rated at all. Once this is decided, listing the various characteristics in the order in which notes will be taken in the field, from planting to harvest and ultimate overall rating, would facilitate use in the field. Characteristics for most crops to date can be handled in about 30 columns, so the 40 columns on the first Plant Characteristic card ("C" in column 31) will be sufficient for the present. If not, the backup cards furnish more than adequate space (nearly 40,000 columns).

Is an overall agronomic or horticultural rating of a line a good thing to include? If so, we should have a column for this; perhaps column 80. This could be noted by recording a rating of poor, average, or excellent for the general overall adaptability of a P.I. accession to the climatic and edaphic conditions where grown, as compared to the performance of acceptable commercial lines of the same crop under similar conditions. Perhaps this serves no real purpose. Plant breeders would appreciate knowing that a line possessing a high level of resistance to a particular disease, is extremely poor agronomically. However, the computer can search key characteristics rated on the cards and come up with the answer.

Dr. Langford suggested a desirability rating (also in column 80). This could lead to indecision as to just why the accession is desirable; vigor, disease resistance, seed yield, etc.

Since the computer can search for desirable material in terms of each characteristic rated, it would be preferable to pick up notably desirable traits on the "D" cards which list comments.

The Data Comments card ("D" in column 31) is used to type out appropriate comments in the 40-column field (38-77). Since 999 backup cards are available, the comments may be typed in 39,960 spaces. Two cards, each with 40 columns for comments, placed end-to-end will print out an 80-column line. This means nearly 500 eighty-space lines which, at 50 lines to a page, give a possible 10 pages of comments. Card "D" would have the same first 30-column identification field as on the characteristic card "C". If this latter suggestion of indicating desirability on the Data Comments ("D") cards is used, then column 80 remains open for future expansion.

The card with a "B" in column 31 would be a Bacterial Disease card, as seen in the previous table. This card would also have the same first 30 columns of identification information as the Characteristic card "C", but columns 38 through 77 would be reserved to rate plant response to a bacterial disease. The bacterial disease card would have 999 backup cards to rate 999 bacterial diseases of beans, and each bacterial organism, represented by a single backup card, has 999 additional cards for races, leaving adequate room for expansion. Midwest workers have recently reported a third race of Halo Blight of beans, so it seems

highly unlikely that much room will be required to list races of bacteria. However, several hundred races are known for some of the rust fungi.

Each regional pathologist has a copy of the Index of Plant Diseases (U.S.D.A. Handbook No. 165). On pages 264-267 of this book there is a listing, by causal entity, of the diseases of beans (*Phaseolus*) which have been reported as occurring in the United States. Only 14 of the diseases on this list are caused by bacteria and four of these occur on lima beans rather than *Phaseolus vulgaris*. It seems best to code all *Phaseolus* diseases in one master list as recorded in the Plant Disease Index.

Bacterial disease card ("B" in column 31) would numerically list bacterial diseases starting with 1 through 9 in column 34, and continuing up to a possible 999 bacterial diseases of a particular crop by using columns 32 through 34 as follows: (Please note that figures of increasing amounts, ones, tens, and hundreds, are entered on the card from right to left, i.e., the first 9 digits appear in column 34, the digits indicating tens are in column 33, and the digits indicating hundreds appear in column 32. This is just as found in adding machines, calculators, etc.)

BACTERIAL DISEASE CARD "B"

Backup Card
Number in

Cols. 32-34

DISEASE

BACTERIAL ORGANISMS from Index of Plant Diseases

1	Stickiness	<i>Achromobacter lipolyticum</i> (Huss) Bergey et al.
2	Crown gall	<i>Agrobacterium tumefaciens</i> (E.F.Sm. & Towns.) Conn
3	Streak	<i>Bacillus lathyri</i> Manns & Taub. * = <i>Erwinia lathyri</i> (Manns & Taub.) Holland
4	Bacterial wilt	<i>Corynebacterium flaccumfaciens</i> (Hedges) Dows.
5	Soft rot	<i>Erwinia carotovora</i> (L. R. Jones) Holland
6	Stickiness	<i>Pseudomonas coadunata</i> (Wright) Chester
7	Stickiness	" <i>ovalis</i> (Ranenel) Chester
8	Halo blight	" <i>phaseolicola</i> (Burkh.) Dows.
9	Brown rot or southern bacterial wilt	" <i>solanacearum</i> E. F. Sm.
10	Bacterial brown spot	" <i>syringae</i> Van Hall
11	Wildfire	" <i>tabaci</i> (Wolf & Foster) F. L. Stevens
12	Root nodules	<i>Rhizobium phaseoli</i> Dangeard
13	Bacterial blight	<i>Xanthomonas phaseoli</i> (E. F. Sm.) Dows.
14	" "	"(?) <i>vignicola</i> Burk.
15	Fuscos blight or bacterial blight	<i>Xanthomonas phaseoli</i> var. <i>fuscans</i> (Burkh.) Starr & Burk.

* Synonyms may be entered in the "Index."

The codes for these diseases could then be written directly in the appropriate places in the "index". In other words, B8 would be Halo blight and B15 Fuscous blight as indicated in the table above.

There are 984 additional cards (numbers 16 through 999) for other bacterial diseases of beans. Columns 35-37 can list 999 possible races for each organism. Disease data for fungi, viruses, etc., would be handled in a similar manner, but would appear on Fungus cards, Virus cards, etc., indicated by a "F" or "V" respectively in Column 31.

The coded data which records the response of an introduction to a particular pest would be punched as a 0 through 9 in column 38. Columns 39 and 40 indicate the severity of the disease or insect by directly entering the percentages from 00 to 99. Thus 37 columns (41-77) are open for additional data. This portion of the disease record cards can be used to cite the literature reference best describing the use of, and type of resistance found in a particular introduction. As an example: Phytopath.24:1101-1110.1934 takes only 27 of the 37 spaces available. Once these references on disease resistance are on the cards, the computer could automatically print out the "Summary of Reports on the Resistance of Plant Introductions to Diseases, Insects, and Nematodes" as presently compiled by the Regional Stations and Beltsville. When sufficient new information has been obtained, a complete updated print-out could be made. The print-out machine can type all data directly on multilith masters which can then be duplicated as required for subsequent distribution.

DISEASE RATING.

A disease rating system was discussed in a November 5, 1964 memo from W-6. This has been slightly changed and is presented on the following page. This system with minor modifications for rating separate diseases is as presently proposed, for use by U.S.D.A. Cereals Pathologists at Beltsville and elsewhere. The ~~light green~~^{test} sheets printed on both sides serve as examples of the use of computer codes for leaf rust, powdery mildew, stem rust, and stripe rust.

We must find a principle which utilizes a system of rating diseases that is devoid of misleading minutia, and yet is directly useful to all plantmen receiving P.I. material. In other words, this system must record the response of plants to diseases in terms of usefulness to breeders in a simple and understandable way. The U.S.D.A. proposal does this effectively. It allows each of the regional pathologists, and others, to use any system of recording diseases they wish to use. Only when the data is put on the cards will they have to make a decision as to whether the line has usefulness to breeders or not, and place it in the Resistant, Intermediate, or Susceptible class as presented in the following table.

Translating Disease Data to Computer Codes

<u>Computer Code</u>	<u>Generalized Description of the Plant Response</u>	<u>Essential Meaning to Breeders</u>
0	No visible indication of the disease in the presence of inoculum as indicated by <u>disease in adjacent plots</u> . Perhaps the resistance is satisfactory from the plant breeding point of view.	Immunity or escapes, but definitely worth a second look.
1	These responses indicate that the specific	Resistant.
2	resistance of the variety is satisfactory	
3	from the plant breeding point of view.	
4	These responses indicate that there is some	Intermediate or field resistance. Possible multiple factors involved.
5	specific resistance evident, but it is not as	
6	good as it should be. In some cases this may be the best available, but still not completely desirable.	
7	These responses indicate that the specific	Susceptible.
8	resistance of the variety or accession is	
9	unsatisfactory as a means of control or damage from the disease.	

To be uniform, everyone should enter ratings on the cards with a blank, meaning no information yet available; a zero as a positive judgment meaning no incidence of whatever measured; 1 as low; 5 as intermediate; and a 9 as the most of whatever characteristic is rated, regardless of which end of the scale indicates the "best" plants. The computer can pick out the best types as discussed in the next section explaining print-outs.

If no information is available, the appropriate column should be left blank. This permits entry of data in their proper place at a later date. If zeros are entered to indicate no data available, then when the information is accumulated later, the card must be completely punched over again instead of merely filling in the blanks on otherwise completed cards. In addition, the computer can print out the P.I. accessions with blanks making a handy list of P.I. accessions requiring additional data to complete the records.

PRINT OUTS (Examples enclosed).

Enclosed you will find a copy of an Alphanumeric Frequency Count on ~~an alternating green and white~~ 2-page, print-out sheet. You will find 27 variables listed on these two pages. This was tabulated by the computer from 354 bean cards punched over a year ago. Please notice both zeros and blanks are recorded. Variable #1 is actually column 24 which rates plant habit for beans according to the old card system; Variable #8 rates flower color; Variable #18 rates pod string; and Variable #27 rates maturity as presented below.

VARIABLE #1 - PLANT HABIT

- | | |
|---------------------|---------------------------|
| 1. bush | 5. bush & vine |
| 2. semi-vine | 6. semi-vine & vine |
| 3. vine | 7. bush, semi-vine & vine |
| 4. bush & semi-vine | |

VARIABLE #8 - FLOWER COLOR

- | | |
|----------------|-----------------------------------|
| 1. red | Note: Additional colors are rated |
| 2. white | in the preceding column on |
| 3. red & white | the card (listed as variable |
| | #7). |

VARIABLE #18 - POD STRING

- | | |
|---------------------------|-------------------------------------|
| 1. stringless (no string) | 3. both string & stringless present |
| 2. with string | 4. stringless when young |

VARIABLE # 27 - MATURITY

- | | |
|-------------------------|-----------------------------------|
| 1. early (80-89 days) | 6. medium & late |
| 2. medium (90-105 days) | 7. early, medium & late |
| 3. late (106-125 days) | 8. very early (1-79 days) |
| 4. early & medium | 9. very late (more than 125 days) |
| 5. early & late | |

In line with our comments on the uniformity of rating, the maturity ratings listed above would be changed with 8 (very early) first, 9 (very late) following the present 3 (late) and the four possible combinations of maturity dates would become 6-9.

Looking at the frequency with which each of the ratings (blank and 0 through 9) occur for each characteristic judged for 354 bean accessions we find: Out of 354 lines of beans, 102 have a bush habit of growth (Variable #1, symbol 1, frequency 102); 151 have white flowers (Variable #8, symbol 2); 93 are stringless (Variable #18, symbol 1); and 177 lines have early to medium maturity (Variable #27, symbol 1 for early and symbol 2 for medium). This print-out gives the total number of P.I. accessions which possess a specific rating for any characteristic rated. It is also possible to determine the overall distribution or array of ratings of each characteristic for all P.I. lines available. This enables us to immediately tell plantmen requesting material exactly how many P.I. accessions are available with the desired characteristics, and possibly to suggest additional lines which have ratings judged to be most closely similar to the requested traits.

Next, with all cards placed in numeric order by the sorter the computer can be instructed to print out the P.I. number, plant name, and origin, for all bean accessions having a bush habit of growth (#1), all lines with white flowers (#8), all with stringless pods (#18), and those with an acceptable threshold of early to medium maturity (#27).

P.I. bean accessions containing one or more of these four desirable characteristics are printed out in numeric sequence on the second enclosed computer listing. Individual accessions containing all four of these characteristics are marked with a double asterisk. Therefore, from this list it is possible to make up a seed order containing only lines with all four characteristics present, any with only three characteristics present, etc. The computer can be specifically instructed to retrieve the necessary information and print it out in acceptable and usable form. The resulting list can be given to the seedsman to fill the orders.

It is possible for the computer to run correlations (actually print in correlation coefficients) between characteristics for all accessions of one crop. In this way it is relatively easy to determine if a certain disease resistance is associated with a particular origin. It may also be possible to determine that other characteristics often occur together, suggesting genetic linkages.

LABELS.

Once the information is on the cards (or tape), labels can be automatically printed up in the required number of replications. W-6 likes labels in duplicate; one for the container, and one for the lid. ~~Enclosed are examples of gummed labels printed up for another program.~~ Our labels would contain: P.I. and number, abbreviated plant name, and origin as found on the cards. The cost of the labels themselves is 1/4 cent each. With three lines of printing it is still less than 1 cent each.

USE OF THE COMPUTER WILL PROVIDE THE FOLLOWING:

1. Rapid retrieval of information.
2. Uniformity of ratings and subsequent reports.
3. Automatic print out of inventories, including comments, on multilith masters for further duplication.
4. Automatic print out of "Summaries of Reports on the Resistance of Plant Introductions to Diseases, Insects and Nematodes."
5. To make rapid correlations between characteristics such as resistance and origin.
6. To make print outs of the frequency and distribution of various ratings for all characteristics.
7. Print out labels.
8. Automatic listing of accessions for which no data is available. This can be used to pinpoint areas where additional work is required to complete the records. It may also point out the failures.

We hope each of you will give this proposal careful consideration and discuss it among yourselves and with others who may be of assistance. It is time to develop a comprehensive program which will do the job efficiently and effectively. We will be looking forward to your suggestions, which should include all possible ways this preliminary evaluation data will be used. This must be determined before the machine is programmed for retrieval and print-out of the accumulated information

- 4/8 enclosures: 1. Punched card pack, 2. Frequency distribution print-out (2-page), 3. Print-out of lines with specific characteristics requested (multi-page), 4. ~~Cocoa~~ disease response cards, ~~5. Machine-printed labels.~~

BM004D - ALPHANUMERIC FREQUENCY COUNT - VERSION OF MAY 22, 1964
 WASHINGTON STATE UNIVERSITY
 STATISTICAL SERVICES
 PROBLEM CODE P. 1.
 NUMBER OF OBSERVATIONS = 354

VARIABLES 1-6 Plant Characteristics

" 7-10 Flower
 " 11-21 Pod
 " 22-24 Seed
 " 27 Maturity

Plant Habit		Plant Size		Plant Foliage		Erectness		Branching	
VARIABLE NUMBER	1	VARIABLE NUMBER	2	VARIABLE NUMBER	3	VARIABLE NUMBER	4	VARIABLE NUMBER	5
SYMBOL	FREQUENCY	SYMBOL	FREQUENCY	SYMBOL	FREQUENCY	SYMBOL	FREQUENCY	SYMBOL	FREQUENCY
Bush	102	0	4	0	21	0	12	0	12
Semi-vine	78	1	45	2	36	1	8	2	29
Vine	155	2	179	3	177	2	106	3	170
Bd Sw	2	3	118	4	119	3	128	4	126
B + V	14	4	2	BLANK	1	4	87	5	16
Sw + V	2	5	2			5	12	BLANK	1
B Sw + V	1	6	3			BLANK	1		
		BLANK	1						

Flower Color		Flower Color		Flower Color		Flower Color		Flower Color	
VARIABLE NUMBER	6	VARIABLE NUMBER	7	VARIABLE NUMBER	8	VARIABLE NUMBER	9	VARIABLE NUMBER	10
SYMBOL	FREQUENCY	SYMBOL	FREQUENCY	SYMBOL	FREQUENCY	SYMBOL	FREQUENCY	SYMBOL	FREQUENCY
1	259	0	117	0	201	0	1	0	1
2	23	1	10	White	2	1	34	1	37
3	30	2	145	3	1	2	133	2	135
4	10	3	75	BLANK	1	3	137	3	124
5	28	6	6			4	45	4	50
6	3	BLANK	1			5	3	5	6
BLANK	1					BLANK	1	BLANK	1

VARIABLE NUMBER	11	VARIABLE NUMBER	12	VARIABLE NUMBER	13	VARIABLE NUMBER	14	VARIABLE NUMBER	15
SYMBOL	FREQUENCY	SYMBOL	FREQUENCY	SYMBOL	FREQUENCY	SYMBOL	FREQUENCY	SYMBOL	FREQUENCY
0	1	2	10	0	2	1	6	1	7
1	55	3	69	1	5	2	44	2	25
2	135	4	139	2	73	3	133	3	107
3	119	5	86	3	168	4	160	4	171
4	37	6	46	4	104	5	10	5	43
5	6	7	3	5	1	BLANK	1	BLANK	1
BLANK	1	BLANK	1	BLANK	1				

VARIABLE NUMBER 16		VARIABLE NUMBER 17		VARIABLE NUMBER 18		VARIABLE NUMBER 19		VARIABLE NUMBER 20	
SYMBOL	FREQUENCY	SYMBOL	FREQUENCY	SYMBOL	FREQUENCY	SYMBOL	FREQUENCY	SYMBOL	FREQUENCY
0	6	0	5	0	3	0	95	0	256
1	56	1	1	1	93	1	62	1	7
2	168	2	111	2	253	2	139	2	53
3	89	3	111	3	4	3	51	3	36
4	32	4	113	BLANK	1	4	6	4	1
5	2	5	12			5	1	5	1
BLANK	1	BLANK	1						

VARIABLE NUMBER 21		VARIABLE NUMBER 22		VARIABLE NUMBER 23		VARIABLE NUMBER 24		VARIABLE NUMBER 25	
SYMBOL	FREQUENCY	SYMBOL	FREQUENCY	SYMBOL	FREQUENCY	SYMBOL	FREQUENCY	SYMBOL	FREQUENCY
0	5	0	305	0	232	0	54	0	256
1	29	1	24	1	48	1	42	1	1
2	73	2	13	2	4	2	56	2	46
3	5	3	2	3	20	3	92	3	43
5	2	4	4	5	10	4	5	6	2
6	3	0	1	A	4	5	1	8	1
8	233	BLANK	5	B	14	6	9	BLANK	5
9	4			C	17	7	4		
				BLANK	5	8	1		
						9	1		
						A	5		
						B	34		
						C	44		
						E	1		
						BLANK	5		

VARIABLE NUMBER 26		VARIABLE NUMBER 27	
SYMBOL	FREQUENCY	SYMBOL	FREQUENCY
0	7	0	13
1	25	1	15
2	174	2	162
3	54	3	104
4	31	4	1
6	58	9	42
BLANK	5	BLANK	17

END OF OUTPUT FOR PROBLEM CODE P. I.

FINISH CARD ENCOUNTERED, PROGRAM TERMINATED

P. I.	NAME	ORIGIN	CHARACTERISTIC			
			1	8	18	27
109863	PHAS VULGAR	VENEZUE	1			2
110230	PHAS VULGAR	RUANDA				1
110230	PHAS VULGAR	RUANDA				1
110233	PHAS VULGAR	RUANDA		2	1	1
136690	PHAS VULGAR	CANADA	1	2		2
136694	PHAS VULGAR	CANADA		2		2
136712	PHAS VULGAR	CANADA	1			2
136716	PHAS VULGAR	CANADA	1			1
136730	PHAS VULGAR	CANADA		2		
136736	PHAS VULGAR	CANADA	1			1
136751	PHAS VULGAR	CANADA	1	2		1
142883	PHAS VULGAR	IRAN			1	2
142897	PHAS VULGAR	IRAN		2		2
142904	PHAS VULGAR	IRAN		2		2
146787	PHAS VULGAR	SAFRICA				2
146792	PHAS VULGAR	SAFRICA				2
150406	PHAS VULGAR	ELSALVA				2
150408	PHAS VULGAR	ELSALVA				2
151391	PHAS VULGAR	COLUMBI	1			
151393	PHAS VULGAR	COLUMBI	1	2		
151393	PHAS VULGAR	COLUMBI	1	2		
154402	PHAS VULGAR	ELSALVA				2
155209	PHAS VULGAR	PARAGUA				2
156960	PHAS VULGAR	PERU				2
161952	PHAS VULGAR	BELGIUM		2		2
163119	PHAS VULGAR	INDIA	1			1
163120	PHAS VULGAR	INDIA.		2		2
163577	PHAS VULGAR	GUATEMA				2

P. I.	NAME	ORIGIN	CHARACTERISTIC			
			1	8	18	27
163584	PHAS VULGAR	GUATEMA	2	1	2	
163584	PHAS VULGAR	GUATEMA	2	1	2	
164093	PHAS VULGAR	SWITZER	1		1	2
164306	PHAS VULGAR	INDIA				2
164314	PHAS VULGAR	INDIA				2
164739	PHAS VULGAR	INDIA				2
164777	PHAS VULGAR	INDIA				2
164926	PHAS VULGAR	TURKEY	1	2		2
164929	PHAS VULGAR	TURKEY				2
165038	PHAS VULGAR	TURKEY				2
165083	PHAS VULGAR	TURKEY				2
165420	PHAS VULGAR	MEXICO				2
165422	PHAS VULGAR	MEXICO				2
165434	PHAS VULGAR	MEXICO				2
165435	PHAS VULGAR	MEXICO				2
165455	PHAS VULGAR	MEXICO				2
165461	PHAS VULGAR	MEXICO				2
165617	PHAS VULGAR	HOLLAND	1	2		2
166031	PHAS VULGAR	INDIA			1	
166151	PHAS VULGAR	INDIA	1		1	2
167104	PHAS VULGAR	TURKEY		2	1	2
167111	PHAS VULGAR	TURKEY				2
167345	PHAS VULGAR	TURKEY **	1	2	1	2
167350	PHAS VULGAR	TURKEY	1	2		2
167382	PHAS VULGAR	TURKEY	1		1	2
167383	PHAS VULGAR	TURKEY	1		1	2
169719	PHAS VULGAR	TURKEY		2		2
169721	PHAS VULGAR	TURKEY	1			

P. I.	NAME	ORIGIN	CHARACTERISTIC			
			1	8	18	27
169725	PHAS	VULGAR TURKEY	2			
169726	PHAS	VULGAR TURKEY	1			2
169731	PHAS	VULGAR TURKEY	2			2
169732	PHAS	VULGAR TURKEY	1			1
169737	PHAS	VULGAR TURKEY	2			
169739	PHAS	VULGAR TURKEY	2			
169745	PHAS	VULGAR TURKEY	2			
169747	PHAS	VULGAR TURKEY				2
169755	PHAS	VULGAR TURKEY	2			
169756	PHAS	VULGAR TURKEY	2			
169762	PHAS	VULGAR TURKEY	2			
169769	PHAS	VULGAR TURKEY	2	1		
169770	PHAS	VULGAR TURKEY	2	1		
169774	PHAS	VULGAR TURKEY	2			2
169776	PHAS	VULGAR TURKEY	2			
169782	PHAS	VULGAR TURKEY	2			
169784	PHAS	VULGAR TURKEY	1		1	2
169784	PHAS	VULGAR TURKEY	1		1	2
169787	PHAS	VULGAR TURKEY				2
169797	PHAS	VULGAR TURKEY	2			
169798	PHAS	VULGAR TURKEY	2			
169800	PHAS	VULGAR TURKEY			1	
169814	PHAS	VULGAR TURKEY	2			
169815	PHAS	VULGAR TURKEY	2			
169824	PHAS	VULGAR TURKEY	2			2
169825	PHAS	VULGAR TURKEY	2			2
169837	PHAS	VULGAR TURKEY	2			2
169840	PHAS	VULGAR TURKEY				2

P. I.	NAME	ORIGIN	CHARACTERISTIC			
			1	8	18	27
169847	PHAS VULGAR	TURKEY		2		
169849	PHAS VULGAR	TURKEY **	1	2	1	2
169859	PHAS VULGAR	TURKEY		2		
169860	PHAS VULGAR	TURKEY		2		
169866	PHAS VULGAR	TURKEY		2		
169867	PHAS VULGAR	TURKEY		2		
169870	PHAS VULGAR	TURKEY			1	
169876	PHAS VULGAR	TURKEY		2		
169885	PHAS VULGAR	TURKEY		2		
169895	PHAS VULGAR	TURKEY		2		
169903	PHAS VULGAR	TURKEY		2		
169906	PHAS VULGAR	TURKEY		2		
169908	PHAS VULGAR	TURKEY			1	
169909	PHAS VULGAR	TURKEY			1	2
169911	PHAS VULGAR	TURKEY	1			2
169912	PHAS VULGAR	TURKEY			1	2
169912	PHAS VULGAR	TURKEY			1	2
169916	PHAS VULGAR	TURKEY		2		
169917	PHAS VULGAR	TURKEY		2	1	
169921	PHAS VULGAR	TURKEY		2		
171740	PHAS VULGAR	TURKEY		2		2
171743	PHAS VULGAR	TURKEY		2		
171746	PHAS VULGAR	TURKEY		2	1	
171760	PHAS VULGAR	TURKEY		2		
171762	PHAS VULGAR	TURKEY		2		
171766	PHAS VULGAR	TURKEY			1	2
171770	PHAS VULGAR	TURKEY		2		
171787	PHAS VULGAR	TURKEY		2		2

P. I.	NAME	ORIGIN	CHARACTERISTIC			
			1	8	18	27
171805	PHAS VULGAR	TURKEY			1	2
172023	PHAS VULGAR	SAFRICA	1			1
172024	PHAS VULGAR	SAFRICA				2
172035	PHAS VULGAR	SAFRICA			1	2
172037	PHAS VULG	SAFRICA	1			2
172925	PHAS VULG	INDIA		2		2
173047	PHAS VULG	TURKEY	1			
173050	PHAS VULG	TURKEY			1	2
173768	PHAS VULG	TURKEY		2		2
174308	PHAS VULG	TURKEY	1		1	
174309	PHAS VULG	TURKEY				2
174996	PHAS VULG	FRANCE	1	2		
175253	PHAS VULG	INDIA	1			
175256	PHAS VULG	INDIA	1			2
175847	PHAS VULG	TURKEY		2		
175848	PHAS VULG	TURKEY		2		
176674	PHAS VULG	TURKEY		2		2
176695	PHAS VULG	TURKEY		2		2
176700	PHAS VULG	TURKEY				2
177035	PHAS VULG	TURKEY **	1	2	1	2
177049	PHAS VULG	TURKEY			1	
177499	PHAS VULG	TURKEY	1			2
177507	PHAS VULGAR	TURKEY				2
177507	PHAS VULGAR	TURKEY				2
177517	PHAS VULG	TURKEY		2		2
177760	PHAS VULG	ITALY	1		1	2
177761	PHAS VULG	ITALY	1		1	2
177764	PHAS VULG	ITALY		2		

P. I.	NAME	ORIGIN	CHARACTERISTIC			
			1	8	18	27
179402	PHAS VULG	TURKEY			1	2
179415	PHAS VULG	TURKEY	1			2
179415	PHAS VULG	TURKEY	1			2
179417	PHAS VULG	TURKEY **	1	2	1	2
179437	PHAS VULG	TURKEY		2		2
179716	PHAS VULG	INDIA	1			
180732	PHAS VULG	GERMANY	1	2	1	
180732	PHAS VULG	GERMANY	1	2	1	
180737	PHAS VULG	GERMANY	1	2	1	
180739	PHAS VULG	GERMANY	1	2	1	
180740	PHAS VULG	GERMANY	1	2		2
180748	PHAS VULG	GERMANY	1	2	1	
180751	PHAS VULG	GERMANY **	1	2	1	2
180752	PHAS VULG	GERMANY **	1	2	1	2
180754	PHAS VULG	GERMANY	1	2	1	
180755	PHAS VULGAR	GERMANY **	1	2	1	2
180758	PHAS VULGAR	GERMANY	1			
180759	PHAS VULGAR	GERMANY **	1	2	1	2
180760	PHAS VULGAR	GERMANY **	1	2	1	2
180761	PHAS VULGAR	GERMANY **	1	2	1	2
180762	PHAS VULGAR	GERMANY **	1	2	1	2
181782	PHAS VULGAR	SYRIA	1			2
181782	PHAS VULGAR	SYRIA	1			2
181782	PHAS VULGAR	SYRIA	1			2
181794	PHAS VULGAR	SYRIA			1	2
181797	PHAS VULGAR	SYRIA	1	2		2
181892	PHAS VULGAR	SYRIA	1			
181894	PHAS VULGAR	SYRIA				2

P. I.	NAME	ORIGIN	CHARACTERISTIC			
			1	8	18	27
181894	PHAS VULGAR	SYRIA				2
181953	PHAS VULGAR	SYRIA			1	2
181953	PHAS VULGAR	SYRIA			1	2
182006	PHAS VULGAR	GUATEMA	2			2
182271	PHAS VULGAR	TURKEY			1	
182280	PHAS VULGAR	TURKEY	2			2
183067	PHAS VULGAR	INDIA	1			
183705	PHAS VULGAR	TURKEY			1	2
184125	PHAS VULGAR	YUGOSLA	2			2
184125	PHAS VULGAR	YUGOSLA	2			2
186439	PHAS VULGAR	FRCAMER	2			
186501	PHAS VULGAR	NIGERIA	1			
186502	PHAS VULGAR	NIGERIA	2		1	
189566	PHAS VULGAR	HOLLAND	2			
190069	PHAS VULGAR	GUATEMA	2			2
193573	PHAS VULGAR	ETHIOPI				2
193576	PHAS VULGAR	ETHIOPI	2			
194333	PHAS VULGAR	ETHIOPI	2			
194333	PHAS VULGAR	ETHIOPI	2			
194335	PHAS VULGAR	ETHIOPI				2
194335	PHAS VULGAR	ETHIOPI				2
197030	PHAS VULGAR	ELSALVA	2			
200954	PHAS VULGAR	GUATEMA	1		1	2
201368	PHAS VULGAR	MEXICO	2			
201380	PHAS VULGAR	MEXICO	2			
201386	PHAS VULGAR	MEXICO	2			
201484	PHAS VULGAR	MEXICO	2			
201490	PHAS VULGAR	MEXICO	2			

P. I.	NAME	ORIGIN	CHARACTERISTIC			
			1	8	18	27
203929	PHAS VULGAR	MEXICO	1	2		1
203936	PHAS VULGAR	MEXICO		2		
204718	PHAS VULGAR	TURKEY		2		
204719	PHAS VULGAR	TURKEY	1		1	2
204720	PHAS VULGAR	TURKEY			1	
204963	PHAS VULGAR	GUATEMA				2
205206	PHAS VULGAR	TURKEY			1	2
205208	PHAS VULGAR	TURKEY	1			2
205209	PHAS VULGAR	TURKEY		2		2
205210	PHAS VULGAR	TURKEY		2		2
205211	PHAS VULGAR	TURKEY			1	
206223	PHAS VULGAR	HONDURA		2		
207005	PHAS VULGAR	MEXICO		2		
207006	PHAS VULGAR	MEXICO		2	1	
207148	PHAS VULGAR	COLOMBI	1			
207153	PHAS VULGAR	COLOMBI		2		
207160	PHAS VULGAR	COLOMBI				2
207203	PHAS VULGAR	COLOMBI	1		1	2
207204	PHAS VULGAR	COLOMBI	1		1	2
207207	PHAS VULGAR	COLOMBI	1		1	
207213	PHAS VULGAR	COLOMBI				2
207372	PHAS VULGAR	COLOMBI				2
207372	PHAS VULGAR	COLOMBI				2
207373	PHAS VULGAR	COLOMBI				1
207405	PHAS VULGAR	COLOMBI		2		2
207405	PHAS VULGAR	COLOMBI		2		2
207423	PHAS VULGAR	COLOMBI	1			
207441	PHAS VULGAR	COLOMBI	1			2

P. I.	NAME	ORIGIN	CHARACTERISTIC			
			1	8	18	27
207586	PHAS VULGAR COLUMBI	1		1		2
207597	PHAS VULGAR COLUMBI			1		
208769	PHAS VULGAR CUBA					2
208773	PHAS VULGAR NICARAG					2
208773	PHAS VULGAR NICARAG			1		2
209053	PHAS VULGAR PRTRICO					2
209053	PHAS VULGAR PRTRICO					2
209258	PHAS VULGAR PERU		2			
209462	PHAS VULGAR MEXICO		2			
209462	PHAS VULGAR MEXICO		2			
209467	PHAS VULGAR MEXICO		2			
209467	PHAS VULGAR MEXICO		2			
209469	PHAS VULGAR MEXICO					2
209469	PHAS VULGAR MEXICO					2
209492	PHAS VULGAR CSTRICA		2			
209799	PHAS VULGAR KENYA		2			
209800	PHAS VULGAR KENYA					2
209808	PHAS VULGAR KENYA	1				1
209814	PHAS VULGAR KENYA					1
209815	PHAS VULGAR KENYA					1
209817	PHAS VULGAR KENYA					2
212110	PHAS VULGAR AFGHANI		2			2
212110	PHAS VULGAR AFGHANI		2			2
212616	PHAS VULGAR AFGHANI		2			
223006	PHAS VULGAR IRAN			1		2
224728	PHAS VULGAR MEXICO					2
224729	PHAS VULGAR MEXICO					2
224730	PHAS VULGAR MEXICO					1

P. I.	NAME	ORIGIN	CHARACTERISTIC			
			1	8	18	27
226525	PHAS VULGAR	IRAN		2		2
226932	PHAS VULGAR	GERMANY	1	2		
226934	PHAS VULGAR	GERMANY **	1	2	1	2
226935	PHAS VULGAR	GERMANY **	1	2	1	2
226937	PHAS VULGAR	GERMANY **	1	2	1	2
226937	PHAS VULGAR	GERMANY **	1	2	1	2
227379	PHAS VULGAR	IRAN		2		
228357	PHAS VULGAR	IRAN		2		
228358	PHAS VULGAR	IRAN		2		
229536	PHAS VULGAR	IRAN		2		2
229770	PHAS VULGAR	IRAN			1	2
229817	PHAS VULGAR	ITALY			1	
229818	PHAS VULGAR	ITALY			1	
229819	PHAS VULGAR	ITALY			1	
229819	PHAS VULGAR	ITALY			1	
229820	PHAS VULGAR	ITALY			1	
236467	PHAS VULGAR	WESTVA.		2		2
251049	PHAS VULGAR	YUGOSLA	1		1	
251624	PHAS VULGAR	YUGOSLA	1		1	2
255309	PHAS VULGAR	MEXICO		2		
262163	PHAS VULGAR	SWITZER		2	1	
264240	PHAS VULGAR	FRANCE	1	2		
264240	PHAS VULGAR	FRANCE	1	2		
264241	PHAS VULGAR	FRANCE			1	
269324	PHAS VULGAR	SWEDEN	1	2	1	
269324	PHAS VULGAR	SWEDEN	1	2	1	
269324	PHAS VULGAR	SWEDEN	1	2	1	
269326	PHAS VULGAR	SWEDEN	1		1	

P. I.	NAME	ORIGIN	CHARACTERISTIC			
			1	8	18	27
269635	PHAS VULGAR	RUSSIA	1		1	
271998	PHAS VULGAR	SPAIN	1	2		1
272004	PHAS VULGAR	SPAIN	1	2		
276327	PHAS VULGAR	NORWAY	1		1	2
278664	PHAS VULGAR	NEWYORK	1			
278665	PHAS VULGAR	NEWYORK		2		
278666	PHAS VULGAR	NEWYORK		2		
278667	PHAS VULGAR	NEWYORK		2	1	
278667	PHAS VULGAR	NEWYORK		2	1	
278667	PHAS VULGAR	NEWYORK		2	1	
278668	PHAS VULGAR	NEWYORK	1			
278668	PHAS VULGAR	NEWYORK	1			
278670	PHAS VULGAR	NEWYORK	1			2
278672	PHAS VULGAR	NEWYORK	1		1	2
278673	PHAS VULGAR	NEWYORK	1			2
278674	PHAS VULGAR	NEWYORK		2	1	
278675	PHAS VULGAR	NEWYORK				2
278675	PHAS VULGAR	NEWYORK				2
278676	PHAS VULGAR	NEWYORK	1			2
278677	PHAS VULGAR	NEWYORK	1			
278678	PHAS VULGAR	NEWYORK	1			
278679	PHAS VULGAR	NEWYORK				2
278680	PHAS VULGAR	NEWYORK	1			2
278680	PHAS VULGAR	NEWYORK	1			2

DISEASE 00 - STEM RUST (*P. graminis*)
on wheat, barley, oats, rye

Severity: 00 to 99 per cent

Description of response*	Symbol	Computer Code
No data, no rust in plot area, escape or plants killed by other diseases		Blank
No visible infection	(0)	0
Minute necrotic flecks	(VR)	1
Minute sporulating pustules surrounded by necrosis	(R)	2
Small sporulating pustules surrounded by necrosis	(MR)	3
Variable sized sporulating pustules with some necrosis and some chlorosis	(M)	4 5 6
Small sporulating pustules surrounded by chlorosis but no necrosis	(MS)	7
Large sporulating pustules surrounded by some chlorosis	(S)	8
Very large sporulating pustules with very little chlorosis	(VS)	9

*According to Loegering

DISEASE 01 - STRIPE RUST
(*P. striiformis*) on wheat, barley

Severity: 00 to 99 per cent

Description of response*	Symbol	Reaction type	Computer Code
No data, no rust in plot area, escape or plants killed by other diseases			Blank
No visible infection but rust in other adjacent plots	(0)	(i)	0
Only chlorotic flecks on leaves	(VR)	(00)	1
No pustules, but chlorosis and/or necrosis	(R)	(0)	2
Small scattered pustules with chlorosis and/or necrosis	(MR)	(1)	3
Intermediate classes	(M)		4 5 6
Pustules with chlorosis and/or necrosis	(MS)	(2)	7
Large pustules with chlorosis behind pustules	(S)	(3)	8
Large pustules without chlorosis, tissue behind pustules green	(VS)	(4)	9

*According to Purdy, Hendrix, Romig, Loegering and others

DISEASES 02, 03 - LEAF RUST
(Puccinia rubigo-vera tritici) on wheat, barley
(Puccinia coronata), Crown Rust on Oats
(Puccinia hordei) on barley

Severity: 00 to 99 per cent

Description of response*	Symbol	Computer Code
No visible infection	(O)	0
Minute necrotic flecks	(VR)	1
Minute sporulating pustules surrounded by necrosis	(R)	2
Small sporulating pustules surrounded by necrosis	(MR)	3
		4
Variable sized sporulating pustules with some necrosis and some chlorosis	(M)	5
		6
Small sporulating pustules surrounded by chlorosis but no necrosis	(MS)	7
Large sporulating pustules surrounded by some chlorosis	(S)	8
Very large sporulating pustules with very little chlorosis	(VS)	9

*Tentative

DISEASE 04 - POWDERY MILDEW (Erisiphe graminis)
on wheat, barley, oats, rye

Severity: 00 to 99 per cent

Description of response*	Symbol	Computer Code
No visible infection but mildew in other adjacent plots	(O)	0
Necrotic brown areas or spots on leaves with no visible mycelium	(VR)	1
Necrotic brown areas or spots on leaves with a trace of visible mycelium	(R)	2
Necrotic brown areas or spots on leaves with abundant mycelium	(MR)	3
Necrotic brown areas or spots on leaves plus a few unrestricted pustules		4
About an equal amount of necrotic brown areas or spots and unrestricted pustules	(M)	5
A few necrotic brown areas or spots among the unrestricted pustules		6
No necrotic brown areas or spots, but with a reduced number of unrestricted pustules	(MS)	7
No necrotic brown areas or spots with many unrestricted pustules	(S)	8
No necrotic brown areas or spots with an abundant number of unrestricted pustules	(VS)	9

*According to Moseman

Knowles

December 20, 1963

Dr. Paul F. Knowles
Department of Agronomy
University of California
Davis, California

Dear Paul:

As you know, W-6 is vitally interested in a method of accomplishing rapid information retrieval, and the IBM punch card system has recently been selected. Since I have done much of the background work on coding this information, Dr. Mullen referred your December 6 letter to me. I have taken the liberty of suggesting one possible way of programing the safflower information on IBM cards. Please do not misconstrue this as being a dictatorial mandate; it is simply a possible format to aid yourself and Dr. Leininger in finalizing the IBM program for safflower. Any and all suggestions are welcome, and I will be happy to work with you, if you wish. I am not familiar with all the characteristics evaluated, or just how you rate them.

Each IBM card contains 80 columns. Each of these columns has a further breakdown of 0 through 9. Three separate evaluations of a plant characteristic, and all possible combinations of the same three evaluations, can be coded in any one column. Example:

- | | | | |
|-----------|-------------------------|---|-----------------------|
| 1. small | 4. small, medium |) | |
| 2. Medium | 5. small, large |) | possible combinations |
| 3. large | 6. medium, large |) | |
| | 7. small, medium, large |) | |

The cards can have specially printed headings for specific information on each crop. An enlargement of the proposed codification is shown on the enclosed "Multiple Layout Form" so that the data taken and spacing may be more easily interpreted.

Proposed Coding on IBM Cards

Columns 1-6. Plant Introduction Number.

These six columns leave room for 999,999 P.I. accessions. From the time plant introductions were first numbered to date, there have been approximately 290,000 numbers assigned. Thus we have used only a little over one-fourth of the total numbers that can be coded in the allotted space. Since P.I. lines are kept by numbers, they may be entered and read directly from the cards.

Columns 7-16. Plant Name (abbreviated and alphabetized).

Columns 7-10 are reserved for the alphabetical abbreviation of the generic name, 11-14 for the specific epithet, and 15-16 for the variety. If the first four letters of a particular genus are the same as another genus, then use the fifth or even last letter to show the difference in the fourth column on the card. The species and variety names can be handled similarly.

Columns 17-21. Place of Origin.

This is also an alphabetical listing, viz., Turkey could be Turkey etc. If latitude and longitude are used instead of political nomenclature, there is still enough room to indicate the origin within one degree (90 x 180). Anything more exact than that can be taken from the collectors' records.

Thus all cards, regardless of crop or station reporting, would have columns 1-6 for the P.I. number, 7-16 for the plant name, and 17-21 for the place of origin. This information can be punched in, and read from the upper margin of the cards directly without coding or decoding. Crop and disease information would appear in columns 22-80.

The following pertains to safflower only:

Columns 22-28. GENERAL PLANT CHARACTERISTICS.

Column 22. Habit.

- | | |
|--------------|----------------------|
| 1. erect | 3. erect & sprawling |
| 2. sprawling | |

Column 23-24. Branching.

Column 23.

- | | | |
|--------|-------------------|-------------------------|
| 1. 1/5 | 4. 1/5 & 2/5 |) possible combinations |
| 2. 2/5 | 5. 1/5 & 3/5 | |
| 3. 3/5 | 6. 2/5 & 3/5 | |
| | 7. 1/5, 2/5 & 3/5 | |

Column 24.

- | | |
|--------|--------------|
| 1. 4/5 | 3. 4/5 & 5/5 |
| 2. 5/5 | |

Columns 25-26. Plant height (inches).

It takes two columns to directly enter height (from 1 to 99 inches possible).

Columns 27-28. Spines.

Column 27.

- | | | |
|------|----------|-------------|
| 0. 0 | 3. 0 & 1 | 6. 0, 1 & 2 |
| 1. 1 | 4. 0 & 2 | |
| 2. 2 | 5. 1 & 2 | |

Column 28.

- | | | |
|------|----------|-------------|
| 1. 3 | 4. 3 & 4 | 7. 3, 4 & 5 |
| 2. 4 | 5. 3 & 5 | |
| 3. 5 | 6. 4 & 5 | |

Columns 29-32. FLOWER CHARACTERISTICS.

Columns 29-34. Bloom date.

Columns 29-30. month

Columns 31-32. day

Columns 33-34. year

Columns 35-36. Color (dry).

Column 35.

- | | | |
|-----------|------------------|-------------------------|
| 1. white | 4. white, cream | 7. white, cream, yellow |
| 2. cream | 5. white, yellow | |
| 3. yellow | 6. cream, yellow | |

Column 36.

- | | |
|-----------|----------------|
| 1. orange | 3. orange, red |
| 2. red | |

Column 37. Pubescence.

Rate 1 to 5, with 1 the least or poorest, and 5 the most or best expression of the characteristic judged. No. 6 means variable.

Columns 38-39. Pappus.

Column 38. Extent of pappus. Rate 1 to 5, 6 as variable.

Column 39. Nature of pappus. Rate 1 to 5, 6 as variable.

Columns 40-41. BRACT.

Column 40. Size. Rate 1 to 5.

Column 41. Shape. Rate 1 to 5.

Columns 42-52. SKED.

Columns 42-43. Shape.

Column 42. Longitudinal. Rate 1 to 5.

Column 43. Cross-section. Rate 1 to 5.

Column 44. Seed coat color (not achene). (Some color code.)

Column 45. Nature of the hull. Rate 1 to 5.

Columns 46-47. Weight per 100 seeds. Enter directly as grams.

Columns 48-49. Oil content. Enter directly as per cent.

Columns 50-52. Iodine value.

Column 53. DISEASE CATEGORY.

- | | |
|--------------|----------------------------|
| 1. bacteria | 5. insects |
| 2. fungi | 6. physiological disorders |
| 3. viruses | 7. parasitic higher plants |
| 4. nematodes | |

Columns 54-63. DISEASE NAME.

The disease name will be an alphabetical abbreviation of the causal

organisms, viz., safflower rust Puccinia carthami would be Pucc. cart.. The varietal spaces (columns 62 and 63) could be used for race designations. If column 53 (disease category) had number 5 punched, then the columns for disease names would be used to name the insect such as Lygus bug; if number 6 is punched in column 53, then cold hardiness and the like can be listed in these columns under physiological disorders. The same applies for the other disease categories listed in column 53.

Column 64. RESISTANCE RATING.

- | | |
|----------------------------|---|
| 0. immune | 5. resistant, susceptible |
| 1. resistant | 6. intermediate, susceptible |
| 2. intermediate | 7. resistant, intermediate, susceptible |
| 3. susceptible | 8. tolerant |
| 4. resistant, intermediate | 9. severe symptoms |

Column 65. DEGREE OF SUSCEPTIBILITY.

- | | |
|-----------|------------------|
| 0. 1-10% | 5. 51-60% |
| 1. 11-20% | 6. 61-70% |
| 2. 21-30% | 7. 71-80% |
| 3. 31-40% | 8. 81-90% |
| 4. 41-50% | 9. 91-100% |
| | / means variable |

Columns 66-80 are open for expansion.

We hope this has been of some help. Both you and Dr. Leininger will probably have valuable suggestions to make. If I may be of further assistance, do not hesitate to write.

Merry Christmas,

S. M. Diets

S. M. Diets
Plant Pathologist, W-6

cc: L. W. Leininger
A. J. Oakes

Encl.

REGIONAL PLANT INTRODUCTION STATION
WASHINGTON STATE UNIVERSITY
JOHNSON HALL 5B
PULLMAN, WASHINGTON 99163

JAN 24 1966

January 20, 1966

Dr. Paul F. Knowles
Department of Agronomy
University of California
Davis, California 95616

Dear Paul:

Glad to have you and Dr. Rogers aboard! We are sending you two copies of our July 27, 1965 proposed uniform format for information retrieval.

Our first attempt at coding safflower data was sent to you and Dr. Leininger December 20, 1963. Enclosed you will find a copy of this letter and the 12/31/63 and 1/21/64 replies sent in by Dr. Leininger. We presently feel the 1965 proposed uniform format is a better overall system than initially proposed in our 1963 letter. These may prove helpful, as well as of interest to you.

W-6 would appreciate being kept informed of your progress toward coding safflower data for any information retrieval system, and would welcome the opportunity to work with you on this project. This might include a pilot run on P.I. safflower. We can discuss this further when you come to Pullman this summer.

Your letter states "several" introductions will be grown here. Dr. Mullen and I would like a more exact figure. Land preparation and irrigation facilities must be arranged.

We read your recent article on the newly developed safflower with high oleic acid. The gene controlling this was found in an introduction from India (UC57-147). Does this have a P.I. number?

Sincerely yours,

S.M.

S. M. Dietz
Plant Pathologist, W-6

Encls.

cc: D. J. Rogers ✓
A. J. Oakes

SAFFLOWER PERFORMANCE NOTES
Regional Project W-6

Scientific Name _____ P.I. No. _____

Origin _____ Acc. No. _____

Habit: erect - sprawling Branching: upper 1/5 - 2/5 - 3/5 - 4/5 - 5/5

Height: inches _____ Spines: 0—1—2—3—4—5— Head Diam* _____

Flowers: bloom date _____ Color (wilted): w - c - y - o - r

Seeds: wt. 100 _____ grams. Oil content _____ % Iodine value _____

Insects: _____

Diseases: _____

Remarks: _____

1 - least.

* - 1/8" units.

Reporting Station and Year: _____

JAN 13 1966

JAN 4 4 1966

UNIVERSITY OF CALIFORNIA, DAVIS

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SANTA BARBARA • SANTA CRUZ

AGRONOMY DEPARTMENT
COLLEGE OF AGRICULTURE
AGRICULTURAL EXPERIMENT STATION

DAVIS, CALIFORNIA 95616

Dr. Rogers
Ft. Collins

January 10, 1966

Dr. S. M. Dietz
Regional Plant Introduction Station
Johnson Hall 59
Pullman, Washington 99163

Dear Sam:

I have just seen your memorandum describing a proposed uniform format for information retrieval. If you can spare them, I should like two copies, one for my files, and one for Dr. David J. Rogers of the Department of Botany, Colorado State University, at Fort Collins. Dr. Rogers and I plan to study some of my introductions of wild and domestic safflower, with a view to determining relationships between them.

Dr. Rogers will be able to help me a great deal, I am sure, in suggesting procedures for recording safflower data having in mind primarily taxonomic characters. You are primarily interested in recording characters of agronomic interest. With your ideas and those of Dr. Rogers, and with my interest in both the botany and agronomy of safflower, we should be able to come up with a system that will permit us to make the most use of safflower introductions.

You will know that I will be growing several introductions at Pullman this coming summer. Right now I am putting up the seed for these plantings, and hope to have it treated with both a fungicide and insecticide. I plan to put on IBM cards the data from the introductions which I collected from one area of India, and let Dr. Rogers use such data in a trial run.

Yours sincerely,

Paul F. Knowles
P. F. Knowles
Professor of Agronomy

PFK:hc

December 20, 1963

Dr. Paul F. Knowles
Department of Agronomy
University of California
Davis, California

Dear Paul:

As you know, W-6 is vitally interested in a method of accomplishing rapid information retrieval, and the IBM punch card system has recently been selected. Since I have done much of the background work on coding this information, Dr. Mullen referred your December 6 letter to me. I have taken the liberty of suggesting one possible way of programming the safflower information on IBM cards. Please do not misconstrue this as being a dictatorial mandate; it is simply a possible format to aid yourself and Dr. Leininger in finalizing the IBM program for safflower. Any and all suggestions are welcome, and I will be happy to work with you, if you wish. I am not familiar with all the characteristics evaluated, or just how you rate them.

Each IBM card contains 80 columns. Each of these columns has a further breakdown of 0 through 9. Three separate evaluations of a plant characteristic, and all possible combinations of the same three evaluations, can be coded in any one column. Example:

- | | | | |
|-----------|-------------------------|---|-----------------------|
| 1. small | 4. small, medium |) | |
| 2. Medium | 5. small, large |) | |
| 3. large | 6. medium, large |) | possible combinations |
| | 7. small, medium, large |) | |

The cards can have specially printed headings for specific information on each crop. An enlargement of the proposed codification is shown on the enclosed "Multiple Layout Form" so that the data taken and spacing may be more easily interpreted.

Proposed Coding on IBM Cards

Columns 1-6. Plant Introduction Number.

These six columns leave room for 999,999 P.I. accessions. From the time plant introductions were first numbered to date, there have been approximately 290,000 numbers assigned. Thus we have used only a little over one-fourth of the total numbers that can be coded in the allotted space. Since P.I. lines are kept by numbers, they may be entered and read directly from the cards.

Columns 7-16. Plant Name (abbreviated and alphabetized).

Columns 7-10 are reserved for the alphabetical abbreviation of the generic name, 11-14 for the specific epithet, and 15-16 for the variety. If the first four letters of a particular genus are the same as another genus, then use the fifth or even last letter to show the difference in the fourth column on the card. The species and variety names can be handled similarly.

Columns 17-21. Place of Origin.

This is also an alphabetical listing, viz., Turkey could be Turkey etc. If latitude and longitude are used instead of political nomenclature, there is still enough room to indicate the origin within one degree (90 x 180). Anything more exact than that can be taken from the collectors' records.

Thus all cards, regardless of crop or station reporting, would have columns 1-6 for the P.I. number, 7-16 for the plant name, and 17-21 for the place of origin. This information can be punched in, and read from the upper margin of the cards directly without coding or decoding. Crop and disease information would appear in columns 22-80.

The following pertains to safflower only:

Columns 22-28. GENERAL PLANT CHARACTERISTICS.

Column 22. Habit.

- | | |
|--------------|----------------------|
| 1. erect | 3. erect & sprawling |
| 2. sprawling | |

Columns 23-24. Branching.

Column 23.

- | | | |
|--------|-------------------|-------------------------|
| 1. 1/5 | 4. 1/5 & 2/5 |) possible combinations |
| 2. 2/5 | 5. 1/5 & 3/5 | |
| 3. 3/5 | 6. 2/5 & 3/5 | |
| | 7. 1/5, 2/5 & 3/5 | |

Column 24.

- | | |
|--------|--------------|
| 1. 4/5 | 3. 4/5 & 5/5 |
| 2. 5/5 | |

Columns 25-26. Plant height (inches).

It takes two columns to directly enter height (from 1 to 99 inches possible).

Columns 27-28. Spines.

Column 27.

- | | | |
|------|----------|-------------|
| 0. 0 | 3. 0 & 1 | 6. 0, 1 & 2 |
| 1. 1 | 4. 0 & 2 | |
| 2. 2 | 5. 1 & 2 | |

Column 28.

- | | | |
|------|----------|-------------|
| 1. 3 | 4. 3 & 4 | 7. 3, 4 & 5 |
| 2. 4 | 5. 3 & 5 | |
| 3. 5 | 6. 4 & 5 | |

Columns 29-32. FLOWER CHARACTERISTICS.

Columns 29-34. Bloom date.

Columns 29-30. month

Columns 31-32. day

Columns 33-34. year

Columns 35-36. Color (dry).

Column 35.

- | | | |
|-----------|------------------|-------------------------|
| 1. white | 4. white, cream | 7. white, cream, yellow |
| 2. cream | 5. white, yellow | |
| 3. yellow | 6. cream, yellow | |

Column 36.

- | | |
|-----------|----------------|
| 1. orange | 3. orange, red |
| 2. red | |

Column 37. Pubescence.

Rate 1 to 5, with 1 the least or poorest, and 5 the most or best expression of the characteristic judged. No. 6 means variable.

Columns 38-39. Pappus.

Column 38. Extent of pappus. Rate 1 to 5, 6 as variable.

Column 39. Nature of pappus. Rate 1 to 5, 6 as variable.

Columns 40-41. BRACT.

Column 40. Size. Rate 1 to 5.

Column 41. Shape. Rate 1 to 5.

Columns 42-52. SEED.

Columns 42-43. Shape.

Column 42. Longitudinal. Rate 1 to 5.

Column 43. Cross-section. Rate 1 to 5.

Column 44. Seed coat color (not achene). (Some color code.)

Column 45. Nature of the hull. Rate 1 to 5.

Columns 46-47. Weight per 100 seeds. Enter directly as grams.

Columns 48-49. Oil content. Enter directly as per cent.

Columns 50-52. Iodine value.

Column 53. DISEASE CATEGORY.

- | | |
|--------------|----------------------------|
| 1. bacteria | 5. insects |
| 2. fungi | 6. physiological disorders |
| 3. viruses | 7. parasitic higher plants |
| 4. nematodes | |

Columns 54-63. DISEASE NAME.

The disease name will be an alphabetical abbreviation of the causal

organism, viz., safflower rust Puccinia carthami would be Pucc. cart. The varietal spaces (columns 62 and 63) could be used for race designations. If column 53 (disease category) had number 5 punched, then the columns for disease name would be used to name the insect such as Lygus bug; if number 6 is punched in column 53, then cold hardiness and the like can be listed in those columns under physiological disorders. The same applies for the other disease categories listed in column 53.

Column 64. RESISTANCE RATING.

- | | |
|----------------------------|---|
| 0. immune | 5. resistant, susceptible |
| 1. resistant | 6. intermediate, susceptible |
| 2. intermediate | 7. resistant, intermediate, susceptible |
| 3. susceptible | 8. tolerant |
| 4. resistant, intermediate | 9. severe symptoms |

Column 65. DEGREE OF SUSCEPTIBILITY.

- | | |
|-----------|------------------|
| 0. 1-10% | 5. 51-60% |
| 1. 11-20% | 6. 61-70% |
| 2. 21-30% | 7. 71-80% |
| 3. 31-40% | 8. 81-90% |
| 4. 41-50% | 9. 91-100% |
| | / means variable |

Columns 66-80 are open for expansion.

We hope this has been of some help. Both you and Dr. Leininger will probably have valuable suggestions to make. If I may be of further assistance, do not hesitate to write.

Merry Christmas,

S. M. Dietz
S. M. Dietz
Plant Pathologist, W-6

cc: L. N. Leininger
A. J. Oakes

Encl.

*Thermostat for Dr. Knowles
he need a copy of Davis letter*

JAN 24 1966
JAN 2 1964

UNITED STATES DEPARTMENT OF AGRICULTURE

AGRICULTURAL RESEARCH SERVICE

Crops Research Laboratory

Utah State University

December 31, 1963

Logan, Utah

	1	2	3	4
	5	6	7	8
	9	10	11	12
	13	14	15	16
	17	18	19	20
	21	22	23	24
	25	26	27	28
	29	30	31	32
	33	34	35	36
	37	38	39	40
	41	42	43	44
	45	46	47	48
	49	50	51	52
	53	54	55	56
	57	58	59	60
	61	62	63	64
	65	66	67	68
	69	70	71	72
	73	74	75	76
	77	78	79	80
	81	82	83	84
	85	86	87	88
	89	90	91	92
	93	94	95	96
	97	98	99	100

Dr. Lowell A. Mullen, Coordinator
Regional Plant Introduction Station
Washington State University
Johnson Hall 59
Pullman, Washington

Dear Lowell:

From the various correspondence in the past month concerning the plant introductions and also the registration of safflower varieties, there seems to me that there are two problems which we need to consider. The first problem is a method of recording, handling, summarizing, etc. the data in such a manner that it would have universal meaning to all investigators of safflower. The second problem, concerning us at the moment, is how we can convert the observations we make on the different safflower genotypes into a meaningful quantitative system. I am sure that each of us have a vague idea at least as to what might be considered a useful and helpful method of seeking a solution to the various aspects of the two problems denoted above.

To my point of view, I would think that the problem of coding could probably better be initiated by a fundamental scientist, such as Dr. Knowles, since it is his needs that are paramount in this particular case. I don't mean to infer by that remark that the plant breeder such as myself does not need a workable system of coding, but rather that I believe the plant breeder can adapt his system more easily to the needs of a fundamental scientist than the fundamental scientist can to the plant breeder. With this in mind, I am suggesting that Dr. Knowles take the initiative in proposing a coding system that would work for all the various regiments in safflower research. I am particularly interested in this phase at the moment since in 1963 we made several hundred selections within the plant introduction nursery that we grew and will have this material in the field in 1964. We are planning on taking comprehensive notes on this material with the thought in mind that we will be able to group the material into various agronomic categories based upon plant expressions as well as seed characteristics, disease resistances, insect attacks, maturities, and many others. We also plan to include all the present genotypes that have been selected here and other places in the past and are readily available to us. We would plan to take extensive notes on this material and group this along with the selections we have made in the plant introductions.

*IBM could
sort for
this*



Growth Through Agricultural Progress

In 1963, we also began a series of selections for flower color, for example, which I believe we have material which would indicate that flower color is probably more closely defined in terms of quantitative genetics rather than qualitative. We would hope to do this same type of thing with such things as seed size by breaking them down into seed lengths, circumferences, widths, and what have you.

In so doing, I think that we have come to the other phase of the problem that faces us at the present time. Namely - How do we describe these physical characteristics in sufficient detail so that a quantitative system of numbers, letters, or other systems of denoting differences can and will be meaningful not only to the person making the notations but also to investigators who would read the data and thereby create an image within his mind exactly like the investigator who made the notes in the first place. This probably can not be accomplished exactly as described above, but I think that we should attempt to approximate it as closely as possible for all characteristics of the safflower plant. I realize, this will not be easy. I don't believe that anyone person is likely to come up with the best solution for all the characteristics into which the plant and seed can be divided.

We will be faced with this problem of notes in 1964. Any suggestions that you or anyone else can make which would be helpful to us and to you in recording data, we would appreciate those comments. Since the number of genotypes is going to be well over 1000, we are going to have to record our data judiciously as well as rapidly at certain periods of the growing season. Therefore, a workable system of desirable information will have to be fairly well established before we attempt to begin recording fiscal data on the safflower genotypes. We would hope to be able to begin our notes with emergence, if such differences exist, length of time in rosette, rapidity of growth after leaving the rosette stage, and then into the more familiar and commonly taken notes such as heights, maturities, etc. When all of this data has been recorded in our field books, the task will then remain as to how best to manipulate the data to best utilize the information that is there. This brings us back to the problem of coding or recording data on punch card, tape, or other systems which of course brings us back to my earlier suggestion that Dr. Knowles initiate some activity in the area of coding and recording of data.

We are fortunate perhaps in safflower in that we have not gone a great distance yet in our research on this plant. Therefore, we do not have established in many investigators' minds ~~the exact~~ the exact way he would prefer to handle much of the physical aspects of note taking, recording, and so forth. At the same time, this may hamper us in arriving at a best universal system of recording data, but I believe

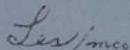
Page 3
Dr. Mullen

that we have within our group some fairly interested and intelligent investigators who can fairly well sort the chaff from the wheat.

Of course all of the proceeding leads us to one point. Speaking from a plant breeder's point of view, the usefulness of all of the note taking that might be accomplished now and in the future is only good if it can be summoned at the time a need for it exists. And it will need to be summoned rapidly. This is what we are hoping to begin doing by the splitting of the many introductions and so forth into distinct and stabilized genotypes. In other words, sometime in the future, we may wish to have in our breeding program a certain plant characteristic. We would then go to whatever system that has been devised, select out those lines which meet this requirement and then further sub-divide those lines based upon other physical attributes of the plant or seed. Eventually it is hoped, bring this number of selections down to less than a dozen, for instance. Then this number could be further screened individually to select the one or two best plants that might be used to make a particular cross for a specific reason.

I hope this gives you some inside into the needs and requirements of a coding system that might be useful to us in safflower work in the immediate future. Any help you can give us, I am sure, will be greatly appreciated.

Sincerely yours,



L. N. Leininger
Leader, Safflower Investigations

LNL/mco

cc: Dr. P. F. Knowles
Dr. J. H. Williams
Dr. J. O. Culbertson

JAN 23 1964

UNITED STATES DEPARTMENT OF AGRICULTURE
AGRICULTURAL RESEARCH SERVICE

Crops Research Laboratory
Utah State University
January 21, 1964
Logan, Utah
84321

NAME	INITIALS	DATE
Dr. S. M. Dietz	MD	
Dr. Paul Knowles	PK	
Dr. L. N. Leininger	LL	

Dr. S. M. Dietz
Regional Plant Introduction Station
Washington State University
Johnson Hall 59
Pullman, Washington

Dear Dr. Dietz:

The enclosed comments and IBM card format is being forwarded to you as the best we can offer from our point of view knowing that its use is for plant introductions. We know that our suggestions may not be feasible in your operations, but have enumerated them here for your consideration. We are sending a copy to Dr. Knowles so that he can comment on these suggestions if he cares to. We hope he will.

We would like to see two cards since it appears that additional criteria might be added in the future, such as amino acids, fatty acids, etc. If we just fill the card, there will be reluctance to add criteria at a later date since this will mean an additional card. If all we have suggested is adapted, then two cards will exist and additional information can be added quite easily.

Sincerely yours,

L. N. Leininger
L. N. Leininger
Leader, Safflower Investigations

LNL/mco

cc: Dr. Paul Knowles



Growth Through Agricultural Progress

IdM Coding

Columns 22-33. GENERAL PLANT CHARACTERISTICS.Column 22. Habit.

- | | |
|--------------|------------------------|
| 1. erect | 3. erect and sprawling |
| 2. sprawling | |

Columns 23-24. Branching habit.

- | | | |
|--------|---------------|---------------|
| 1. 1/5 | 6. 1/5 & 2/5 | 11. 2/5 & 4/5 |
| 2. 2/5 | 7. 1/5 & 3/5 | 12. 2/5 & 5/5 |
| 3. 3/5 | 8. 1/5 & 4/5 | 13. 3/5 & 4/5 |
| 4. 4/5 | 9. 1/5 & 5/5 | 14. 3/5 & 5/5 |
| 5. 5/5 | 10. 2/5 & 3/5 | 15. 4/5 & 5/5 |
| | | 16. Mixed |

Column 25. Extent of Branching.

1. 1/ primary
2. 1/ secondary
3. 1/ tertiary

Column 26. Stem characteristics.

1. heavy stems.
2. fine stems.
3. round stems.
4. flat stems.

Column 27. Leaf characteristics.

1. round shape
2. normal shape
3. long shape
4. serrated margin
5. smooth margin

Column 28. Bract width. (perhaps 2 columns)

- | | |
|---------|----------|
| 0. 5 mm | 5. 10 mm |
| 1. 6 mm | 6. 11 mm |
| 2. 7 mm | 7. 12 mm |
| 3. 8 mm | 8. 13 mm |
| 4. 9 mm | 9. 14 mm |

Column 29. Bract length. (perhaps 2 columns)

0. 10 mm	5. 15 mm
1. 11 mm	6. 16 mm
2. 12 mm	7. 17 mm
3. 13 mm	8. 18 mm
4. 14 mm	9. 19 mm

Columns 30-31. Spines. (0 least, 5 most)

0. 0	6. 0 & 1	14. 1 & 5
1. 1	7. 0 & 2	15. 2 & 3
2. 2	8. 0 & 3	16. 2 & 4
3. 3	9. 0 & 4	17. 2 & 5
4. 4	10. 0 & 5	18. 3 & 4
5. 5	11. 1 & 2	19. 3 & 5
	12. 1 & 3	20. 4 & 5
	13. 1 & 4	21. Mixed

Columns 32-33. Plant Height.

Enter directly from 1-99 inches.

Columns 34-42. YIELD COMPONENTS.

Columns 34-35. Yield/plant.

Directly in grams.

Column 37-38. Heads/plant

Directly

Column 39-40. Head diameter.

In millimeters.

Column 41-42. No. seeds/head

Directly.

Columns 43-48. FLOWER BLOOM DATE.

Columns 43-44. Month.

Columns 45-46. Day.

Columns 47-48. Year.

Column 43. FLOWER COLOR (dried)

- | | |
|---------------------------|-----------------------------------|
| 0. white | 5. orange |
| 1. white with dark border | 6. red |
| 2. cream | 7. yellow and orange |
| 3. yellow | 8. yellow (dries orange) & orange |
| 4. yellow (dries orange) | 9. Mixed |

Column 50. DISEASE CATEGORY

- | | |
|--------------|----------------------------|
| 1. bacteria | 5. insects |
| 2. fungi | 6. physiological disorders |
| 3. viruses | 7. parasitic higher plants |
| 4. nematodes | |

Columns 51-60. DISEASE NAME.

Column 51-54. Genus.

Column 55-58. Species.

Column 59-60. Variety.

Column 61. RESISTANCE RATING.

- | | |
|----------------------------|---|
| 0. immune | 5. resistant, susceptible |
| 1. resistant | 6. intermediate, susceptible |
| 2. intermediate | 7. resistant, intermediate, susceptible |
| 3. susceptible | 8. tolerant |
| 4. resistant, intermediate | 9. severe symptoms |

Column 62. DEGREE OF SUSCEPTIBILITY.

- | | |
|-----------|------------------|
| 0. 1-10% | 5. 51-60% |
| 1. 11-20% | 6. 61-70% |
| 2. 21-30% | 7. 71-80% |
| 3. 31-40% | 8. 81-90% |
| 4. 41-50% | 9. 91-100% |
| | 4 means variable |

Columns 63-96. SEED CHARACTERISTICS.

Column 63. Shape. (Longitudinal)

- | | |
|-----------|---------------|
| 1. normal | 5. banana |
| 2. narrow | 6. pear |
| 3. round | 7. triangular |
| 4. curved | 8. other |

Column 64. Shape. (Crosssection)

- | | |
|-----------|---------------|
| 1. normal | 4. triangular |
| 2. narrow | 5. smooth |
| 3. round | 6. ribbed |

Column 55. Length.

1. short
2. normal
3. long

Column 56. Size.

- | | |
|---------------|---------------|
| 1. very small | 4. large |
| 2. small | 5. very large |
| 3. medium | |

Columns 57-70. Weight/100 seeds. (Directly as grams)

Columns 71-72. % hull. (Directly)

Column 73. Hull color and characteristics.

- | | |
|----------|-----------------|
| 0. white | 5. light stripe |
| 1. gray | 6. dark stripe |
| 2. tan | 7. speckled |
| 3. brown | 8. thin hull |
| 4. other | 9. hullless |

Column 74. Seed coat color. (Not achene)

1. light
2. medium
3. brown

Column 75. Appearance of hull.

1. rough
2. ribbed
3. smooth
4. shiny

Column 76-77. % pappus (Directly)

Column 78-79. Test weight (Directly)

Column 80. Card number.

Column 81-82. % oil (Directly)

Column 83-84. Iodine No. (Coded by subtracting 100)

Column 85-86. % protein. (Directly)

Recommend two cards so that other data can be added. For example, it may become advantageous to identify amino acids, fatty acids, etc.

53-7
JAN 3 1 1966

UNIVERSITY OF CALIFORNIA, DAVIS

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SANTA BARBARA • SANTA CRUZ

AGRONOMY DEPARTMENT
COLLEGE OF AGRICULTURE
AGRICULTURAL EXPERIMENT STATION

DAVIS, CALIFORNIA 95616

January 27, 1966

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

Dear Dave:

Enclosed is a format for information retrieval proposed by Dr. Sam Dietz. I would appreciate it very much if you would comment on it. I enclose a copy of Dr. Dietz' letter to me dated December 20, 1963. He feels that the 1965 format will be more useful.

This summer I intend to test out his format in recording data on the introductions which will be grown at Pullman. I shall also test it on wild species which will be grown here. After testing its value this summer, I believe we should get all data from safflower introductions on cards or tape as quickly as possible.

Dave, could you send me the name and source of the chart for color ratings?

Also, could you send me the names and addresses of persons who would be interested in the symposium on 'Wood' of the Society for Economic Botany?

I enjoyed very much our visit in Berkeley. I hope we can meet again this summer.

Yours sincerely,

A handwritten signature in dark ink, appearing to read "P. F. Knowles".

P. F. Knowles
Professor of Agronomy

PFK;hc
Enclosures

- Taxonomy Laboratory

February 4, 1966

Dr. P. F. Knowles
Agronomy Department
College of Agriculture
Agricultural Experiment Station
University of California
Davis, California 95616

Dear Paul:

In answer to some of the questions in your letter of the 27th, the following is the best I can do for you. First of all you wanted to know the name and source of the color chart. The name of the color chart is a Nickerson Color Fan and you can get it from the American Horticultural Society, 1600 Bladensburg Road, N. E., Washington, 2, D. C. The price is, I believe \$6.50 plus postage.

You asked about people and addresses of persons interested in the symposium on "Wood." Are you expecting to develop the symposium yourself or is this something that the program chairman has to take care of? The most important person that I can think of in connection with wood is Dr. B. F. Kukachka at the Forest Products Laboratory, U. S. Forest Service, Madison, Wisconsin. I think he is by far the most outstanding well-rounded individual with respect to wood science of anybody in this country, and perhaps, in the world. I suggest that you contact him and tell him the plans for the symposium and ask him for a set of names. I would emphasize the inter-disciplinary nature of our society and that we are looking for people who may or may not even be called wood technologists. I would suggest that you contact your own forestry school if it is there on the Davis campus. They would very likely have a list of west coast scientists and companies interested in various aspects of wood. Certainly Crown Zellerbach would be one of the major places and you might write to their director of

research. Then there is the Georgia-Pacific Plywood Company. I'm sorry that I don't have the addresses of these people in my hands. Most of them are members of the Society for Economic Botany, however, and a letter to Bob Bresch at the New York Botanical Garden, Bronx Park will get you the addresses of these people if they are members of the society or if they are subscribers to the journal without being members of the society. Another person who comes to mind whom I'm sure would be very much interested in this is Dr. William Stern, The Division of Botany, U. S. National Museum, Smithsonian Institution, Washington, D. C. Bill is very much interested in wood anatomy and I would even guess that he would be willing to talk about this as a part of the symposium if you have to organize that too.

I am still going over your format for information retrieval and will have some comments to make on it, but I'm not fully finished with it at this stage of the game. More will come on that later.

Sincerely,

David J. Rogers
Professor of Botany

DJR/pam

- Taxonomy Laboratory

January 27, 1966

Dr. Paul F. Knowles
Department of Agronomy
University of California
Davis, California 95616

Dear Paul:

I have just received the copies of letters from S. M. Dietz to you. They are very interesting and I'm very glad to have this summary of the activities with relation to safflower and the information retrieval aspects of things.

Unfortunately, we did not write down a summary of our meeting at Berkeley. As a result, I cannot remember whether I was supposed to send you something or not. As I recall the situation, you were going to have a student code up information about one species as a trial run on our methodologies. Would you mind jogging my memory a little bit by telling me whether I suggested that I would send you a list or a set of instructions that would tell you how to get the data ready for computing. Please forgive me for my nebulous memory.

Have you been able to determine the most convenient time for going to Pullman next summer? I would like to begin to schedule time for the summer, and certainly want to have the time free that is best for safflower. Let me know when this time is as soon as you can determine it.

Sincerely yours,

David J. Rogers
Professor of Botany

DJR/pam

- Taxonomy Laboratory

December 16, 1965

Dr. P. F. Knowles
Agronomy Department
University of California, Davis
Davis, California 95616

Dear Paul:

I have just made my final schedule for the AAAS meetings. As yet I am not certain of my room assignment, but I hope to be in the dormitory.

I plan to arrive at Berkeley by 5:30 P. M. Sunday the 26th. I would like to spend as much time as possible with you, going over the possibilities of coding and running a classification of your safflower data. This would probably take an afternoon or part of an afternoon of discussion.

Let me know what day will be convenient to you. There are no parts of the program that are so important to me that I can't skip them. I do have to leave by noon on the 30th.

Sincerely,

David J. Rogers
Professor of Botany

DJR/pac

October 21, 1965

Dr. P. F. Knowles
Professor of Agronomy
College of Agriculture
University of California
Davis, California 95616

Dear Paul,

I've finally gotten around to the answering of long overdue correspondence.

We came here actually to further the work we were already doing in New York. After we get ourselves established in this place, we will have a lot better arrangements for both research and teaching. We had no teaching in New York, actually, and here we will have students. This is the best thing that we can do to keep ourselves on the toe and to spread the word about this method which is quite different, in the way of numerical taxonomy, from other peoples' operations. The way we were operating in New York, collaborating with others, is essentially the way we will do it here; and for this reason, we are very eager to have your data as soon as you have a chance to prepare it. It would probably be a good idea to have a chat with us here, or perhaps I could meet you at the AAAS meetings at Berkeley at Christmastime -- I plan to be there -- to talk about how to set up your data for the most efficient use of it.

We have discovered some methodologies in setting up characters and attributes in such a way that they give us much better in-put for classification than anything we have so far published. I can bring you up-to-date on these methods and make it such that you have the best possible out-put from our programs. The programs are being rewritten for the machinery we have here. Because the computer in New York does not speak the same language as the one here, this should take about two to three months, if nothing goes wrong. We really are eager to have your safflower data, because I have the feeling that you have much better data than a good share of others interested in the process of classification and

Letter to P.F. Knowles
October 21, 1965

Page 2.

you are working on a group that will really test the mettle of our process. I hope you understand that we are still "experimental" in our programs and are not completely satisfied that we have the final answer as far as process of classification is concerned. What we have to date makes very good sense, and has proved useful in a number of test cases; but that still does not make us satisfied. We think we can do even better.

Let me know if by some chance you have enough money to get over the mountains to see us sooner than Christmastime. If not, I will be looking forward to seeing you then.

Sincerely,

David J. Rogers
Professor of Botany

DJR/ec

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SANTA BARBARA • SANTA CRUZ

AGRONOMY DEPARTMENT
COLLEGE OF AGRICULTURE
AGRICULTURAL EXPERIMENT STATION

DAVIS, CALIFORNIA 95616

August 10, 1965

Dr. David J. Rogers
The New York Botanical Garden
Bronx, New York 10458

Dear Dave:

I have just received your letter of August 4 in which you state that your Department of Quantitative Taxonomy is being transferred to Fort Collins. I am most interested and pleased to learn that you are moving further West. Perhaps when you are settled in your new position, you will be able to tell me more about the direction of your research at the new location.

As you may know, I have just returned from sabbatic leave. I still remember our conversations of a year or two ago about the possibility of putting the classification of safflower introductions on a quantitative basis. This subject is even of more interest to me now since I have been able to collect more materials during the last year. When my affairs are straightened out a bit here, I shall be contacting you further about this matter.

With best wishes for the future.

Yours sincerely,

P. F. Knowles
Professor of Agronomy

PFK:hc

*rel. by postcard
8/17/65
marg*

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SANTA BARBARA • SANTA CRUZ

AGRONOMY DEPARTMENT
COLLEGE OF AGRICULTURE
AGRICULTURAL EXPERIMENT STATION

DAVIS, CALIFORNIA 95616

October 29, 1965

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

Dear Dave:

Thank you for your letter of October 21. It would appear that you will now be able to make a more significant contribution to plant taxonomy than when you were in New York. I wish I could visit you in the near future at Fort Collins, but I have neither the money nor the time. I shall look forward to our discussions at Christmas time, probably in Berkeley.

We have accumulated a good deal of data on safflower introductions now. Introductions obtained on my last trip will be grown at Pullman, Washington next year and at Davis a year later. In the nursery at Davis in 1967 I plan to include all safflower introductions which have been brought into the United States. Needless to say, I shall have a very large nursery.

A former student of mine, Dr. Amram Ashri, plans to grow most of our introductions of safflower in his nursery at the Hebrew University, Rehovot, Israel. He will be doing this under a Public Law 480 contract. His study will be primarily to evaluate the introductions for their resistance to insects and disease. Many of the insects and diseases of safflower in the Middle East have not yet arrived in the United States. It would be nice to be working on resistance to them before they arrive.

Other people working on safflower have grown the introductions also. I suspect that they would be willing to cooperate in a thorough study of the characteristics of the introductions.

For the present I plan to make at least two visits to the nursery of introductions which will be grown at Pullman next year. It should be possible to collect a good deal of information during those visits.

...continued...

Dr. Rogers

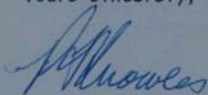
October 29, 1965

-2-

I shall not burden you with any further descriptions of my proposed plantings of safflower materials. This can be left until I see you at a later date.

With best regards.

Yours sincerely,

A handwritten signature in blue ink, appearing to read 'P. F. Knowles', written in a cursive style.

P. F. Knowles
Professor of Agronomy

PFK:hc

UNIVERSITY OF CALIFORNIA
COLLEGE OF AGRICULTURE
AGRICULTURAL EXPERIMENT STATION

DEPARTMENT OF AGRONOMY
DAVIS, CALIFORNIA

December 6, 1963

Dr. Lowell A. Mullen, Coordinator
Regional Project W-6
United States Department of Agriculture
Agricultural Research Service
Regional Plant Introduction Station
Washington State University
Johnson Hall 59
Pullman, Washington

Dear Lowell:

In your letter of November 27 you asked for comments on codes that might be used to describe the appearance and performance of safflower materials in the World Collection of safflower. As you say, I am interested in this, but the pressure of other things has prevented me doing much about it during the last several months.

While there are several good reasons why we should move rapidly on this, I still feel that it is more important to develop the most useful sort of code. My hope is that the code will be adaptable to use on wild species also.

We safflower people have not looked closely enough at certain morphological characteristics, and have not recorded such things as: pubescence of flower parts; proportion of ovules that are rudimentary; extent and nature of pappus; shape of seed in both longitudinal and cross-section; color of seed (not achene) coat; nature of hull; spine index; and bract shape and size. It would be desirable to have all such information available, particularly if we wanted to inquire into evolutionary developments.

As I mentioned to you in the past I have discussed this matter with Dr. David J. Rogers of the New York Botanical Garden. He has offered to help me in developing a system of coding safflower, and perhaps in analysing the data, but I have not followed up on his offer. In any case his papers on the subject will be helpful. They are:

Rogers, David J. Recent endeavors with computers in taxonomy. The Garden Journal. Nov.-Dec. 1961 pp.2-1-204.

_____. Studies of *Manihot esculenta* Crantz and related species. Bull. of the Torrey Botanical Club. 90:43-54, 1963.

_____, and Taffee T. Tanimoto. A computer program for classifying plants. Science 132:1115-1118. 1960.

.....continued

Page (2)

December 6, 1963

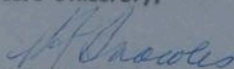
Letter to: Dr. Lowell A. Mullen

You may know that Dr. David J. Ward made a thorough analysis of variability in barley, and his publication on the subject is:

Some evolutionary aspects of certain morphological characters in a world collection of barleys. USDA Tech. Bull. 1276. pp. 112. 1962.

I realize that this letter is not too helpful to you, if you want to present a concrete proposal to the people in Beltsville. Perhaps in the new year I can work on this in more detail.

Yours sincerely,



P. F. Knowles
Professor of Agronomy

PFK/jr

cc: Dr. L. N. Leininger
Dr. J. O. Culbertson
✓ Dr. David J. Rogers
Dr. A. J. Oakes

May 23, 1963

Dr. P. F. Knowles
Department of Agronomy
University of California
Davis, California

Dear Paul:

In response to your letter of May 8, from the description of the job that you have on hand for safflower, I definitely consider your outline procedures as being most appropriate to the type of work we are doing.

I do not know whether you have had an opportunity to see in the April issue of the AIBS Bulletin, under Research Notes, the paper that we have published under the title "Data recording: an inexpensive and efficient method." The rationale for data recording used is given in the procedures. May I suggest that you peruse that article, and then when you have specific questions arise as to procedures, I can answer them more specifically. I hope that in there we have given a satisfactory description of how to process with the data accumulated and how to set up the data. The IBM gadget, the Port-a-Punch is, I am sure, available to you from various IBM sources in the Davis area.

Concerning the processing of the data once it is accumulated on the cards, we are hoping to be able to process yours and a few other peoples', at least for a while, without any charge, the idea being that we are still in an experimental stage as far as the computer program for plant classification is concerned, and we do not claim to have the answer to taxonomic problems with this technique. Our great need is to have people with tremendous skills and knowledge of a particular plant group willing to collaborate with us by supplying data in punch card form and then taking the output from the computer program to determine whether the output bears any relationship to your ideas of the value of the computation, then letting us know whether or not the output reflects your ideas about the classification of the collection. If it does not, wherein does it fail to satisfy your needs? In answering questions like this, we can then modify the program so that it does do better work for you.

May 23, 1963

I think that the systematic organization of the data, whether or not you get any real value from the computer program, has the added advantage of giving value to your thought processes about the group. I know that in my own data accumulation such activity as proceeds the computer programming has helped me to see things that I could not see otherwise.

When you have decided on the process of value to you, let me know and I shall send to you a set of cards satisfactory to punch up whatever amount of information you may wish to accumulate. I enclose herewith one of the cards so that you may have it in hand as you read the AIBS article.

Sincerely

DJR:MDF

Enclosure

UNIVERSITY OF CALIFORNIA
COLLEGE OF AGRICULTURE
AGRICULTURAL EXPERIMENT STATION

DEPARTMENT OF AGRONOMY
DAVIS, CALIFORNIA

May 8, 1963

Dr. David J. Rogers
New York Botanical Garden
Bronx Park, New York

Dear Dave:

Thank you very much for the publications which you sent to me the other day. I found them very interesting, and I believe they point the way to real improvements in taxonomic procedures. I feel that these methods will be useful in future studies of mine on safflower. I will be quick to confess, however, that the math was beyond me in the latter part of the paper in Science.

As I told you on our flight from Madison to Chicago, I am interested in using these techniques in a number of ways. In particular I would like to study:

- (1) Relationships in collections of cultivated safflower.
- (2) Relationships in species of safflower with 10 pairs of chromosomes.

Cultivated safflower has been obtained from different areas of North Africa (mostly in the Nile Valley), through the entire Near and Middle East, and India. Classifications of these collections have been a bit rough, but I hope to refine them in the future.

The species of safflower with 10 pairs of chromosomes have been difficult for taxonomists, and each comes up with a different grouping. There seems to be little in the way of barriers, other than geographic ones, between the different taxons. We have found evidence of a translocation when some taxons are crossed.

Do you think these taxonomic procedures which you describe might be adapted to field studies of this group?

When I ask this question I am thinking of taking field notes on a large amount of material as I find it growing, with only a few herbarium specimens being taken. Notes that might be taken are:

Flower:

Color:
Length of floret:
Stamen color:

Outer bract:
Length:
Width:
Spine length:

Middle bract:
Length:
Presence of dentate characteristic:

May 8, 1963

Seed:

Weight:

Texture of pericarp:

Pappus characteristics:

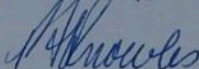
Habitat: Roadsides; as a weed in cultivated fields; in pasture areas; etc.

If I can possibly arrange it, I should like to do this for a few islands of the eastern Mediterranean, and adjacent continental areas. This might give some idea as to whether or not divergence is underway on some islands.

When you get time I would appreciate getting your comments.

Thanks for the reference to the monograph on Carthamus in Feddes Repertorium. I have a copy of this monograph, and have corresponded with the author. As a matter of fact, I have translated the original publication of this as a dissertation.

Yours sincerely,



P. F. Knowles

Professor of Agronomy

PFK:jh

April 24, 1964

Dr. P. F. Knowles
Department of Agronomy
University of California
Davis, California

Dear Paul:

Under separate cover we are sending the reprints that we spoke of the other day on the use of computers. This is, of course, not the final output. As I said, we will have more coming along soon.

I will be interested in your comments and hope that we can get together for some work on safflower. The main thing to remember is that we are still in the experimental stage and are constantly modifying to fit the needs more adequately.

The forthcoming paper in the AIBS Bulletin (we hope the April issue) will describe the punch cards which allow you to communicate from your laboratory, field or herbarium location directly with the computer. We will send a reprint of that when it comes out.

Sincerely yours

David J. Rogers
Curator of Economic Botany

DJR:MDF

Duke University Marine Laboratory

BEAUFORT, NORTH CAROLINA

28516

March 28, 1967

Dr. David J. Rogers
"Taxometric Computer Program"
Department of Botany
Colorado State University
Ft. Collins, Colorado

Dear Dr. Rogers:

Enclosed are the data for the computer study on "Inter-specific relationships in the deep-sea isopod genus Storthyngura." For every one of the 41 morphological characters, the stage number is entered in the 'Main Input Data Sheet' for all the 37 species. There are four Matrix characters (18, 19, 20, 31) as well as five well-ordered characters (12, 14, 23, 24, 37) and the other characters are simple with distinct states. The distributional data are entered in 46, 47 and 48 which could be treated apart for any significant correlations. A copy of the description of character-states including Matrix is herewith enclosed. Hope from this basic data, you would arrange to get the information punched for the computer analysis.

Dr. Menzies is on a research cruise for a week on R/V EASTWARD. We both express our sincere thanks and best wishes to you, Dr. Henry Fleming, and to Mr. George Eastabrook.

Sincerely yours,

R. Y. George

R. Y. George

/h
Enclosures

Duke University Marine Laboratory
BEAUFORT, NORTH CAROLINA
28516

March 31, 1967.

Dear Mr. Eastabrook,

At the outset let me offer my sincere thanks to you all for the pleasant and useful time we had in your midst during our brief sojourn. A week ago I sent the data on the deep-sea isopod genus Storothyngura for the computer analysis to Dr. David J. Rogers. I got all the character-states rechecked for the 37 species and I find that an error has crept in. For Species no.25, state no.3 should be entered instead of 2 for the character numbers 2, 5, 6, 7, & 8. I hope it is not too late to incorporate this correction in the data.

With my kindest wishes and regards,

Very truly,

Robert Y. George.

Robert Y. George.

- Taximetrics Laboratory

April 18, 1967

Dr. Robert Mensies
Duke University Marine Laboratory
Beaufort, North Carolina 28516

Dear Bob:

I don't think that I would bother putting in internal connections beyond L25. Do just the R sets. I have subgraphed up to L24 (notice notes on shift of red circle rule). Much information is lost under the rule of 3, of course, but avoids spaghetti drawings. It might be wise for you and Bob ~~and~~ George to redo the subgraphs to check on me as I have done them rapidly and because they may provoke questions. You will notice that cluster 14, 15, and 16 all join 12 and that 14 also joins 34. It may mean something that I don't have the knowledge to give significance to (level 24).

Species 20 may belong to this genus but I would take a sharp look at it. It is 52% or more different from everything else.

If after working this over, you wish to change the characters, do so. The whole operation is to give the taxonomist feed back and information. This is the start.

You might give us the data-address etc. of Slater in Washington and any pertinent information on his Max Planck Institute idea.

Best to Lucille--expect to see you both out here soon. Haul along George and his wife--Kerala is a long ways from the Himalyas and these will do well as second best.

As ever,

Henry S. Fleming

HSE/ch

- Taximetrics Laboratory

February 23, 1967

Dr. Robert Mensies
Duke University Marine Laboratory
Beaufort, North Carolina

Dear Bob:

It was great hearing from you.

We will expect you and Strong on or about March 17. Bring a list of the morphological states that you expect to use as a basis for comparison of your taxa or specimens and anything else that you think pertinent.

Some data for you:

Address: Colorado State University
Taximetrics Laboratory
Dept. of Botany and Plant Pathology
Fort Collins, Colorado 80521

Telephone No.: 491-5326 (Laboratory) - Area code 303
667-7286 (Home) - " " "
491-5201 (Dave's Lab) - " " "

Home Address: RFD 1, #281B
Loveland, Colorado 80537

What I will want from you is date, flight number and E.T.A.

See you soon.

Sincerely,

Henry S. Fleming
Associate Professor of Botany

HSF:ch

January 25, 1965

Dr. George Llano
Assistant Director
Antarctic Research Program
National Science Foundation
Washington 25, D. C.

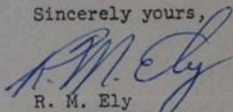
Dear Dr. Llano: Subject: Amendment to Research Grant NSF GA71
(81-6195) Duke University Extension of-
Dated January 8, 1965

This letter refers to the above subject Amendment and it is requested that it become a part of this Amendment.

We request that pages two and four of the Amendment be deleted and that the enclosed pages be inserted in place thereof.

We request permission to use the estimated \$4000 remainder of the present grant as proposed on page four enclosed for the continuation of the grant. We should like to use this balance for (1) \$1700 toward salary for a Research Assistant and (2) general contingencies such as travel, supplies and materials, publication costs, and preparation of reports.

Sincerely yours,



R. M. Ely
Business Manager

RME:bn

Encls:

Dr. George Llano
National Science Foundation
Washington, D. C.

-2-

January 8, 1965
(Revised Jan. 25, 1965)

supported research project. Dr. Rogers will supply instructions for data regarding Termatex punching. We will supply the fundamental data for such analysis from our studies on Antarctic species and genera.

It is intended that the added Research Assistant will perform the arrangement of data according to the instructions supplied by Rogers. We can take up the problem of computer time at a later date.

The budget for this work is as follows:

SALARIES

Research Associate (Dr. George Schultz)-----	\$ 7,600.
Research Assistant-----	1,800.
Scientific Illustrator-----	3,000.
Principal Investigator-----	-000-

Subtotal Salaries - \$ 12,400.

FRINGE BENEFITS (8.8% of Salaries)-----\$ 1,091.

UNIVERSITY OVERHEAD (20%)-----\$ 2,698.

GRAND TOTAL - \$ 16,189.

CONTINGENCIES:

Exchange USSR Scientist, Isopod Expert in
Exchange Program - 3 months salary
(USSR Scientist Mr. Oleg Kussakin)

Dr. George Llano
National Science Foundation
Washington, D. C.

-4-

January 8, 1965
(Revised Jan. 25, 1965)

By March of 1965 our present grant will expire. At this time it is estimated that an unused balance of \$4,000 will remain in the grant. This balance has been previously explained as being due to help by Duke University in the procurement of capital equipment.

It is proposed that the \$4,000 balance be carried over to 1965-66 and that \$16,189 be awarded as an amendment to our present grant.

The funds are required no later than March 1, 1965. It will be appreciated if notification of award could be made earlier than this date so that time could be had to insure prompt employment of personnel.

Respectfully submitted,

Robert J. Menzies
Principal Investigator

RJM:csw

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FOR DISCUSSION
IN NEW YORK

PRELIMINARY DRAFT

A STUDY ON THE WORLD GENERA OF THE
MARINE ISOPODA

INTRODUCTION

Since 1953 the writer has pursued an active research interest in the systematics of marine isopods. In the course of these investigations which have involved descriptions of 10 apparently new genera and around 200 apparently new species the writer has been impressed with the serious need for a careful and systematic study on the detail anatomical characteristics commonly used in generic definition. In order to meet this need at least in part, the writer has compiled over the years as a by-product of other investigations, a photocopy catalog (2/3 complete) of the original descriptions of marine isopod genera and a card file index to all genera known to him. Unfortunately, neither of these is complete and both require collation and reference verification if they can serve as a really useful guide to the new knowledge that is required, and form the base for revision of the order.

Almost without exception each genus presents some serious gaps in knowledge that requires filling before a comprehensive systematic study can be made on its characteristics. This statement requires some amplification because it forms the core of the proposal. A good example is the genus ANTLAS Richardson 1908. This genus was established in 1908 by Richardson on the species A. ^cpharcoti. The genus appears to have acquired no synonyms. In all the various works regarding this genus and its species, one still does not know from genotypic information (1) the number of somites comprising the pleon (abdomen), (2) the structure of the pereopods (legs), (e.g. ^{do} they have one, two, or three terminal dactyls?), (3) the structure of the five pairs of ^{do} (relative widths of rami). It is correct that the above mentioned features are known for species A. uniramous, Menzies and Miller, but this does not

assure us that the species A. charcoti, the type of the genus, has the same characteristics. The probability is good, of course, that this is the case but it is equally clear that verification of the characteristics in the A. charcoti species is required through examination of specimens of that species before one can accept these characteristics as truly part of the generic picture. The kind of problem cited here typifies the distressing "state of the art" on which marine isopod classification is based. It is a serious situation that requires correction as soon as practical and possible. Otherwise, the future will see generic evaluations based not upon genotypes but on a composite knowledge from various species, some of which may or may not belong to the genus. A chaotic situation so common to many major taxa of animal life can result and be perpetuated simply because no single investigator can afford the time and effort to delve into the complicated anatomical and taxonomic history of each genus. Projects involving local faunal survey, such as the writer has conducted in the past, generally do not lead to the kind of basic information sought here. This is due to the fact that the components of a local or regional fauna can be easily distinguished without the necessity of checking the characters of each known genus.

MATERIALS AND METHOD

It is proposed that the original descriptions of each genus be assembled and the known characteristics tabulated. In cases (commonly so) in which the knowledge is deficient it is proposed that specimens of the ^{type species} genotype be obtained on loan and the characteristics in question be determined and illustrated and that finally a comprehensive systematic diagnosis be prepared for each genus.

An effective and efficient means of determining the composite of distinguishing generic features will be to put the data on IBM punch cards. In this way, synonyms and dubious genera could be objectively identified and deficiencies in the overall generic diagnosis and characteristics could be systematically ^{and promptly} determined.

Finally an illustrated key to the known genera would be prepared accompanied by a fully illustrated catalog of the anatomy of each known genus.

The work proposed conveniently divides itself into phases:

Phase I. Completion of assembly of information on described genera, determination of type species, determination of added data required.

Procurement of specimens of ^{+1/2L 01/10/52} genotype for study. Description and illustration of required parts of ^{+1/2L 01/10/52} genotype. (estimated time table, three years).

Phase II. Set up of IBM punch card system with code system worked out in conjunction with Dr. Rogers and Henry Fleming (techniques determined in one year with coding to continue for a three year period).

Phase III. Preparation of diagnoses, synonymies, illustrated keys into a publication on the genera of the Marine Isopods (one year, namely, the last year; bringing the total to four years).

MATERIALS: The following materials would be required for this study -

I. Optical Equipment -

- a. Compound microscope ----- Provided by Duke Univ.
- b. Stereomicroscope, with camera lucida attachment ----- ^{Provided by Duke Univ.} Required:
- c. Projection apparatus ----- Provided by Duke Univ.
- d. Photomicrography ----- Provided by Duke Univ.

II. Storage Materials -

Adequate jars and vials will be required.

Drafting paper will be required.

III. Storage Space ----- Provided by Duke Univ.

IV. Technical Assistance -

- 1. Scientific Illustrator - ink-in drawings, make up plates (1/4 time)
- 2. Technical Assistant: card sort, care for specimens, make preparations (full time)

V. Specimen Procurement -

Funds will be required to cover mailing cost of specimens to and from the Marine Laboratory.

BUDGET

<u>CAPITAL EQUIPMENT</u> <i>(all provided by Duke University)</i>	<u>First Year</u>
1. Compound microscope (Provided by Duke) -----	
2. Stereomicroscope, Wild # _____ with accessories ---	802.00
3. Projection apparatus -----	Provided by Duke Univ.
4. Photomicrography -----	Provided by Duke Univ.
Sub Total -	<u>802.00</u>

SPACE

Museum shelving to house collection of 350 genera ----- (no cost)

MATERIALS & SUPPLIES (Expendable)

Drawing paper -----	50.00
Kohlonohr Drafting Pens (1 set) -----	26.50
Miscellaneous ink, pens, paper -----	10.00
Zippitons, etc. (est.) -----	20.00
Jars (museum), 3 gross, (various sizes) -----	107.00
Vials (various sizes) -----	42.00
Miscellaneous microscope slides, etc. -----	20.00
Punch cards and file cabinet -----	?
Alcohol and glycerine (25 gals.) -----	25.00
Photographic and Photocopy supplies -----	<u>150.00</u>

Sub Total -

TECHNICAL ASSISTANCE

1. Scientific Illustrator -----	1,250.00 per year
2. Technical Assistant -----	3,200.00 per year
3. ~~Technical Assistant~~ <i>(complete photocopy catalog)</i> -----	~~2,400.00~~ <i>one year</i>
4. Secretarial Assistance (Provided by the Duke University Marine Laboratory Business Office) -----	600.00
Sub Total -	<u>7,450.00</u>

SPECIMEN PROCUREMENT

A variable factor est. on 5 oz. airmail to and from
Europe at \$ /ounce for 200 specimens per year ----- \$ 400.00

TRAVEL & SUBSISTANCE

processing at New York
(U.S.N.M.) Data Center 4 trips/year @ air fare (RT) 85.00
auto & taxi 16.20
specimen examination per diem 64.00
165.20
x4
660.80 660.80

UNIVERSITY OVERHEAD -----

XERO COPY
XERO COPY
XERO COPY
XERO COPY

LITERATURE CITED

BIOGRAPHY & PUBLICATIONS OF PERSONNEL

GRANTS HELD BY PRINCIPAL INVESTIGATOR

DR. ROGERS

January 8, 1965

*Hope this is all agreeable
with you. At least we can
get started. Bob Menzies*

Dr. George Llano
Asst. Director
Antarctic Research Program
National Science Foundation
Washington 25, D. C.

Dear Dr. Llano:

Subject: Amendment to Research Grant
NSF GA71 (81-6195) Duke
University Extension of -

The aim of this letter is to request an amendment and extension of NSF GA71 "The Systematics, Distribution and Origin of Antarctic Deep-Sea Marine Isopoda."

The objectives remain unchanged with the idea to continue the work as originally proposed with the strengthening of the effort. The added strength does not alter the objectives but will serve to expedite the laboratory analyses for the next year.

- (1) Delete travel to Europe for study on European collections. The reason for this deletion is due to the fact that we are not as yet prepared for this work and will not be prepared for it for at least another year.
- (2) Delete salary of Principal Investigator. Originally it was intended that the Principal Investigator would join the ELTANIN once each year. This has proved impractical. Some subsequent year it may become highly desirable but it is not foreseen for the next year.
- (3) Add a Research Assistant at an approximate salary of \$3,500 per year. It is intended that this person will tabulate and process data for a generic analyses of all Antarctic genera and ultimately for the species; assist with bibliographic material procurement; assist in curating the collections; labeling and filing of data, as well as assemble and procure ancillary ecologic data from the Antarctic program for inclusion in our studies.
- (4) Add as contingency only the salary and travel, 3 months, of Mr. Oleg Kussakin of Moscow State University.
- (5) Add, at no cost, the collaboration of this project with Dr. David Rogers and Mr. Henry Fleming of the New York Botanical Garden in order that the isopod data may be given sophisticated computer analysis in Dr. Rogers' ONR

Dr. George Llano
National Science Foundation
Washington, D. C.

-2-

January 8, 1965

supported research project. Dr. Rogers will supply instructions for data regarding Termatex punching. We will supply the fundamental data for such analysis from our studies on Antarctic species and genera.

It is intended that the added Research Assistant will perform the arrangement of data according to the instructions supplied by Rogers. We can take up the problem of computer time at a later date.

The budget for this work is as follows:

SALARIES

Research Associate (Dr. George Schultz)-----	\$ 7,600.
Research Assistant -----	3,500.
Scientific Illustrator -----	3,000.
Principal Investigator -----	-000-

Subtotal Salaries - \$ 14,100.

FRINGE BENEFITS (8.8% of Salaries) ----- \$ 1,241.

SUPPLIES & MATERIALS (Est.) ----- \$ 500.

PUBLICATION COSTS, PREPARATION OF REPORTS,
AND PURCHASE OF REPRINTS ----- \$ 500.

TRAVEL

Washington, D. C. and New York -----	\$ 500.
Europe -----	-000-

UNIVERSITY OVERHEAD (20%) ----- \$ 3,368.

GRAND TOTAL - \$ 20,209.

CONTINGENCIES:

Exchange USSR Scientist, Isopod Expert in
Exchange Program - 3 months salary
(USSR Scientist Mr. Oleg Kussakin)

We now have in the collections, as indicated in prior reports, a total of 3703 specimens representing around 158 genera of marine isopod crustaceans collected by the ELTANIN. These represent not less than 300 distinct species of which we can expect around 200 new to science.

The accumulation of collections has resulted in a need for a modicum of curatorial care of the collections. This is needed while we house the collections here. There is no intent to keep them indefinitely but help with labels and collection care is needed temporarily at least. We envision that the research assistant will handle this job.

The entrance into the data processing program of Rogers and Fleming is a natural for the stage of development of this project. This can be a mutually beneficial collaboration at minimal cost to all parties. It is envisioned that Rogers will provide materials and the instruction for data processing, as indicated in his letter, and that we would provide the attribute (taxonomic characteristic) analysis. This would also be done by the research assistant under supervision of Dr. Menzies and Dr. Schultz. Computer time will not be involved at all during this year.

Our major problem now is in keeping on top of the collections in the best way possible. We have sorted the collections to species, identified the species and have now prepared illustrations and descriptions for forty new species and three new genera. Approximate titles have been assigned to nearly completed manuscripts as follows:

<u>Author</u>	<u>Approximate Title</u>	<u>Mss Pages</u>
Menzies-Schultz	The first deep-sea photographs of Isopoda from the Antarctic Sea.	5 pp
Menzies-Schultz	The genera <u>Hydroniscus</u> and <u>Antennuloniscus</u> from the Antarctic deep-sea.	10 pp
Schultz-Menzies	The genus <u>Haploniscus</u> from the Antarctic deep-sea.	50 pp
Menzies-Schultz	Some new genera of deep-sea Isopoda from the Antarctic.	8 pp
Menzies-Frankenber	The genus <u>Mesosigum</u> collected by the ELTANIN.	16 pp

Dr. George Llano
National Science Foundation
Washington, D. C.

-4-

January 8, 1965

By March of 1965 our present grant will expire. At this time it is estimated that an unused balance of \$6,000 will remain in the grant. This balance has been previously explained as being due to help by Duke University in the procurement of capital equipment.

It is proposed that the \$6,000 balance be carried over to 1965-66 and that the difference between \$20,209 and the \$6,000 be awarded as an amendment to our present grant. This difference amounts to \$14,209 for 1965-66.

The funds are required no later than March 1, 1965. It will be appreciated if notification of award could be made earlier than this date so that time could be had to insure prompt employment of personnel.

Respectfully submitted,

Robert J. Menzies
Principal Investigator

RJM:csw

APPROVAL

Dr. C. G. Bookhout - Director
Duke University Marine Laboratory
Beaufort, N. C.

Mr. R. Ely - Business Manager
Duke University Marine Laboratory
Beaufort, N. C.

Mr. G. C. Henricksen
Vice Pres. for Business & Finance
Duke University
Durham, N. C.

Dr. E. C. Horn - Chairman
Zoology Dept.
Duke University
Durham, N. C.

Dr. R. J. Menzies
Principal Investigator
Duke University Marine Laboratory
Beaufort, N. C.

Dr. George Schultz
Research Associate
Duke University Marine Laboratory
Beaufort, N. C.

January 25, 1965

Dr. George Llano
Assistant Director
Antarctic Research Program
National Science Foundation
Washington 25, D. C.

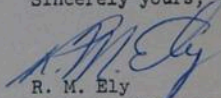
Dear Dr. Llano: Subject: Amendment to Research Grant NSF GA71
(81-6195) Duke University Extension of-
Dated January 8, 1965

This letter refers to the above subject Amendment and it is requested that it become a part of this Amendment.

We request that pages two and four of the Amendment be deleted and that the enclosed pages be inserted in place thereof.

We request permission to use the estimated \$4000 remainder of the present grant as proposed on page four enclosed for the continuation of the grant. We should like to use this balance for (1) \$1700 toward salary for a Research Assistant and (2) general contingencies such as travel, supplies and materials, publication costs, and preparation of reports.

Sincerely yours,



R. M. Ely
Business Manager

RME:bn

Encls:

Dr. George Llano
National Science Foundation
Washington, D. C.

-2-

January 8, 1965
(Revised Jan. 25, 1965)

supported research project. Dr. Rogers will supply instructions for data regarding Termatex punching. We will supply the fundamental data for such analysis from our studies on Antarctic species and genera.

It is intended that the added Research Assistant will perform the arrangement of data according to the instructions supplied by Rogers. We can take up the problem of computer time at a later date.

The budget for this work is as follows:

SALARIES

Research Associate (Dr. George Schultz)-----	\$ 7,600.
Research Assistant-----	1,800.
Scientific Illustrator-----	3,000.
Principal Investigator-----	-000-

Subtotal Salaries - \$ 12,400.

FRINGE BENEFITS (8.8% of Salaries)-----\$ 1,091.

UNIVERSITY OVERHEAD (20%)-----\$ 2,698.

GRAND TOTAL - \$ 16,189.

CONTINGENCIES:

Exchange USSR Scientist, Isopod Expert in
Exchange Program - 3 months salary
(USSR Scientist Mr. Oleg Kussakin)

Dr. George Llano
National Science Foundation
Washington, D. C.

-4-

January 8, 1965
(Revised Jan. 25, 1965)

By March of 1965 our present grant will expire. At this time it is estimated that an unused balance of \$4,000 will remain in the grant. This balance has been previously explained as being due to help by Duke University in the procurement of capital equipment.

It is proposed that the \$4,000 balance be carried over to 1965-66 and that \$16,189 be awarded as an amendment to our present grant.

The funds are required no later than March 1, 1965. It will be appreciated if notification of award could be made earlier than this date so that time could be had to insure prompt employment of personnel.

Respectfully submitted,

Robert J. Menzies
Principal Investigator

RJM:csw

September 17, 1964

Dr. Robert Menzies
Duke University Marine Laboratory
Beaufort, North Carolina

Dear Bob:

We received the copy of your note to Sid and thought it was well presented. It should hit a responsive cord.

The enclosed blurb you are free to edit as you wish and include it in your contract proposal. We are largely trying to supply you with ammunition. The budgets are provisional but probably as accurate as anyone could anticipate. Try to incorporate some provision for overhead to The New York Botanical Garden--it is a poor outfit with no tobacco!

You might give some thought to the idea that your research will result in publication that could be entitled Genera Isopodorum.

I hope the ship and associated involvements are in good shape. Mary and I and perhaps Willie expect to be down for the dedication. We will most likely drive. We will write later in regard to this. Thank Lucille for the invitation. Perhaps we can talk about the grant then.

Our mathematician, George Estabrook, has joined us, and we expect our English biometrician at the beginning of next month. Ideas are budding all over the lab.

If there are any further questions, just write. In the meantime, Dave sends you his regards. Also give Mary's and my best to Lucille.

Hasta la vista,

HF:MDF
Enclosure

Taxonomy is confronted with an ever-expanding accumulation of information. Nonetheless, no effort has been made to employ any of the modern techniques to the correlation of the properties of taxa which would enable the research worker to get a better understanding of the group he is concerned with and to write keys and diagnoses of a calibre that would enable other workers to determine their material. This is particularly true of marine plankton.

The Isopoda with over 500 genera is beyond any one individual's capacity to encompass properly even if he were able to devote full time to the task. It is part of the aim of the present proposal to develop a program that will, with the use of modern techniques, increase the capacity and efficiency of the taxonomist several fold.

Such a program must have three objectives. (1) It must be an efficient method to record and store the attributes of the organisms being studied. (2) It must provide the facility for rapid and economical retrieval of this information. (3) It must allow the researcher to manipulate the information rapidly and efficiently. The system should encompass negative as well as positive information.

Edge sort card systems are impractical for this project because of the mechanical difficulty of handling the cards and, more important, because of the limited quantity of data that can be recorded on the cards.

We propose to employ the Termatrex machine manufactured by the Jonkers Business Machines, Inc., which has been supplied to The New York Botanical Garden by the Office of Naval Research. The Termatrex method of data recording involves the use of an opaque plastic card that provides high accuracy and durability. These cards are $9 \frac{5}{8}$ " x $11 \frac{1}{2}$ " and allow for the punching of 10,000 holes approximately $\frac{1}{16}$ " in diameter with $\frac{1}{12}$ " between rows. These holes are punched by a drilling machine that positions the holes with a high degree of accuracy. These cards are then read by a light stand with a plastic gridded overlay. The interpretation of the card is determined by the numerical position of the hole.

We shall employ the coordinate searching system for the recording of the attributes of the 500 genera. This method will require one punch card for each attribute or property characterizing the genera of the Isopoda. This method has the advantage of being an open system; as more information about the Isopoda is discovered, new cards are incorporated within the system without altering the coding. The method also has the advantage that it can be modified at any stage. Properties can be combined or deleted without affecting the other terms.

The retrieval of attributes from this system involves a search of the attributes to determine which genera are characterized by one or more attributes. A search thus involves only those attributes which are pertinent to the question or interest. This is accomplished manually by simply superimposing two or more cards specifying the attributes being investigated on the light reader and recording which holes are common to the set of cards.

Since the number of cards determines the size of the system and since it is unlikely that the Isopoda will contain more than 400 attributes, but 400 cards will be necessary to characterize 10,000 organisms.

We also intend to incorporate a linear information retrieval system with the coordinate system. This is the customary standard method used by librarians, etc. and while it does have several disadvantages will contribute to this area of research by enabling us to rapidly construct a zoological dichotomous key. In other words, mutually exclusive properties of the combinations of various sets and subsets can be determined rapidly. Since the Isopoda contain approximately 500 genera, such a system is completely feasible and will enable the creation of dichotomous keys to be much more precise and accurate as well as enormously speeding up the construction of a key.

Both methods, but primarily the coordinate system of retrieval, have the added advantages of permitting a much sharper and more critical analysis of the attributes of the Isopoda. It will also permit for the Isopoda an analysis of the theory that those attributes that are most prevalent throughout a taxa are also the most primitive characters and thus give an indication of the evolution and phylogeny of taxa.

Budget

750 Termatrix cards @ 35¢ a card	\$262.50
Termatrix operator 200 hours @ \$2.50/hour	500.00
Social Security	
Overhead	

The type species of a genus defines the genus to the extent that the genus must contain the nomenclatural species even though the specimen is not necessarily typical. We can with the above limitation think of the type species as representing and thus defining the attributes of the genus. Consequently, from a pragmatic and heuristic point of view the most rapid and expeditious approach to a revision and consequent definition of the Isopoda is a classification based on the 500 odd type species. Such a classification could form the basis and framework for an eventual world monograph of the Isopoda.

* Since a mathematical computerized model has been devised for determining the differences between biological constructs, the validity of the characteristics used in the construct definition and the relationships between the constructs and characteristics, we can rapidly and with greater accuracy and objectivity then heretofore construct a hierarchical classification.

A classification based on this computerized model has the advantage that all the known properties of the order may be handled simultaneously and not in the step-wise fashion imposed by human limitations in dealing with the magnitude of data accompanying an order composed of 500 genera.

The information prepared and derived from both the Termatex operation and the computerized mathematical classification program will interdigitate and complement each other as research tools.

Budget 2nd year data processing, 10 hours @ \$225/hour	\$2,250
Port-A-Punch cards, 2000	14

* Rogers and Tanimoto; Rogers and Fleming

July 17, 1964

Dr. Robert J. Menzies
Duke University Marine Laboratory
Beaufort, North Carolina

Dear Bob:

Glad to hear from you. I am getting ready to leave for London on Monday. Dave Rogers is giving a paper on our computerized taxonomic model. Mary will be coming along, too. Part of the time she will be collecting lichens in Snowden, in Wales. By the way, Willie is collecting lichens in Iceland.

Let me say right off that we will go along with you whole hog.

What I assume you want is a method that will group your taxa into proper sets and indicated the characteristics that determine the parameters of these sets. If so, it looks as if we have something for you.

We can't predict the amount of computer time you will need. We are paying \$225.00 an hour for a CDC 1604A computer at the present time. Small sets of data can be computed in a couple of minutes, but larger sets take hours of running time. If you can get your grant routed through the computer section of a granting agency, you will find that they consider the mentioned amounts as very modest, but if you go through a normal systematic panel, they'll hit the roof over the high cost.

I would suggest coming to New York after the 15th of August to talk this thing over--some of the methods will make sense if we can get together, but would take a lot of time if by correspondence.

We have in press for BioScience (Sept. issue) a paper on our methods, and though this isn't quite the technique we're following at the moment, it will give you the major run-down on the technique. We'd send a paper from Science, if we had any reprints left, but have distributed over 1500 copies, and are completely out. This paper, by Rogers, D.J. & Tanimoto, T.T., was in Science 132 (3434): 1115-1118. 1960.

We are sending one paper that may get you started.

I repeat--lets try to get together when Rogers and I get back from Europe and perhaps we can organize everything.

Best to Lucille.

Very truly yours,

Henry Fleming

Duke University Marine Laboratory
BEAUFORT, NORTH CAROLINA

June 29, 1964

Mr. Henry Fleming
New York Botanical Garden
Bronx Park
New York, N. Y.

Dear Hank:

I should like to enter into the modern world of computer science with some hope that the methodics will reveal results at least in proportion to the effort invested.

As the enclosed proposal suggests, I would like to take a long hard look at marine isopod genera. Is there any chance of using your techniques and facilities to reach this aim? If your answer is "yes", then will there be costs associated with this cooperation and use and what would the magnitude of these costs be?

You can see from this proposal that I had originally intended to work through the NODC but I am not sure this is the best way to accomplish the desired results.

I want a computer to remember around 80 characteristics in 350 genera and to retrieve these on call by name and by characteristics and combinations of characteristics.

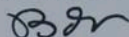
I do not imagine that I would need more than 24 hrs. of computer time per year.

I need to know how codes are established? How many cards I should have? What the cost of cards is? Any consulting fees or ancillary charges that might be needed? What magnitude of help I might anticipate?

Please let me know if you or your group can help and please send any reprints and reports that may help.

I wish to make it clear that I have no aim to become a biocomputer expert. I would just like to be able to use those functional techniques which you have established to accomplish a job. Beyond this, I have no interest in the technique.

Very truly yours,



Robert J. Menzies
Director-Oceanographic Program

/csw

The above named features are known
for A. uniramens Menges & Miller, & some
are known for other species but their
presence in the type species
can only be inferred in probabilistic terms.
~~their presence in the type species~~. A
variation or difference in these characters
might well be evidence supporting the
erection of a separate, distinct genus. The
systematics & nomenclature can only be satisfactorily
determined after an examination of the holotype
& specimens of the type species, — A. cherotii

17 September 1969

Armory 101

Mr. Theodore W. Hurst
Worthington, Hurst and Associates
333 N. Michigan Avenue
Chicago, Illinois 60601

Dear Ted:

Quite a bit has happened to us since we last were in contact, some good, much not so good. The worst first: all our efforts to continue the Taximetrics Lab via the grant route have come to naught. No matter how we have tried, we can't strike NSF (or other Federal agency) for a sufficiently large grant to continue our present activities. Having finished the development of a really hot information management/retrieval system, we had hoped to get funds to help establish the system in a number of useful areas in biology. NSF did not buy this service function, saying it's up to us to sell the package on the open market, and to get our funds from the users. I can see why NSF has this policy, even though I had had an initial reading that they would support us while we helped install our system in various significant biological endeavors. However, they couldn't go along with the idea because of the very deep cuts they received in their own budget.

We've tried, unsuccessfully, to get the University of Colorado to fund us on an interim basis until we did strike it rich again. The University is itself under somewhat heavy restrictions on funds and they have other questionable reasons which prevent them from keeping us around, even though we do support the work of a segment of the university students and faculty. I guess our PR isn't too good.

To try to keep body and soul together, we've put together a small corporation - called the Carex Corporation, in keeping with our botanical origins - by which we offer ourselves as rather special information management experts, with ability to provide software in certain areas. However, we know there are many software houses about, and for this reason, we do not intend to compete with all of them. In those areas where syntheses of information are called for, we believe we can provide good techniques with the supporting software, and more than this, we can provide cost/effectiveness analyses to measure the effect of using our systems as compared with other systems.

17 September 1969

To give us the capacity for doing a well-rounded job, we've added a couple more people to our staff that I do not think you've met. One is a very sharp economist with specialties in operations research; the other is a young lawyer who has turned his talents to working in our group, giving us expertise in an area certainly not covered by George, Henry, Bob or me. With this additional talent, we have every confidence that we can hack it in the world outside academe, but we would still like to work with, among other things, certain problems in academe.

We are evidently new to the game, and need all the expert advice we can get, and one of our first thoughts is to turn to you for some good and useful ideas about where and how our services can be applied. If you are amenable to talking about such things, I'd be very appreciative. We expect to be passing that way wither late in this month or early in October, and hope that we can catch you in for some period of time. Let me know if you are willing, and when you are expecting to be there.

One other favor, if I may ask it. One of our possible alternatives to our present very tenuous connections with the University of Colorado is through a very old and good friend of mine, Dr. M. T. Hall, who now directs the Morton Arboretum, just to the west of Chicago, in Lisle. He has hopes for adding us to his staff to build up their program, which is now rather minimal. Would you mind if I gave him your name as a reference, so that you could respond to a phone call from him, in the event he wishes to check up on us? It might be interesting to him to hear an evaluation from you. I won't say anything to him until you give me the okay to give him your name and phone number.

Sincerely,

David J. Rogers
Professor of Biology

DJR:gm

Worthington, Hurst and Associates

333 N. Michigan Avenue • Chicago 1 • DEarborn 2-1161 area code 312

Psychological Services for Industry

September 16, 1968

Dave Rogers
University of Colorado
Taximetrics Laboratory
Department of Biology
Armory 101
Boulder, Colorado 80302

Dear Dave,

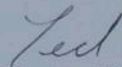
I thought you might find the enclosed article from "Science"
interesting if you haven't seen it before.

(30 August 1968,
Vol. 161, No. 3844
p. 849 seq.)

It was good to see you in Colorado. Do us the same favor if
you come to or through Chicago.

Joan told me that your wife was to have surgery shortly after
we were there. How is she? Give her our best wishes.

Sincerely,


Theodore W. Hurst

TWH:pb
enc.

Title: Measurement, Statistics, and the Schemapiric View.

FEB 26 1968

Worthington, Hurst and Associates

333 N. Michigan Avenue - Chicago 1 - DEarborn 2-1161 area code 312

Psychological Services for Industry

February 23, 1968

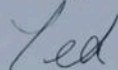
Dr. David J. Rogers
University of Colorado
Boulder, Colorado 80302

Dear Dave:

Under separate cover I am sending you some material for the proposed student-researcher to read. (Tell Henry that what is one man's non sequitur is another man's children's plans for a birthday celebration.) The next statement I make is going to show you how far removed I have been from our joint project. Do you not have the punched cards for a 200 X 200 matrix on my data? If not, you had better let me know post haste and I will search here.

I plan to arrive in Denver on Thursday, March 7 on Continental flight 29 at 12:10 P.M. I plan to leave Denver on Sunday at 6:15 P.M. It'll be good to see you-all again.

Sincerely,



Theodore W. Hurst

pb

18 January 1968

Dr. Theodore W. Hurst
Worthington, Hurst and Associates
333 N. Michigan Avenue
Chicago, Ill. 60601

Dear Ted:

I am just getting around to responding to yours of the 14th which I am pleased to have. I met yesterday with two quantitative psychologists and they were enthusiastic about the potential for support for a graduate student through your efforts. There are several possibilities for working out things and I think that any one of them would be useful. We could have a student registered in psychology taking his curriculum under the direction of a psychologist doing his research work on a project of mutual interest to you and to us. I think that would be probably the best way to run it. Or, we could have one whose thesis problem pertained to your interests and have him under the direction of the quantitative psychologist. I would choose the former route, but we have to wait on good students which we do not have on the horizon at the moment. If you have someone to recommend as a graduate student we would be glad to have him.

We could work out the cost arrangements relatively easily. The usual arrangement for students on a research grant is at the rate of \$2500 for nine months and \$500 expense account. This is half time work and would therefore require four years for the Ph.D. or 12 grand for four years. We actually have to put up some scratch for summer time work (two months full time) which amounts to about \$1600 for the summer. Thus an extra \$6400 for a full four years or a total of \$18,400. We could do this year by year because students sometimes come in for a year and then change their direction. If done year by year we are not stuck with the commitment. I hope this sort of information is what you are looking for. I think the idea of a graduate student working on these problems has a potential for pay off.

Thanks for writing.

Sincerely,

David J. Rogers
Professor of Biology

DJR:fm

Worthington, Hurst and Associates

DEC 18 1967

333 N. Michigan Avenue • Chicago 1 • DEarborn 2-1161 area code 312
60601

Psychological Services for Industry

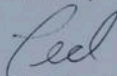
December 14, 1967

Dr. David Rogers
Institute of Numerical Taxonomy
University of Colorado
Boulder, Colorado 80304

Dear Dave:

I haven't forgotten your suggestion about helping to support a graduate student in psychology to work with you. I want to pursue this further. Right now I am up to my ears in our work with Head Start but I should have a breather after the first of the year. Write me and give me some of the details of how we might work something out.

Sincerely,



Theodore W. Hurst

TWH/pn

MLC/earn
7362

Don Probert

12 February 1968

Dr. Theodore W. Hurst
333 N. Michigan Avenue
Chicago, Ill. 60601

Dear Ted:

I am answering for Dave as he is off with the flu. The 7th of March is OK and we will await confirmation. I am disappointed if for no other reason than that I expected to have a drink with you.

I am referring your letter to an industrial psychologist in Chicago who has a devious method of determining peoples' personalities. I am interested in the personality type expressed by such non-sequiturs as birthday - March 1, travel - March 7.

As ever,

Henry S. Fleming

HSF:gm

P. S. Could you send us out some preliminary data in the meantime? I'd like to get this kid started, if possible. Did you ever publish anything about this stuff, or even write a mimeographed sheet?

FEB 12 1968

Worthington, Hurst and Associates

333 N. Michigan Avenue - Chicago 1 - DEarborn 2-1161 area code 312

Psychological Services for Industry

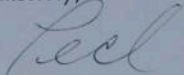
February 8, 1968

David J. Rogers
Taximetrics Laboratory
University of Colorado
Boulder, Colorado 80302

Dear Dave:

I can't make it Feb. 15th since Joan and I have tickets for a play on the 17th and that would make it too tight a schedule. My birthday is March 1st. How about the 7th of March? Is that too late? It's about the earliest I can make it and sneak in a weekend in Colorado.

Sincerely,



Theodore W. Hurst

pb

Worthington, Hurst and Associates

333 N. Michigan Avenue - Chicago 1 - DEarborn 2-1161 area code 312

Psychological Services for Industry

February 20, 1967

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

Dear Dave:

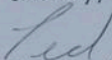
I know my silence has been unconscionable. Procrastination and then guilt about the procrastination have been the villains.

You ask in your note of October 13, 1966 if I have decided to drop my efforts. Dave, I haven't "decided" to quit but I'm afraid the result is the same as if I had. I have sweated out the data I brought back from Colorado and I could not make a great deal from it that made sense to me. Then, when I went back for another look after a lapse of several months I could no longer even figure it out very well. Sheer faith in the basic concepts kept me going for a long time but I guess my faith has weakened. Maybe I would feel differently if the attribute analysis had been ready. Maybe I will still feel different when it is ready! However, I got to the point where I felt like I was just beating my head against a wall.

I have had no one--and I mean no one--to talk to about this research, no one to kick ideas around with, no one to give a word of encouragement. I guess I'm just too social a guy ever to be just a backroom researcher. Without hard facts I need consensual validation to maintain my moral.

Could you do me the favor of keeping me posted on your efforts. I still have a glimmer of hope that you will yet come up with techniques and tools that will be very significant for psychology. Give my best to your family and the team. I'm still rooting for you.

Sincerely,



Theodore W. Hurst

TWH/pn

- Taxonomy Laboratory

October 13, 1966

Mr. Theodore W. Hurst
Worthington, Hurst and Associates
333 N. Michigan Ave.
Chicago, Ill. 60601

Dear Ted:

Whatever happened to you? Did you decide to drop your efforts
in this line? Sorry if you did. Let us hear from you.

Sincerely,

David J. Rogers
Professor of Botany

DJR:ch

October 13, 1965

Mr. Theodore W. Hurst
Worthington, Hurst and Associates
333 N. Michigan Avenue
Chicago, Illinois 60601

Dear Ted,

I had hoped to see you on my way west in August, but arrived in Chicago on Saturday night and left for Urbana on Sunday morning.

I am writing to inquire if there are any 'no logicals' included in the ordered characters. If there are, the 'no logicals' should be excluded from the ordering.

Why not stop off and say hello on one of your regular flights west?

Sincerely,

Henry S. Fleming

HSF/ec

Worthington, Hurst and Associates

333 N. Michigan Avenue - Chicago 1 - DEarborn 2-1161 area code 312

Psychological Services for Industry

October 5, 1965

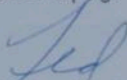
Dr. David J. Rogers
Department of Botany
Colorado State University
Fort Collins, Colorado 80521

Dear Dave,

Enclosed are the punched cards and the three code sheets from which the cards were punched. Each of the 150 subjects is represented by 3 code sheets and 3 cards. The attribute range is 101 to 365 (numbers 366 - 370 were not used). The attributes for a single characteristic are all within that characteristic's series of boxes on the code sheet. The N for each cell is not indicated since you can obtain that information more quickly from the cards. The ordered characteristics are identified on the code sheets by the red arrows.

Let us know as soon as you have something. Perhaps you or one of the staff might be able to stop off in Chicago on what are presumably regular flights East.

Here's hoping. Onward and upward.



Theodore W. Hurst

TWH/bpm
encl.

53-1

FEB 2 1966

Worthington, Hurst and Associates

333 N. Michigan Avenue • Chicago 1 • DEarborn 2-1161 area code 312

Psychological Services for Industry

January 31, 1966

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

Dear Dave,

I'm very anxious to come out and go through the data but it looks like I'll be too tied up for the next two weeks to move. On about the 15th or so I'll write or call to see if we can make definite plans.

Sincerely,



Theodore W. Hurst

TWH/bpm

- Taxonomy Laboratory

January 27, 1966

Mr. Theodore W. Hurst
Worthington, Hurst and Associates
333 N. Michigan Avenue
Chicago, Illinois 60601

Dear Ted:

We finally have a printout of your information. Anytime that you are interested in coming out we'd be glad to go over it. We are already making some preliminary examinations so that we will be better able to go through the data when you get here.

Looking forward to seeing you.

Sincerely yours,

David J. Rogers
Professor of Botany

DJR/pam

Worthington, Hurst and Associates

333 N. Michigan Avenue • Chicago 1 • DEarborn 2-1161 • area code 312

Psychological Services for Industry

December 30, 1965

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

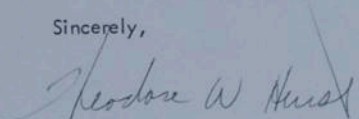
Dear Dave,

I find that I will be in Chicago on the 5th. Would you have George contact me so we can get together.

It seems probable that I will be in Los Angeles on the 27th. I could arrange to be in Fort Collins either just before then or just after.

Drop me a line.

Sincerely,


Theodore W. Hurst

- Taxonomy Laboratory

October 26, 1965

Mr. T. W. Hurst
Worthington, Hurst and Associates
333 N. Michigan Avenue
Chicago, Illinois 60601

Dear Ted,

Thanks for the character-attribute sheets. I have marked up the N values for the program, for forwarding to New York. Unfortunately, Page 5 which includes characteristics 18-23; attributes 201-222 is missing. This missing page would contain two ordered characters. Character 20 I have listed N=4. Character 23 I have listed N=5 rather than 6. This handling of character 23 is based on the last telephone conversation between you and Dave. If you disagree with the above N value for character 23, drop us a letter and we will have it changed in New York. In effect, attribute 222 is being considered as a 'not logical' and is not included in the ordering.

After having gone over your attributes, I have marked all other ordered characters (than character 23) with an N value covering the complete range of the character. You might like to make note of this in your records.

We are getting settled here and expect to start de-bugging the Sij part of the program for the 7094 next week. Wish us luck.

Dave sends his best.

Sincerely,

Henry Fleming

HF/ec

Worthington, Hurst and Associates
Psychological Services for Industry

333 N. Michigan Avenue • Chicago 1 • DEarborn 2-1161

October 24, 1965

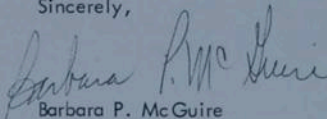
Dr. David Rogers
Colorado State University
Department of Botany & Plant
Pathology
Fort Collins, Colorado

Dear Dr. Rogers,

At the request of Mr. Theodore W. Hurst I am
enclosing the attached typed data sheets.

If you have any questions please call Mr. Hurst.

Sincerely,



Barbara P. McGuire
Secretary to Mr. T. W. Hurst

BPM/bpm
encl.

Worthington, Hurst and Associates

333 N. Michigan Avenue • Chicago 1 • DEarborn 2-1161 area code 312

Psychological Services for Industry

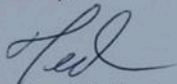
August 25, 1965

Mr. Henry Fleming
Department of Botany
Colorado State University
Fort Collins, Colorado 80521

Dear Henry,

I hope you have received my letter of August 7. I made my deadline of July 20th but when I called The Botanical Gardens it became obvious that your trek westward had already begun. I have the cards all punched, ready to go. Please give me the word when you want them shipped. Also give my best to Dave and George -- and Mike?

Sincerely,



Theodore W. Hurst

TWH/bpm

P.S. Given half an excuse,
I might also come to Fort
Collins.



October 11, 1965

Mr. Theodore W. Hurst
Worthington, Hurst and Associates
333 N. Michigan Avenue
Chicago, Illinois 60601

Dear Ted,

We have received your cards and hope that we will be able to run them fairly shortly. Henry has opened the deck, but I have not yet fully explored to see whether things are in order or not. I am sure that they must be. We will have to run these cards in New York because our programmers are not yet running here. I will ask that the CDC Service Bureau send us the print-out, so that we can look it over, get our "feel" of the data, and then report it to you.

This might offer you the opportunity you are looking for to visit us here in Fort Collins. If you have an opportunity to come out anyway, please feel free to do so. We want to find out more about these green-eyed blondes.

Sincerely,

David J. Rogers
Professor of Botany

DJR/ec

November 20, 1964

Worthington, Hurst and Associates
333 N. Michigan Avenue
Chicago 1, Illinois

Attention Mr. Theodore W. Hurst

Gentlemen:

Thank you for your letter of November 13
and your generous contribution of \$1,250 to
further the work that our Dr. David J. Rogers
is doing.

In accordance with your wishes, these funds
are being credited as current income to Dr. Rogers's
Department of Quantitative Taxonomy.

Sincerely yours,

Charles B. Harding
President

CBH:md

cc: Dr. Rogers ✓
Dr. Steere

Worthington, Hurst and Associates

333 N. Michigan Avenue • Chicago 1 • DEarborn 2-1161 area code 312

Psychological Services for Industry

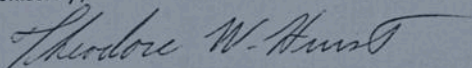
November 13, 1964

The New York Botanical Garden
Bronx Park
New York 38, New York

Gentlemen:

I wish to make a contribution to further the work of Dr. David J. Rogers and to that end I am enclosing a check for \$1,250.00. Would you please earmark these funds for the operation of The Department of Quantitative Taxonomy.

Sincerely,



Theodore W. Hurst
TWH/bpm

The New York Botanical Garden

RECEIPT FORM

1065

Date Nov. 18, 1964
Name Worthington, Hurst & Associates
333 N. Michigan Ave.
Chicago 1, Ill.
Address

Contribution to Dept. of Quantitative
Taxonomy; credit as current income

Amount \$ 1,250

Securities #3-53-67

Unrestricted

Restricted

Remarks (Restrictions, source, etc.)

Received with letter dated Nov. 13, 1964.

cc: Dr. Rogers ✓
Dr. Steere

(NOTE if amount of contribution qualifies donor for new or
different type of membership)

(Signed) Robert F. Kolkebeck

November 16, 1964

Mr. Theodore W. Hurst
Worthington, Hurst and Associates
333 N. Michigan Avenue
Chicago 1, Illinois

Dear Mr. Hurst:

Your comments, believe it or not, are more valuable to me than the \$1,250. However, we ~~will~~ appreciate very deeply the amount that you have contributed to our assistance. You will receive shortly, I am sure, an official acknowledgement of the check.

Sincerely yours

David J. Rogers
Curator of Quantitative Taxonomy

DJR:MDF

P.S. The Port-A-Punch and cards will be along shortly.

MEMORANDUM 11/16/64

TO: Mr. Kolkebeck

FROM: Dr. Rogers

Will you please take care of the enclosed check for \$1,250 received as a contribution from Worthington, Hurst and Associates? Transmittal letter is attached.

Worthington, Hurst and Associates

333 N. Michigan Avenue • Chicago 1 • DEarborn 2-1161 area code 312

Psychological Services for Industry

November 13, 1964

Dr. David J. Rogers
The New York Botanical Garden
Bronx Park
New York 58, New York

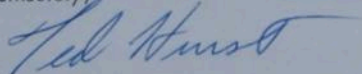
Dear Dr. Rogers:

Enclosed is a check for \$1,250.00 and a letter of transmittal to the appropriate administrative officials at the New York Botanical Gardens. I trust that the letter is explicit enough to insure that the funds will be earmarked for your work.

I also trust that this will be of some aid to you in continuing with the projects which you presently have on tap. As you know, we out here in Chicago feel this to be a methodological breakthrough of the first magnitude. I am presently in the process of attempting to encourage clients to loosen their purse strings a bit but, as I am sure you know, these things take time.

Do keep in touch, not only because I am specifically interested in running our data but also because I feel your work to be exciting and important in general.

Sincerely,



Theodore W. Hurst
TWH/bpm
encl.

P.S. To date I have not received a Porta-Punch or any instructions. Would it be more convenient for me to obtain these locally through IBM?

November 5, 1964

Mr. Theodore W. Hurst
Worthington, Hurst and Associates
333 N. Michigan Avenue
Chicago 1, Illinois

Dear Mr. Hurst:

I must apologize for the great delay in responding to your kind offer of the 24th of October. As I told you over the phone, I was not able to accept the offer of \$1,250 until our business manager had had a chance to "think." Apparently, he has "thought" and now finds it possible for us to accept your offer to help us out. If you merely make the check payable to The New York Botanical Garden and in the covering letter state that the funds are to be earmarked for the operations of the Department of Quantitative Taxonomy, it will be satisfactory. Thank you kindly for your thoughts in this direction.

We will very shortly, I trust, have for your benefit a program useful for cluster analysis.

We also look forward to receipt of any other funds that you may be able to scratch from your colleagues, clients, etc., in the Chicago area who will benefit from this type of analysis.

Most sincerely yours

David J. Rogers
Curator of Quantitative Taxonomy

DJR:MDF

Worthington, Hurst and Associates

333 N. Michigan Avenue • Chicago 1 • DEarborn 2-1161 area code 312

Psychological Services for Industry

October 24, 1964

David J. Rogers
Curator of Economic Biology
The New York Botanical Gardens
Bronx Park 58, N.Y.

Dear Dr. Rogers,

Dave Storey came back from his visit with you and your colleagues vintly impressed with the progress you have made with the taxonomy program. Since I will be out of town next

week I wanted to let you know immediately how hopeful we are of working with you -- hence the handwritten letter, this being Saturday and no clinical help on duty.

I am very anxious to cooperate with you in any way I can in the hope that, when feasible, we might be able to use your program for our data and perhaps even get some help in making what adjustments might be necessary to run our data. It is my firm ~~conf~~ conviction that

The taxonomy approach will have broad application in the biological and behavioral sciences.

Maybe you and I could look forward to doing something together which might lead to joint, cross disciplinary publication. I should certainly be pleased to associate myself with you and your group -- and grateful as well.

Dave told me of your difficulty in getting sufficient

research funds. If I understand it correctly, the next phase of your work needs \$5000⁰⁰ more or less to complete it.

I want to do what I can to help and am prepared to commit my firm for 25% of that amount -- namely about \$1250⁰⁰. I wish it could be a good deal more.

I would also like to make some efforts to raise additional

funds for your work. It may be possible for me to persuade some of my clients to make a donation. However, I would not take any steps in this direction without your prior approval.

I will be back in Chicago the week after this coming week and will give you a call then.

Sincerely & Hopefully
Theodore W. Hurst

Worthington, Hurst and Associates

333 N. Michigan Avenue - Chicago 1 - DEarborn 2-1161 area code 312

Psychological Services for Industry

October 8, 1964

David J. Rogers
Curator of Economic Botany
The New York Botanical Garden
Bronx Park
New York 58, New York

Dear Mr. Rogers:

In 1962 and 1963 I had some correspondence and some telephone conversations with you about the IBM 704 Taxonomy Program. Since that time there have been a number of developments in my work and a few snags.

I had a pleasant lunch with Dr. Tanimoto near Boston last year and subsequently lost contact with him. He had offered to send me a bibliography and when I did not hear from him for several months I tried to contact him again with no success. Evidently he has moved again.

I have been trying to get the program re-programmed for the IBM 7094 at The University of Chicago where I am working for my Ph. D. I want to increase the matrix size. Unfortunately, I have only very limited access to professional programming help and the reprogramming job has not yet been completed. However, as you may know some people at The Illinois Institute of Technology and Michael Reese Hospital have recently become interested in the program and I hope we can cooperate. I have made all my prior work available to them and I expect they will do the same for me.

A colleague of mine, Mr. David R. Storey, will be going to New York on business in the next week or so. I hope you can find some time to talk to him and bring us up to date on your work with the Taxonomy Program. I will call you on Monday October 12 to find out when it would be convenient for him to call on you.

Sincerely,



Theodore W. Hurst

December 4, 1962

Dr. Theodore W. Hurst
Worthington, Hurst and Associates
333 N. Michigan Avenue
Chicago 1, Illinois

Dear Dr. Hurst:

In reference to your letter of the 30th requesting Dr. Tanimoto's address, the best we can do is to tell you that he works for Raytheon in the Boston area and that his phone number is CR 4-7100. Extension 2195.

We have progressed considerably beyond the stage of the original program. However, developments are such that it would take quite a bit of time to explain in a letter. If you are so inclined, why don't you stop in to see us here in New York, and we will go over the matter with you?

Sincerely yours

David J. Rogers
Curator of Economic Botany

DJR:MDF

Worthington, Hurst and Associates

333 N. Michigan Avenue • Chicago 1 • DEarborn 2-1161 area code 312

Psychological Services for Industry

November 30, 1962

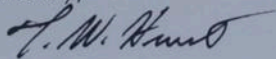
David J. Rogers, Ph.D.
Curator of Economic Botany
New York Botanical Gardens
New York City, New York

Dear Dr. Rogers:

I am rather anxious to get in touch with Dr. T. T. Tanimoto with regard to some technical aspects of your taxonomy program. I am planning to use the program with psychological data and an expanded matrix on an IBM 7090 and I have run into some difficulties about programming with which I am sure Dr. Tanimoto can help me. I have tried getting in contact with him at Melpar in Watertown, Massachusetts and they inform me only that he is no longer employed with them. Anything you could do to put me in contact with him would be very much appreciated.

Have you done any further work with the program? If so, I would also appreciate any insights or suggestions you would care to give me beyond those contained in your article in *Science*, Oct. 21, 1960.

Sincerely,



Theodore W. Hurst

TWH/jc