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#### *About the Institute*

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

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

DEPARTMENT OF BIOLOGY



THE UNIVERSITY,  
SOUTHAMPTON  
SO9 5NH

TEL. 559122  
EXT. 2444  
TELEX 47661

FAB/AB

23rd February 1977

Dear Dave,

Thanks for your letter and your telegram. Both were very welcome - to jog me out of my relative inactivity concerning the magnum opus!

I have read through the prospectus, Dave, and like it. I think 1977 is a timely moment to get our message over and at present I know of no direct competitor. Shall I put a few comments on the prospectus in the post to you in the next few days? Before we can really sell it to a publisher we shall need to be very firmly agreed on the purpose. I think you are right in aiming it primarily at taxonomists and taxonomy-users and only secondarily as an advanced undergrad/graduate text. Somehow we want to reach both the museum taxonomist and the agricultural or pharmaceutical research station staff with clear, practical ideas for modern extensions of what classical taxonomists started.

I have already paid £213.80 (US \$ 364) for a T.W.A. Apex (Advanced Payment) flight to Denver. Will you be able to reimburse this from the money mentioned in your telegram Dave? I do hope so as I am disastrously overdrawn on my bank account at present! I enclose the travel agent's receipt for your attention. I suggest the easiest transaction would be for you (or your finance office) to have the payment ready for me in dollars when I arrive. This would save you (or them) problems of getting it over here before my departure and I could use the dollars in Boulder.

My flight brings me to Denver on the evening of March 22nd and I depart at lunch time on April 21st.

You will hear from me again soon.

Yours sincerely,

32. 1/85  
TWA 6.20 P.M. Y  
F.A. Bisby

Professor D.J. Rogers,  
Department of Environmental, Population and Organismic Biology,  
University of Colorado,  
Boulder,  
Colorado 80309,  
U.S.A.

Working Party on Systematics of the Genisteae

8th - 10th June, 1977

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Firm programme, compiled January 1977, to be held at Biology Department,  
Building 44, Southampton University

Wednesday, 8th June.

- 18.00 Sherry at Building 44, visit Genisteae collection in Valley Garden nearby.
- 19.30 Dinner at a Restaurant, transport provided.

Thursday, 9th June.

- 9.30 Introduction to the Genisteae. F. A. Bisby (Southampton)  
Recent advances in systematic information. For the following papers each contributor has been asked to review the most recent findings for the Genisteae in the information that is his own speciality.
- 10.20 Serology. G. Cristofolini (Istituto ed orto botanico, Trieste)
- 11.00 Coffee
- 11.15 Alkaloids. G. Faugeras (Faculte de Pharmacie, Paris)
- 12.05 Amino-acids. E. A. Bell (King's College, London)
- 13.00 Lunch in the S.C.R.
- 14.00 Flavonoids. J. B. Harborne (Department of Botany, Reading)
- 14.50 Chromosomes. A. Sanudo (Universidad Autonoma de Madrid)
- 15.40 Tea
- 16.00 { 2 papers not yet finalised. Hopefully a review of seedling information  
{ and a brief report on Plant Insect Relationships.
- 18.00 Visit further collection of Genisteae in the Walled Garden at Chilworth, transport provided.
- 20.00 Dinner at a Restaurant, transport provided.

Friday, 10th June.

Systematic synthesis for the Genisteae.

- 9.30 Patterns of relationship. R. M. Polhill (Royal Botanic Gardens, Kew)
- 10.20 Patterns of information. F. A. Bisby and J. Harris (Biology Department, Southampton).
- 11.00 Coffee
- 11.20 Discussion
- 13.00 Lunch in the S.C.R.
- 14.00 Cytisus and allies. Discussion led by R. M. Polhill, possibly with contributions from A. Skalicka and D. G. Frodin.
- 15.00 Genista and allies. Discussion led by G. Cristofolini
- 15.40 Tea
- 16.00 Cytisus sessilifolius L.
- 16.30 Options in classification
- 17.00 Summing up.
- 17.30 Meeting closes (Transport available for 18.10 train)
- 20.00 Dinner at a Restaurant for those staying on.

Further details are available from:-

Dr. F. A. Bisby,  
Biology Department, Building 44,  
University,  
Southampton SO9 5NH,  
England.

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UNIV COLO LIB

VIA WUI  
EE

UNIV SOTON TELEX 47661 26 JANUARY 1977 REF 1900

DAVID ROGERS  
ENVIRONMENTAL BIOLOGY  
UNIVERSITY OF COLORADO BOULDER

REDUCED FARE ALREADY PURCHASED BUT HOPE YOU CAN PAY.  
ARRIVE MARCH TWENTYSECOND LEAVE APRIL W TWENTYFIRST.

THANKS

FRANK BISBEY. BIOLOGY  
SOUTHAMPTON UNIVERSITY

UNIV CO HB

+ 7187

JAN 26 1977

Jan. 24, 1977

Dear Frank:

Good news! I just uncovered a small residue of funds that I can use to buy a roundtrip ticket for you. There are no extra funds for living expenses--does your situation still hold that you do not need expense money?

Let me know as soon as possible. This little amount of money was from an old IBM grant made to me and another faculty member some time ago, and both of us had forgotten there was anything left in the bank. It's good to be forgetful now and then.

I think we should go ahead with the prospectus, to get some publisher to say that he will take our book, even if he doesn't have to put out anything in advance. You should have received me rewording of the initial outline you made up some time ago by now. I mailed it on January 20.

Regards,

Jan. 20, 1977

Dear Frank:

It shouldn't have taken me this long to get out that which is enclosed. We may have waited too long as it is, and not have funds to pay for your travel over here. Circumstances have changed drastically since I last wrote, and I no longer have any funds that could be used, from any source. I resigned from the genetic resources work for the international community last October, and separated my activities entirely from Hersh, et al. here. It wasn't too pleasant, and I had to just get away from it all for a while. I even stopped calling my work taximetrics, and am, therefore, no more than a member of the Dept. of EPO Biology, which is the address you should use for me.

Enclosed is a still-rough draft of the prospectus. It can be polished up, and I'm asking a friend of mine to read it over to smooth it out. I send it to you "as is" to get your reaction, corrections, additions, and/or substitutions. Please give it rather prompt attention, and if you like, you can take whatever parts you want, and try for assistance with publishers there in the UK.

I'm sorry about the delay--it may upset the plans, but I think it is worth while doing such a book. Now I should have much more time to devote to the writing, since I don't have a huge staff of people to supervise. You will note that I've written in a style that is intended to be understandable to editors, more than specifically to our colleagues. That may, or may not be, a useful approach.

Do what you can, as soon as you can, and let me hear from you.

Sincerely,

David J. Rogers, etc.

file

July 20, 1976

Dr. Frank Bisby  
Dept. of Biology  
Building 44  
The University  
Southampton SO9 5NH  
England

Dear Frank:

Thank you for your's of June 9. To answer your question specifically, I will try (as you are) to contact the publisher right away for advice and perhaps financial resources. There are probably other resources, however, that we should examine; and I will ask that Gil Hersh follow up on them so that even if we are not able to get funds from the book publishers directly, there may be other resources available to us to continue.

I do not believe at anytime in our correspondence that I mentioned that Lois Abbott, who is a Ph.D. degree candidate under my direction, is interested in assisting us with the book. Lois is quite an experienced individual, mathematically and biologically; and is much better off than the average student with a broad base of knowledge in many computer aided models, as well as well-founded in mathematics. She will be of great help to us in the development. She is occupied this summer with a course in California, but will be back in September when she will be able to participate with us more fully.

I plan to be away during the month of August, but hope to get out a more detailed outline for the proposed book. I really look forward to this work. And hope that you will continue to <sup>give</sup> ~~chip~~-up more ideas for it.

Best regards,

David J. Rogers  
Director

DR:rs

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SO9 5NH

JUN 24 1976

TEL. 559122  
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TELEX 47661

FAB/AP

9th June 1976

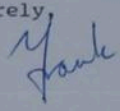
Dear Dave,

Thanks for your letter.

I confirm that I shall come to Boulder for the period 23rd April to 23rd May 1977. What kind of sources will you try for some finance? Do we prepare a more detailed draft and contact a publisher right away or leave all this until we have a few chapters written? I occasionally get circular letters from publishers looking for potential authors. Normally they go in the bin but I will start keeping them now.

Best wishes.

Yours sincerely,

  
F. A. Bisby

Dr. D. J. Rogers,  
Taximetrics Laboratory,  
1229 University Avenue,  
University of Colorado,  
Boulder,  
Colorado 80309,  
U.S.A.

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FAB/AP

17th February 1976

Dear Dave,

*Dave, Here is copy of Bisby's address. I hope you asked for it. Thanks my friend*

Thank you very much for entertaining me so handsomely in London, I was very happy to see you again. I didn't open your letter until mid January on returning from holiday. I've been dreadfully busy since then and delayed replying until I had time to tabulate at least an initial idea for planning the book. It is only a first idea, so do feel free to tear it up and make a fresh start! I think it important to show two attitudes which are missing from other works:-

- 1) Taxonomic services should be seen to service all biologists by attending to their special needs, encouraging them to contribute their own comparative information and arranging for regular feedback.
- 2) The principle information techniques should not be associated with particular taxonomic philosophies.

The techniques can prove useful across the whole spectrum of taxonomic philosophies. Their use is justified on grounds of automation - labour saving, accuracy and repeatability - and of scholastic precision - the ability to state explicitly what process of analysis was used.

Best wishes.

Yours sincerely,

F. A. Bisby

D. J. Rogers Esq.,  
University of Colorado,  
Taximetrics Laboratory,  
Department E.P.O. Biology,  
Boulder,  
Colorado 80302

## CURRICULUM VITAE

FRANK AINLEY BISBY

Nationality BRITISH

Date of birth 24th April 1945

Marital Status SINGLE

### Schools and colleges attended

|                                                                    |                        |
|--------------------------------------------------------------------|------------------------|
| ABINGDON SCHOOL, Abingdon, Berks, U.K.                             | Sept. 1956 - July 1964 |
| OXFORD, St. John's College UNDERGRADUATE                           | Oct. 1964 - July 1967  |
| GRADUATE                                                           | Oct. 1967 - Aug. 1970  |
| UNIVERSITY OF COLORADO, GRADUATE SCHOOL, Boulder, Colorado, U.S.A. |                        |
| Research visit Jan. - July 1969 at Taximetrics Laboratory.         |                        |

### Awards

OPEN EXHIBITION (Botany), St. John's College, 1964 - 1967

CHRISTOPHER WELCH RESEARCH SCHOLARSHIP, 1967 - 1970

### Degrees at OXFORD UNIVERSITY, U.K.

SCHOOL OF NATURAL SCIENCE, B.A., HONOURS BOTANY 2ND CLASS, 1967  
(Also M.A., 1970)

FACULTY OF BIOLOGICAL SCIENCES, DOCTOR OF PHILOSOPHY, 1970  
Examiners - Prof. A. J. Cain and Dr. W. T. Stearn,  
Supervisor - F. White,  
Thesis - "Numerical Techniques in Plant Taxonomy".

### Present position

LECTURER in Department of Biology, University of Southampton, U.K.  
since Oct. 1970. Permanent position confirmed 1973.

### Publications

Bisby 1970, The evaluation and selection of characters in Angiosperm taxonomy: an example from Crotalaria, New Phytol. 69, 1149-1160.

Bisby 1973, The role of taximetrics in Angiosperm taxonomy. I. Empirical comparisons of methods using Crotalaria L., New Phytol. 72, 699-726.

Bisby and Polhill, R.M. 1973, The role of taximetrics in Angiosperm taxonomy. II. Parallel taximetric and orthodox studies in Crotalaria L., New Phytol. 72, 727-742.

Bisby and Nicholls K.W. 1976, Effects of varying character definitions on classification of Genisteae (Leguminosae). Bot. J. Linn. Soc. 72, in press.

Also Book Reviews for New Phytol. and Natural History Reviews and annual Seed and Accession lists for the Southampton University Botanic Garden.

### Invited Conference Contributions

XII th International Botanical Congress, Leningrad 1975. (Section 2, Symposium 3, Computers in Systematics and Floristics)  
"Stability in Taximetric Classification".

Systematics Association Symposium, Teaching Taxonomy, Portsmouth 1975. "Are the most important topics in taxonomy covered in undergraduate courses?"

Linnean Society of London 1976, Numerical methods in taxonomy, pollen analysis and plant ecology. "Using numerical techniques to examine taxonomic procedure".

### Courses taught at Southampton (B.Sc. Course)

BY 1.6 Higher Plants : Structure and Function (about  $\frac{1}{3}$ )  
MA 1.11 Statistics, Computing and Numerical Methods for Biologists (about  $\frac{1}{3}$ )  
BY 2.2 Population Biology and Taxonomy (about  $\frac{1}{3}$ )

3rd Year courses

BY 3.16 Principles of Classification in Science  
BY 3.3 Plant Taxonomy

1st year Botany field course in Systematics - 2 weeks duration (held in Ireland, 1971, and Vorarlberg, Austria, 1972 and 1973, Andalucia, Spain, 1974-6).

### Research projects in progress

1. Formulation of taxonomic characters for taximetric classification of Angiosperms (Science Research Council Grant B/RG/3163 Oct. 72 - Sept. 74). (with Research Assistant, K. Nicholls, B.Sc.)

To investigate the relationship between observed plant variation, the loosely defined taxonomic characters used by orthodox Angiosperm taxonomists, and the rigidly formulated characters used in taximetrics. The effects of varying procedures will be investigated for each of three stages:-

- (a) Formulation of comparative characters (includes initial recognition, precise formulation and possibly later adjustment).
- (b) Selection or weighting of characters.
- (c) Coding of taxonomic data for computer processing.

The species of Genista, Cytisus and related genera of the Genisteae are used as the base for the investigation.

2. World-wide classification of Crotalaria L. using taximetric techniques. Much work on African Crotalaria is complete (Bisby and Polhill 1973). This project temporarily held up while S. American species are revised. Visit to Brazil supported by Royal Society Grant and New York Botanic

Garden funds July - Oct. 1973.

3. Use of data-retrieval systems to improve speed and efficiency of taxonomists' treatment of very large and/or geographically wide-spread groups. Presently implementing the TAXIR programme on a CDC 7600 computer (with Departmental Programmer Mrs. A. Wardle, B.Sc.).
4. To examine the relationship between classifications of the same taxa based on different kinds of information with a view to providing an alternative to the 'non-specificity hypothesis'. Species of Genisteae (Leguminosae) are used (with Miss J. Harris reading for a Ph.D., supported by a Science Research Council Studentship).
5. To experiment with the use of karyotype data in taximetric plant classification. Species of Narcissus are used. (with Miss T. Almeida reading for a Ph.D. supported by Coimbra University Botany Department).
6. To experiment with information on pollinator behaviour and floral morphology and chemistry to test an "adaptive specificity hypothesis". (with Miss M. Adey - planned for 1976 - 7.)

Other particulars

Botanical Secretary of the Systematics Association since 1968.

Member of the Council of the Classification Society (1976 - 9).

APR 23 1975

## DATE RECEIVED:

Initial

Abbott, Lois  
 April, Jay  
 Bailey, Mark  
 Bishop, Judy  
 Borsuk, Ronnie  
 Bryant, Peter  
 Emery, Don  
 Fellay, Helga  
 Gruidel, Ed  
 Hanley, Jim  
 Hersh, Gil  
 Kalin, Nancy  
 Kaltenhauser, J.  
 McArthur, Greg  
 Rawal, Kanti  
 Rogers, Connie  
 Rogers, Dave  
 Schiffman, R.  
 Shafton, Allan  
 Sim, Bev  
 Snow, Jim  
 Snyder, Max  
 von Borstell, G.  
 Weinert, J.  
 Welner, Steve

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SO9 5NH

TEL. 559122  
EXT. 2444  
TELEX 47861

FAB/AP

15th April 1976

Dear Dave,

I am just back from a two-week field course for our undergraduates and off again tomorrow for a week collecting Genisteae material in Italy, so please excuse the brevity. By taking on this field work this Easter I hope to leave myself free of vacation commitments next year.

For how long should I try to visit you next year Dave? Do you think two months or two one-month visits would be about right? At present I am free 10th December 1976 - 10th January 1977, 23rd March 1977-23rd April 1977 or for a slightly longer period in the summer. I think the time is right for writing the book now and that if possible, we should get on with it this next academic year rather than delaying until I have sabbatical leave the following year.

I should be able to maintain myself in Boulder on the salary that I draw here so the funds you should look for will be simply one or two transatlantic air fares. In addition I imagine you can supply a desk to sit at and some typing help within your organisation.

I will have a curriculum vitae typed and in the post to you in ten days time when I am home again.

Best wishes.

A handwritten signature in blue ink that reads 'Frank'.

Frank Bisby

Handwritten initials 'RB' in blue ink.  
D. J. Rogers,  
1229 University Avenue,  
University of Colorado,  
Boulder,  
Colorado 80309



DEPARTMENT OF BIOLOGY



MAY 10 1976

BUILDING 44,  
THE UNIVERSITY,  
SOUTHAMPTON  
SO9 5NH

TEL. 558122  
EXT. ~~2400~~  
TELEX 47661

29.4.76.

Dear Dave,

Here is the Curriculum vitae you asked for.

Best wishes

Y  
Frank.

25 Oct 1976

Dear Frank:

I have waited until now, because it seems to take my former team an inordinate amount of time to do anything. I say former, because I have cut them out of the Taximetrics Lab., but unfortunately, they are the only ones now who can do such things as run off tapes. Now, it seems that they are about to run off a TAXIR tape (which name I hope you will maintain, even though the word EXIR may now be appended to it).

On the book, I think it best to prepare a "prospectus" to send to various publishers. I have talked to several representatives who come around to sell books, and they all think it best to prepare such a work, and to add to it our own little personal history. The latter needs only a small sketch. I send herewith a copy of that which appeared in a fairly recent "Who's Who". Lois, who will work with us, is still doing her PhD under me (or rather, I'm the administrative director, and two others, one a mathematician, one a cyto-geneticist, are the real directors of her research). She is however, rather well experienced by having taught Taximetrics here while I was gone. Her earlier training includes a math degree from Harvard. Now, she is either a "mathematically-oriented biologist" or a "biologically-oriented mathematician", and I'm not sure which is more important to her.

I have just read Farris' review of the book by Clifford & Stevensen. I have not seen the book itself, although the way Farris wrote about it, I should really see it, since Farris says it is so bad! Farris does justly point out that most of those starting in on numerical taxonomy do so without having done the hard work of setting their own statements about what the goals are. In a sense, what we are trying to do is Dodge the issue, but on the other hand, I think we make the point that one use of taxonomic results is as an information science in biology. To that extent, we have a stated goal. I doubt that that would satisfy Steve Farris, however. If this is our stated goal--to indicate that the information-carrying content of a classification is a justification (or one of them) for taxonomy then I believe that this does something else as well, and that is to keep us from having to get into cladistic or phylogenetic discussions. I say this because there are so few data for making decisions that more hypothesis is at work, and that we are not intent on such. I still am not that strongly opposed to evolutionary (?) computer-aided analyses that you can't convince me that we should ~~exclude~~ it, but convince me you must.

Hopefully, a tape of TAXIR will be on its way to you soon. Looking forward to hearing from you.

Please try to convince the publishers in the UK, as I will try to convince those in the US.

I am off on my last trip for genetic resources work coming next week, to be gone until Nov. 21. We will have to get moving if we're going to get on with the work.

Yours,



FAB/AP

3rd September 1976

Dear Dave,

*I dictated this before going on holiday  
and it should have been sent off by the  
secretary - alas, not!*

I'm afraid my last letter was written in great haste Dave, as we had to make a decision about Mrs Settar before I go on holiday today.

First, I look forward to meeting Louis and presumably the three of us working over the principal chapters of the book next Easter. I hope to be in Boulder on the weekend before March 23rd so as to have a day to acclimatize and find somewhere to sleep before getting down to it. I shall write to one or two of my old friends in Boulder to see whether they have a room they could spare me for a month.

I thought you would dislike the idea of a chapter on phylogenetic deduction when I wrote it! The question really is how to treat something that we think unimportant but which others value. Do we just omit it or will it be more persuasive to include it briefly with an opportunity to say why we think it irrelevant? What do you think?

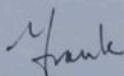
Have you read Farris's review of "Introduction to Numerical Classification" by Clifford and Stevenson in *Systematic Zoology* 25 (2)? It's worth reading just to see some of the problems in presenting a book to society. I know that Joyce Lambert was writing a book which she gave up - partly through lack of a cohesive theory or attitude, partly because Clifford and Stevenson's book stole her thunder (it was primarily ecological) and she was part of the 'Australian school' (or non-school) when it started in Southampton (Williams Lance Watson Lambert) before three of them emigrated to Australia. I think we need to know what is in George Estabrook's little book too. I think it is a guide to Graph/Charanal/Taxir for environmental scientists.

Secondly, could you possibly send me a recent version of Taxir or GR/CIDS? Unlike two years ago I now have a string of potential users and am planning two grant proposals both of which would need a working version. Our computer programmer let us down badly during the last year and we never had the early Taxir working smoothly. We now have a new more knowledgeable person who has just started and I have hopes of making this his No. 1 priority. If you could send an up to date version that runs on CDC 7600 Scope 2.1.3 or failing that CDC 6600 Scope 3.4, this would open the doors for a lot of work here - for which I'd be most grateful. You could do as before, that is, send the program on a mini-tape with a bill for the cost of the tape.

I'd like to discuss the grant proposals with you Dave, but I think that had better wait till they are better formed in my mind.

Best Wishes.

Yours sincerely,



Dr. F. A. Bisby

 Mr. D. J. Rogers,  
Taximetrics Laboratory,  
1229 University Avenue,  
University of Colorado,  
Boulder,  
Colorado 80309,  
U.S.A.

DATE RECEIVED:

SEP 01 1976

Initial

|                     |       |       |
|---------------------|-------|-------|
| Abbott, Lois        | _____ | _____ |
| April, Jay          | _____ | _____ |
| Bailey, Mark        | _____ | _____ |
| Bishop, Judy        | _____ | _____ |
| Borsuk, Ronnie      | _____ | _____ |
| Bryant, Peter       | _____ | _____ |
| Emery, Don          | _____ | _____ |
| Gruidel, Ed         | _____ | _____ |
| Hanley, Jim         | _____ | _____ |
| Hersh, Gil          | _____ | _____ |
| Higgins, Sandy      | _____ | _____ |
| Kaltenhauser, Jerry | _____ | _____ |
| McArthur, Greg      | _____ | _____ |
| Metcalf, Geneva     | _____ | _____ |
| Rawal, Kanti        | _____ | _____ |
| Rogers, Connie      | _____ | _____ |
| Rogers, Dave        | (11)  | ✓     |
| Schiffman, Robert   | _____ | _____ |
| Sellers, Rita       | _____ | _____ |
| Shafton, Allan      | _____ | _____ |
| Sim, Bev            | _____ | _____ |
| Snow, Jim           | _____ | _____ |
| Snyder, Max         | _____ | _____ |
| Vincent, Lou        | _____ | _____ |
| von Borstell, Gail  | _____ | _____ |
| Welner, Steve       | _____ | _____ |
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SEP 01 1976

19 Aug 76

Dear Dave,

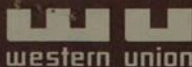
Could you possibly give me a hurried reference on Mrs. Nedret Settar, data management officer of the Aegean Regional Agricultural Research Inst. at Izmir? She has applied to do an M.Phil (masters research 2yr degree) here on "The numerical analysis of biological data". We would like to take her but are a little doubtful of her qualifications and use of English.

Could you possibly send me a quick, candid note of your impressions of her intelligence, motivation and use of English? Unfortunately I need to make a decision by Sept 3.

Thanks for your letter Dave. I'll write again soon.

Yours

Frank



# Telegram

Cables

|                      |              |          |                          |                                                                                                                        |
|----------------------|--------------|----------|--------------------------|------------------------------------------------------------------------------------------------------------------------|
| NO. WDS.—CL. OF SVC. | PD. OR COLL. | CASH NO. | CHARGE TO THE ACCOUNT OF | <input type="checkbox"/> OVER NIGHT TELEGRAM<br>UNLESS BOX ABOVE IS CHECKED THIS<br>MESSAGE WILL BE SENT AS A TELEGRAM |
|                      |              |          | night letter             |                                                                                                                        |

Send the following message, subject to the terms on back hereof, which are hereby agreed to

Sept. 2, 1976

|              |                                               |                        |
|--------------|-----------------------------------------------|------------------------|
| TO           | Frank Bisby                                   | CARE OF<br>OR APT. NO. |
| STREET & NO. | Biology Dept., Bldg. 44                       | TELEPHONE              |
| CITY & STATE | The University, Southampton, England, SO9 5NH | ZIP CODE               |

Re: Nedret Settar. Do not consider her qualifications satisfactory for  
proposed work with you. English understanding is poor. Skills are  
non-numeric and taxonomy nil.

signed: Dave

rs

Operator # 212

9/2, 2:05  
Date/ Time

Confirmation yes

SENDER'S TEL. NO.

NAME & ADDRESS

WU 1207 (R 5-69)

DEPARTMENT OF BOTANY  
BIOLOGY



BUILDING 44,  
THE UNIVERSITY,  
SOUTHAMPTON  
SO9 5NH

TEL. 59122  
EXT.  
TELEX 47661

Prof. D.J. Rogers,  
Taximetrix Laboratory,  
Hale Building,  
Dept. Of Biology,  
University of Colorado,  
Boulder, Colorado, 80302,  
U.S.A.

20th February 1973.

Dear Dave,

I enclose a cheque for 25 dollars to cover your costs of postage, xeroxing and the tape you sent TAXIR on. You should be able to pay it straight into your own bank.

I've now read the TAXIR tape onto the CDC7600 in London and have started working on it. It doesn't compile (of course) but I don't think the FORTRAN changes needed are at all severe.

Last Friday Dr. Brennan (Keeper of the Herbarium at Kew) agreed to give me written support in applying for funds to employ a programmer on this job. He also took well to the idea of me trying to get TAXIR going and then helping others here use it.

Best wishes,  
Yours sincerely,

Frank Bisby.

file

May 24, 1976

Dr. F. A. Bisby  
Dept. of Biology  
Building 44  
The University  
Southampton SO9 5NH  
England

Dear Frank:

Thank you for your letter of April 15. The end of the semester caught me with too much to do to respond earlier.

With respect to your proposed visits, it is very likely that we will have to have more than one period together. But let us arrange that after we have had a one month session. I would suggest that you plan the second alternative mentioned in your letter, i.e. March 23, 1977 to April 23, 1977. I trust that this is agreeable to you.

In the meantime, I will proceed to uncover the necessary financial resources to accommodate your travel arrangements. I assume at the moment that we will be successful and we should not have to worry that we will or will not have those funds available. However, obviously during these times of financial restrictions we must also be prepared that that which we need may not be forthcoming. Sorry to have to put it on these terms, but c'est la vie.

If the above travel is agreeable to you, please let me know and then we will establish some sort of working procedure.

Sincerely yours,

David J. Rogers  
Director

DR:rs

Bisby Per.  
File

MEMO

TO: Dave

FROM: Gil

DATE: May 21, 1976

RE: Discussions on 5/19/76.

One point concerned the scheduling and funding of a work time to plan and develop the "Taximetrics Test". Our specific concern was to find the funds and time to bring together people from this group, Frank Bisby from UK and Lois Abbott.

It was my suggestion that if this piece of work was important enough we would reserve the funds necessary out of the general operating funds (for example, the GRCIDS budget) to bring Bisby to the United States and to support him here both at the cheapest possible rate. The same would be true of Abbott if she left after finishing her degree and before this meeting could take place.

It was discussed that other funds would be sought, for example from a book publisher who might be interested in doing this. I feel that we should in fact attempt to bring other funds in but that if its important enough we make contingency plans to use funds we have available.

With respect to scheduling, Bisby in his letter mentions a series of dates, if I'm not mistaken, they are January-February 1977, March-April 1977, or the Summer of 1977. Although it is not clear at the present time, the earlier date of January might be in conflict with our AC meeting. Other dates are entirely possible.

This is merely a summary of the conversation.

DATE RECEIVED:

FEB 25 1976

Initial

April, Jay  
 Bailey, Mark  
 Bishop, Judy  
 Borsuk, Ronnie  
 Bryant, Peter  
 Emery, Don  
 Fellay, Helga  
 Gruidel, Ed  
 Hanley, Jim  
 Hersh, Gil  
 Kalin, Nancy  
 Kaltenhauser, J.  
 McArthur, Greg  
 Rawal, Kanti  
 Rogers, Connie  
 Rogers, Dave  
 Schiffman, R.  
 Shafton, Allan  
 Sim, Bev  
 Snow, Jim  
 Snyder, Max  
 von Borstell, G.  
 Weinert, J.  
 Welner, Steve

(4)

JCA

(3)

JA

(4)

OK

(1)

RJR

Abbott, Jans

(2)

LA

Filing:

Original

Borby

Copies:

IN

✓ OK

OUT

INTERNAL

Fiscal/Contract

Organization

COMMENTS:

~~Working copy for Dave~~

I think this is very important,  
 and we must do something  
 with it toute de suite!

OK. what should we do  
 Jay

DEPARTMENT OF BIOLOGY



FEB 25 1976  
BUILDING 44,  
THE UNIVERSITY,  
SOUTHAMPTON  
SO9 5NH

TEL. 559122  
EXT. 2444  
TELEX 47861

FAB/AP

17th February 1976

Dear Dave,

Thank you very much for entertaining me so handsomely in London, I was very happy to see you again. I didn't open your letter until mid January on returning from holiday. I've been dreadfully busy since then and delayed replying until I had time to tabulate at least an initial idea for planning the book. It is only a first idea, so do feel free to tear it up and make a fresh start! I think it important to show two attitudes which are missing from other works:-

- 1) Taxonomic services should be seen to service all biologists by attending to their special needs, encouraging them to contribute their own comparative information and arranging for regular feedback.
- 2) The principle information techniques should not be associated with particular taxonomic philosophies.

The techniques can prove useful across the whole spectrum of taxonomic philosophies. Their use is justified on grounds of automation - labour saving, accuracy and repeatability - and of scholastic precision - the ability to state explicitly what process of analysis was used.

Best wishes.

Yours sincerely,

A handwritten signature in dark ink, appearing to read 'Frank'.

F. A. Bisby

D. J. Rogers Esq.,  
University of Colorado,  
Taximetrics Laboratory,  
Department E.P.O. Biology,  
Boulder,  
Colorado 80302

INFORMATION (OR COMPUTER) TECHNIQUES IN (TAXONOMY) BIOLOGY

1. FUNCTIONS OF TAXONOMY - THE INFORMATION SCIENCE FOR BIOLOGY

- functions
- (Could be several chapters - analysis of present situation )
- future needs - input from all biologists
- user feedback

2. (TECHNIQUES FOR) GENERATING INFORMATION FROM OBSERVATIONS

- a) Observations, Characters, Sampling error, Partitioning ranges, Scaling
- b) Characters for particular motives - field identification, cladistic speculation etc.

3. (TECHNIQUES FOR) STORING AND RETRIEVING INFORMATION

- a) Conventional herbaria, Botanic Gardens
- b) TAXIR - for herbaria, monographic projects, gene banks etc.
- c) Kew microfiche system
- d) Primary/Secondary information

4. (TECHNIQUES FOR) ASSESSING INFORMATION

Multiple regression,  $\chi^2$ , CHARANAL, PCA

5. (TECHNIQUES FOR) CLASSIFYING ORGANISMS

Methods - Single-linkage, GRAPH clustering etc.

Interpretation - Probabilistic vs Deterministic, Space-dilation, Detecting natural pattern vs Partitioning continua.

6. (TECHNIQUES FOR) IDENTIFYING ORGANISMS (GIVEN A CLASSIFICATION)

- a) KEY MAKING. POLYCLAVES,
- b) ON-LINE - KEYS, MULTIPLE ENTRY, MATCHING
- c) Discriminant functions, Canonical analysis.

7. (TECHNIQUES FOR) PHYLOGENETIC SPECULATION

- a) Theory behind intuitive approaches
- b) Parsimony approach
- c) Character compatibility approach

8. Selected examples
- General purpose (i.e. morphological) taxonomy
  - Special purpose
  - Phylogenetic speculation etc.

F. A. Bisby

17.2.76

*file*

March 4, 1976

Dr. Frank A. Bisby  
Department of Biology  
Building 44  
The University  
Southampton, SO9 5NH  
England

Dear Frank:

I was pleased to get your letter of the 17th, with the very good set of suggestions for chapter headings for our projected book. About the only one I might argue with is #7, (Techniques for) Phylogenetic Speculation - but that is not a significant argument!

The next thing I think needs to be done is to ask you to propose the time you would like to spend with us on such a book, and what financial arrangements you would need. When you send this information, please also enclose a curriculum vitae. We may be able to spring loose some funds for this purpose from some granting agencies in the United States. The sooner we get started on this, the better; but I suspect that we can't get going on the work until next fall.

Please let me have your response at your earliest convenience.

Sincerely yours,

David J. Rogers  
Director

DR:rs

DEPARTMENT OF BIOLOGY



answering 3/4  
FEB 25 1976  
BUILDING 44,  
THE UNIVERSITY,  
SOUTHAMPTON  
SO9 5NH

TEL 559122  
EXT. 2444  
TELEX 47661

FAB/AP

17th February 1976

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The techniques can prove useful across the whole spectrum of taxonomic philosophies. Their use is justified on grounds of automation - labour saving, accuracy and repeatability - and of scholastic precision - the ability to state explicitly what process of analysis was used.

Best wishes.

Yours sincerely,

F. A. Bisby

D. J. Rogers Esq.,  
University of Colorado,  
Taximetrics Laboratory,  
Department E.P.O. Biology,  
Boulder,  
Colorado 80302

INFORMATION (OR COMPUTER) TECHNIQUES IN (TAXONOMY) BIOLOGY

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- (Could be several chapters
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  - analysis of present situation
  - future needs
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- c) Character compatibility approach

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- General purpose (i.e. morphological) taxonomy
  - Special purpose
  - Phylogenetic speculation etc.

F. A. Bisby

17.2.76

B. 367

December 15, 1975

Frank A. Bisby  
Botany Department  
The University, Southampton  
SO9 5NH, UK

Dear Frank:

I am very glad that we had the chance to meet and I certainly appreciate the fact that you took time out from the visit with your parents to come into London on Saturday night. I am very excited about the opportunities for cooperation with you with respect to a textbook on taxonomy as the information science for biology. I hope we can proceed along to develop the concepts and ideas on this and get started with the work which is of mutual concern for us both.

I talked to Francis Lupton about you and your colleague's concern to do some work on Phaseolus. Lupton states that there are people at Cambridge also concerned with the same genus and that he would be pleased to introduce you to that group (unfortunately I do not remember their names), but that might be an interesting start if you have desires for a concerted effort for further studies in that highly significant group. I do not know yet how, but it seems to me that there should be some means to support the kinds of work that you care to do, inasmuch as there is worldwide interest in the crops derived from this genus.

I look forward to your recommendations with respect to an outline of the book as discussed above.

Thanks again for coming in to visit with me last Saturday night and best wishes for the Christmas season.

Sincerely,

David J. Rogers

DJR:hfr

*Bisby*

November 18, 1975

Dr. F. A. Bisby  
Department of Botany  
The University of Southampton  
Southampton SO9 5NH  
England

Dear Frank:

I hope to be in the UK on Saturday, December 6, and would like a chance to visit you either the evening of that day or the next, Sunday the 7th, before going to Cambridge to the Plant Breeding Institute. Will you be available then? I will try to call you from Rome before coming to London to give you final details of flights, times, etc.

Looking forward to seeing you.

Sincerely,

David J. Rogers

DJR:hfr

Mar. 7, 1973

Dr. Frank Bisby  
The University, Southampton SO9 5NH

Dear Frank :

Thanks for your letter of the 20th Feb., with enclosed check. I had quite forgotten that you were going to send any money--you could have saved yourself some cash!

I hope you can get TAXIR up and running over there--it would be nice to see it working there. In connection with the program, I am enclosing a program description of "TIDY" which might be helpful in cleaning up the program as it came to you, and sort out some of the problems. We have the program running here, and we might be able to get a listing for you, if you want it.

I am leaving tomorrow for Rome to participate in a Technical Conference on Genetic Resource Centers, at FAO. Hopefully, we will learn there whether there will be continuing action to establish these centers, and what fate, if any, there is for TAXIR as the IR system. When and if I learn anything of interest to you in this connection, I will certainly let you know.

We did get most of the work for a Pilot Study of potato data done, but not everything we wanted. However, we will demonstrate our results at the conference.

Let me hear how you're progressing with TAXIR, and if there are any problems. Just to keep me informed, I hope you will write me first about it, rather than any of the other members of the old team.

Thanks, and sincerely,

David J. Rogers  
Prof. of Biology

Encl.

Mr F. White, Forest Herbarium  
Dept. of Forestry  
Commonwealth Forestry Inst.  
University of Oxford, OXI 3RB

FW/C

12 January 1971

Professor David J. Rogers,  
Professor of Biology,  
Dept. of Biology,  
Armory 101,  
University of Colorado,  
BOULDER, Colorado 80302

Dear Dave,

If you have not already been told, I am sure you will be pleased to know that Frank Bisby has successfully completed the requirements for the Degree of Doctor of Philosophy of this University. His oral examination was held just before Christmas and his examiners, Professor A.J. Cain and Dr W.T. Stearn, were obviously very pleased with his thesis.

As his Supervisor, I would like to acknowledge the considerable stimulus and help he received from you and your colleagues when he visited your Department two years ago.

I hope all goes well with you.

With best wishes,

Yours sincerely,

*Frank*

F.White

P.S. Give my  
Christmas  
regards to any of the others  
still around - Apper, Henry etc

Botany Dept  
University  
Southampton  
SO9 5NH

MERRY CHRISTMAS AND A  
HAPPY NEW YEAR

Dear Dave,

What news from Boulder? I'm just settling  
in to my new job here. The department  
here is fairly well orientated for taximetric  
work, with a programme, punches and a fair  
amount of mathematical/statistical work going on.

I was very sorry Dave, to hear from Marie  
Lora about the final dissolution of the taximetric  
lab. She was in Europe this summer and visited  
me briefly. It must have been so disappointing.

I submitted my D.Phil thesis in June and  
was examined (successfully!) a few days ago  
by Storch and Cain. Thank you very much  
for your tuition and help while I was in  
Boulder. It really is very much appreciated.

My paper in New Phytologist came out in  
October. I'll send you a packet of reprints  
in the next few days.

The Charanad programme is now running  
at the Atlas Computing Laboratory (Chilton, Didcot, Berks, England)  
under the careful eye of Mrs. S. Hockey. I have  
enclosed a slip of paper giving this information with  
all the reprints I've sent out in Europe. The people  
seem to write in for reprints from the oddest places -  
Portugal, Poland etc.

U.S.A.  
BOULDER, COLO., 80302  
UNIVERSITY of COLORADO  
Department of Biology  
Professor D.J. Rogers



PAR AVION AEROGRAMME  
BY AIR MAIL  
AIR LETTER

SECOND FOLD HERE

Designed by Peter Gault FSA and printed by McCordquodale & Co Ltd.  
The Stamp: Angel, East Harling, Norfolk. 15th Century.  
Front: The Nativity, Great Malvern Priory Church, Worcestershire. 15th Century.  
Above: Adoration of the Shepherds, East Harling, Norfolk. 15th Century.  
Early English stained glass

An air letter should not contain any enclosure: if it does it will be surcharged or sent by ordinary mail.



Sender's name and address  
F A BISHOP  
BOTANY DEPT  
UNIVERSITY  
SOUTHAMPTON  
SO9 5NH

TO OPEN SLIT HERE

TO OPEN SLIT HERE

Do keep me in touch with yourself and/or taxonomic developments here. By the way, you will be interested (if not enthralled by!) The Nicole Tardieu's book "Mathematical Taxonomy" that is coming out this month.

Best Wishes to you and your family  
Frank

P.S. At last Stearn is publishing his work on Opplonia  
Digitized by the Herbarium Institute for Botanical Documentation

St John's College  
Oxford

20th July 1969

Dear Dave,

After a few days at home, I'm now trying to get back into the swim of things here. My memories of some of our conversations are still very vivid & it seems as though I have a great deal to communicate to Mr White. He should be back from Paris next Monday. While he's away the secretary and lab. technicians have gone on holiday so I can't easily find out yet whether he sent a 'testimonial' to C.U. or not. Unless it was done in the 2 days before he left (unlikely) I am certain it will not have been done yet.

I'm should have the typed script of the report I left by now. Could you possibly send me at least one copy for Mr White and include with it any of your comments, either separately or written in the margins? Not only do I have to give him an account of my activities and study but also he has to be able to report on my work to the Trustees of the Fund that pays my Scholarship, so that it can be extended for a third year. (about the conference ~~there~~)

As yet I don't have any word from Tardieu at Cambridge, but possibly he's on holiday just now.

I've learned a great deal while I was at Boulder, Dave, and I don't know how to thank you enough for making the whole trip possible. I shall do my best to communicate with people over here. Thank you very much.  
(Bridg)

TELEPHONES: OXFORD  
55757 PROFESSOR  
57851 DEPARTMENT  
FAB/C

DEPARTMENT OF FORESTRY  
COMMONWEALTH FORESTRY INSTITUTE  
UNIVERSITY OF OXFORD OXI 3RB  
10 September 1969

AIR MAIL

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

Dear *Dave*

Please give my thanks to Geneva or whoever it is that is dealing with my mail. I have now received a copy of the report that I wrote for you, all the parcels I left behind and a good deal of mail that was addressed to me at the Armory.

You did not include any comments with the copy of the report that was sent on to me. Does this mean that you don't have any? Please do let me know if there was anything in it that you would argue with.

Dare I ask what is the present situation for the Taximetries Lab. ? Frank White sent an excellent letter of recommendation in response to your request. I hope it arrived in time.

... I am enclosing just one paragraph of the paper on character analysis that I am writing at the moment. I am trying to make the paper readable to botanists and have avoided undue reference to mathematical formulae or to programming and computer activities. I am doing this by referring to the mathematical appendix in George's paper (Taxon 1967) and separating the details of the CHARANAL programme into this appendix for this paper. Please would you help me by looking this through and checking some of the facts for me, possibly with George or Bob. The statements on the CHARANAL performance about 200 comparisons per minute of C.P.U. time is based on my memory alone. As far as I remember repeated runs of one experimental character against about 50 others each took about 15 seconds C.P.U. time. Could you also please confirm that your address is and will remain at the Armory building?

Could you also let me know whether acknowledgment for my finances at Boulder should be made to you or to some particular grant from the N.S.F.?

Do you remember the name of Dr. A.J. Richards in the Botany Department here with whom you planned to examine specimens here in Oxford? He is an

/over

expert in the genus Taraxacum and would like to use ~~the~~<sup>a</sup> clustering technique for recognizing some groups in the progeny of some breeding experiments. I have told him that you will be willing to run his data on the Graph programme at Boulder. He says he doesn't see any reason why the Botany Department should not pay the bill in dollars. I shall endeavour to interest him in some preliminary Character Analysis but I am doubtful if this will meet with much response. Can you confirm that this will be O.K. and possibly send him the two pamphlets, one describing the deck set-up and the other describing the interpretation of the output. Could you also send to me (surface mail will do) two or three copies of these pamphlets so that I can give them to people interested in these methods?

Please give my best wishes and regards to Henry, George and Bob, and Gill!

Yours sincerely,

*F.A. Bisby*

F.A. Bisby

10 Appendix : CHARANAL, a computer programme for character analysis

This programme performs comparisons between pairs of characters. For each pair the following quantities are calculated and printed out :- Conditional probabilities; information content of each; information quantity held in common and information quantity held in common expressed as a fraction of the information content of each. The individuals missing data in one or both of the characters are listed and eliminated from the computation.

The user <sup>specifies</sup> ~~specifies~~ which of the characters he wishes to compare. In an initial character analysis this will usually be all of the possible  $\frac{n(n-1)}{2}$  comparisons amongst  $n$  characters. In subsequent runs one or a few experimentally formalised characters will be compared with the remainder.

The programme CHARANAL is written in FORTRAN for the C.D.C. 6400 and requires only a minimal amount of core storage. Details and a listing are available from :- Prof. D.J. Rogers, Taxidmetrics Laboratory, 101 Armoury, University of Colorado, BOULDER, Colorado 80302, U.S.A.

Using the C.D.C. 6400, processing was at the rate of about 200 comparisons per minute of central processor time.

Forest Herbarium,  
Dept. of Forestry,  
Commonwealth Forestry Institute,  
University of Oxford.

Ox1 3RB October 9 1969

Professor David J. Rogers,  
Taximetrics Laboratory,  
Dept. of Biology,  
ARMORY 101,  
University of Colorado,  
BOULDER, Colorado 80302.

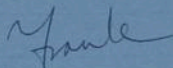
Dear

Dave

I am now looking round for a job for next year and wondered if I could give your name as a referee? In particular there is one appointment for which the application has to go in by the 20 October. I have assumed that you will be willing to act as referee for this. I hope this is all right. It is a job on a research project concerned with information retrieval of biological abstracts from the literature.

The main work on the paper that I am writing on Character Analysis is complete but I am afraid it is taking much too long getting it approved by Mr. White. I have been trying my best to hurry him on this but it will certainly be some time yet before it can go to the press.

Yours sincerely,



F.A. Bisby

Thank you everybody for giving me such an exciting  
time over here. Good-luck in fund-hunting in the  
next few weeks. I have great memories of this place

Frank

12 May 1969

This is to certify that Mr. F. A. Bisby is in academical residence  
and is pursuing biological studies.

David J. Rogers  
Professor of Biology

# UNIVERSITY OF COLORADO FACULTY

REQUEST FOR APPOINTMENT, REAPPOINTMENT, OR CHANGE OF STATUS  
INSTRUCTIONS FOR PREPARATION: SEE REVERSE SIDE OF LAST COPY

DISTRIBUTION  
1. DEAN OF FACULTIES  
2. DEPT. PROCESSING  
3. DEPT. OF COLLEGE  
4. DEPT. ADMISSIONS & RECORDS

UCDF-1 APRIL 1968  
5. DEPT. CHAIRMAN  
6. DEPT. OF COLLEGE  
7. APPOINTMENT  
8. RETAIN IN DEPT. OFFICE

|     |                                                                                                                                  |                                  |                    |                                                                                   |                        |                             |
|-----|----------------------------------------------------------------------------------------------------------------------------------|----------------------------------|--------------------|-----------------------------------------------------------------------------------|------------------------|-----------------------------|
| (a) | <input type="checkbox"/> MR <input type="checkbox"/> MRS <input type="checkbox"/> MISS<br><input checked="" type="checkbox"/> MR | NAME (LAST IN CAPS) <b>BISBY</b> | FIRST <b>Frank</b> | MIDDLE/MAIDEN <b>A.</b>                                                           | SOCIAL SECURITY NUMBER | DATE <b>21 October 1968</b> |
| (b) | RANK OR TITLE<br><b>Graduate student</b>                                                                                         |                                  |                    | CITY/STATE (SPECIFY COUNTRY)<br><b>England</b>                                    |                        |                             |
| (c) | DEPARTMENT OR PROJECT TITLE<br><b>Research Assistant</b>                                                                         |                                  |                    | PRESENT MAILING ADDRESS<br><b>Forest Barbarian, University of Oxford, England</b> |                        |                             |
| (d) | ACCOUNT NUMBER (DEPT. NO. SUB. R.C. OBJECT CLASS)<br><b>1708 - 43 - 2 - 200</b>                                                  |                                  | POSITION NUMBER    |                                                                                   |                        |                             |

(SUBMIT THE ABOVE INFORMATION IN ALL CASES, AND USE SPACE PROVIDED BELOW TO DESCRIBE SPECIAL CONDITIONS OF EMPLOYMENT.)

We recommend that the above named:

1. ☒ Be APPOINTED ☐ Be REAPPOINTED TO THE POSITION DESCRIBED ABOVE FOR THE PAY PERIOD AND DATE INDICATED BELOW AT A SALARY OF **300/month** AT **50** % OF TIME [EFFECTIVE DATE IF OTHER THAN BEGINNING OF PAY PERIOD: MONTH: (DAY) (YEAR) AND ENDING: MONTH: (DAY) (YEAR)]
 

|            |                                                                                                                                                                                      |                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |                                                                                                                                                                                                    |
|------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| PAY PERIOD | <input type="checkbox"/> ACADEMIC YEAR<br><input type="checkbox"/> FALL SEMESTER<br><input type="checkbox"/> SPRING SEMESTER<br><input type="checkbox"/> 8 WEEK SUMMER HALF SEMESTER | <input type="checkbox"/> FISCAL YEAR BEGINNING (MONTH) (DAY) (YEAR) AND ENDING (MONTH) (DAY) (YEAR)<br><input checked="" type="checkbox"/> SPECIAL PERIOD BEGINNING (MONTH) (DAY) (YEAR) AND ENDING (MONTH) (DAY) (YEAR)<br><input type="checkbox"/> MONTHLY RATE BEGINNING (MONTH) (DAY) (YEAR) AND ENDING (MONTH) (DAY) (YEAR)<br><input type="checkbox"/> SUMMER OTHER THAN 8 WEEK HALF SEMESTER BEGINNING (MONTH) (DAY) (YEAR) AND ENDING (MONTH) (DAY) (YEAR) | <input type="checkbox"/> SUMMER ONLY, OR ONE YEAR OR LESS<br><input type="checkbox"/> 2 YEARS <input type="checkbox"/> 3 YEARS <input type="checkbox"/> WITH TENURE <input type="checkbox"/> OTHER |
|------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
2. ☐ Be TRANSFERRED FROM (DEPARTMENT OR PROJECT TITLE) (ACCOUNT NUMBER) (POSITION NO.) TO (DEPARTMENT OR PROJECT TITLE) (ACCOUNT NUMBER) (POSITION NO.) AT A SALARY OF \$ ( ) AT ( ) % OF TIME PER (ACADEMIC YEAR, SEMESTER, OR TERM) AS OF (EFFECTIVE DATE) REASON ( )
3. ☐ Be CHANGED IN RANK OR TITLE AS OF (EFFECTIVE DATE) REASON ( )
4. ☐ Be CHANGED IN SALARY FROM \$ ( ) AT ( ) % OF TIME PER (ACADEMIC YEAR, SEMESTER, OR TERM) TO \$ ( ) AT ( ) % OF TIME PER (ACADEMIC YEAR, SEMESTER, OR TERM) AS OF (EFFECTIVE DATE) REASON ( )
5. ☐ Be GRANTED LEAVE ☐ WITH PAY ☐ WITHOUT PAY FOR (ACADEMIC YEAR, SEMESTER, OR TERM) REASON ( )
6. ☐ Be TERMINATED (SEMESTER, TERM OR LAST DAY OF SERVICE) REASON ( ) REAPPOINTMENT WITHIN THE UNIVERSITY ( ) ACCEPTED A POSITION IN ANOTHER UNIVERSITY ( ) ACCEPTED A POSITION IN INDUSTRY ( ) OTHER (STATE IN SPECIAL CONDITIONS)

SPECIAL CONDITIONS: CONCURRENT APPOINTMENTS, FULL-TIME PROBATIONARY SERVICE AT OTHER INSTITUTIONS, ETC. (SEE INSTRUCTIONS.)

**Two-degree graduate student**

|                                           |                                |                                                                                         |
|-------------------------------------------|--------------------------------|-----------------------------------------------------------------------------------------|
| PROJECT DIRECTOR<br><i>[Signature]</i>    | DEAN OR ADMINISTRATIVE OFFICER | APPROVED FOR THE PRESIDENT OF THE UNIVERSITY<br><b>Ernest E. Hallstrom</b><br>12-4-1968 |
| DEPARTMENT CHAIRMAN<br><i>[Signature]</i> |                                | FUND CLASSIFIED AS RESEARCH ACCOUNTANT                                                  |

January 2, 1969

The Secretary  
University Chest  
16/20 Wellington Square  
Oxford, England

Dear Sir:

This is to certify that F.A. Bisby has taken  
up academical residence at the University of  
Colorado, Boulder, Colorado, U.S.A.

Sincerely,

David J. Rogers  
Professor of Biology  
Project Director

1, Tragells  
Avenue Road  
Farnborough  
Hants

20 Dec 1968

Dear Professor Rogers,

Thank you for your letter, which probably crossed mine in the post.

I should have mentioned in my previous letter that the University have accepted me as an International Student and put me in touch with the Foreign Student Center who have reserved me a room in a Hall of Residence.

I have booked a ticket on the TWA flight 155 Kennedy → Denver arriving at Denver 10.50 (M.S.T) Dec 31st. ~~and with help~~ Thank you for offering to have someone meet me

Yours sincerely  
F.A. Bisby.

F.A. Bisby.

DEC

DEC 9 1968

FAB/C

Forest Herbarium, Dept. of Forestry,  
Commonwealth Forestry Institute,  
University of Oxford, OXI 3RB.

3 December 1968

Dear Professor Rogers,

I think I have now completed all the formalities for coming to Boulder for the beginning of January, that is, I have a student visa, air ticket and travel grant from Oxford. I shall be arriving in New York on December 31 and should be in Boulder on January 1.

The Foreign Student Centre has been very helpful and I understand a room has been booked for me in a Hall of Residence.

I shall be sending various items, mainly reprints and xerox's through the post addressed to myself c/o your Taximetrics Laboratory, which should await my arrival please.

I look forward to seeing you at Boulder on January 1 or 2.

Yours sincerely,



F.A. Bisby

Professor David J. Rogers,  
Taximetrics Laboratory,  
Dept. of Biology,  
University of Colorado,  
BOULDER, Colorado, U.S.A.

AEROGRAMME

2 December 1968

Mr. Frank A. Bisby  
Forest Herbarium, Dept. of Forestry  
Commonwealth Forestry Institute  
University of Oxford  
Oxford, England

Dear Mr. Bisby:

Since we haven't heard from you recently, we are assuming that the Admissions and Graduate School offices are taking care of you. ~~Inter~~campus communications do tend to get bogged down.

Regarding fees: a minimum tuition charge of \$39 permits you to take up to three credit hours, which can be independent study. The student fee is optional (\$46.20) but it includes the services of the student health service, insurance, and other fee-supported activities.

We understand that your housing in a university dormitory is being taken care of.

Let us know about your travel plans, when you have them confirmed, and we will try hard to have someone at the Denver airport to meet you.

Sincerely yours,

David J. Rogers  
Professor of Biology

DJR:gm

10 October 1968

Mr. Robert Hefling  
Regent 125  
Campus

Dear Mr. Hefling:

Enclosed is the application from Mr. F. A. Bisby for recognition as a non-degree graduate student here. Mr. Bisby, who is at present enrolled at Oxford University, England, has been accepted by us as a graduate research assistant for six months beginning January 2 through the end of June 1969. His objective in being here is to work in our laboratory discovering computer methods for biology.

Would you be kind enough to process his papers and send him the necessary visa application forms? If more information is needed please let me know.

Thank you for your efforts.

Sincerely,

David J. Rogers  
Professor of Biology

DJR:gm

Oct 18 - accepted, immigration form sent

6463

Forest Herbarium, Dept. of Forestry,  
Commonwealth Forestry Inst.,  
University of Oxford.

1 October 1968

Professor David J. Rogers,  
Taximetrics Laboratory,  
Dept. of Biology,  
University of Colorado,  
BOULDER, Colorado, U.S.A.

Dear Dr. Rogers,

Thank you for your letter and enclosures. We too have red tape and it has taken me a week to obtain a degree certificate and a College letter, the nearest Oxford equivalent to a transcript. There are no such things as "semester hours" or "grade points" at English Universities so I have had to leave this part of the form empty.

From reading the various pamphlets that you have sent, it is clear that I am eligible to apply to be a non-degree student, so obtaining library and student facilities (this is important for cheap travel facilities) and avoiding income tax difficulties. I decided to send the forms to you so that before sending them in you could perhaps add a note to the effect that you are going to pay me a graduate research assistant's grant. (They should go direct to the Graduate School, Regent 125, University of Colorado, etc., and not through the Biology Dept.) Could you please send these on?

I have assumed in my budgeting that I shall have to pay the student's fee for the Spring semester, but that I shall not have to pay tuition fees unless I am obliged to sign on for courses, in which case I pay at the resident student rate. Can you please confirm this and let me know if I have overlooked any other fees (such as Health Scheme?).

As a result of my decision to apply for recognition as a student I have not filled in the Petition form. Instead I shall need "Immigration and Naturalization Service" Form I-20A from your Admissions Office. This will enable me to go to the U.S.A. Embassy in London and obtain a student's visa fairly easily.

Yours sincerely,

F.A. Bisby

10 October 1968

Dean Lawson Crowe  
Regent Hall  
Campus

Dear Dean Crowe:

I have agreed to have Mr. Frank A. Bisby as my graduate research assistant at the rate of \$300 a month, chargeable to my research grant, account #1708-48, for the period January 1, 1969 to June 30, 1969.

Mr. Bisby will be working on problems in computer methods for Biology.

I have known Mr. Bisby's major professor for some time and have the highest confidence in his ability.

Sincerely,

David J. Rogers  
Professor of Biology

DJR:gm

9. 15. 68. 11:25 Am.

Dave:

The Naturalization and Immigration service  
(Denver, 297-3526) will send us ~~an~~  
Form I 29 B which we must return to  
them.

The person for whom we apply must be  
one of exceptional and scarce "talent".

Instructions should also be included.

JH

P.S. 11:45. <sup>ref.</sup> Mrs. Owen

ref:

1. if person to be employed as  
"Graduate Research Assistant"  
must be student  
enrolled with course load.  
~~and~~ "Independent" study a possibility.

P.

Forest Herbarium,  
Dept. of Forestry,  
Commonwealth Forestry Inst.,  
University of Oxford.

28 August 1968

Dear Dr. Rogers,

Thank you for your letter and duplicate official grant offer, which I am pleased to accept.

It is most kind of you to offer to help me in organising my accommodation. I have little idea of what arrangements are normal for a Boulder graduate student, what to expect or how much to pay. If I write down here what I do and prefer in Oxford, I'm sure you can deduce what sort of arrangement I should prefer at Boulder, bearing in mind that I shall be living on \$275 per month January to June.

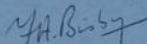
In Oxford the price of rooms is inflated by excessive demand and consequently it is much cheaper to live in a college (vaguely equivalent to a Hall of Residence) or a college-owned house, than in rented flats or bed-sitting rooms. In addition, I am reasonably sociable, like to meet people and prefer eating cheaply in student restaurants, to cooking for myself. So I think, if at all possible, my first choice would be to live in a Hall of Residence (not necessarily restricted to graduates), and only if this is not possible, in a rented bed-sitting room. In the latter case proximity to the Biology Department and to the Campus or student restaurant facilities would be more important than the quality of the rented room. (For instance, cooking and laundry facilities, or telephone, not necessary).

At the moment I am paying about one quarter of my student grant for a rented room, as I have already had my quota of 2 years in college. This is on the cheap side.

Is this information sufficient to guide you? Let me know if there are any queries about this.

Could you please let me know on what date you would like me actually to start work in the Biology Dept.? I ask this as I'm not quite sure whether to cross the Atlantic before or after Christmas.

Yours sincerely,



F.A. Bisby

19 September 1968

Mr. F. A. Bisby  
Forest Herbarium  
Dept. of Forestry  
University of Oxford  
Oxford, U.K.

Dear Mr. Bibby:

Governmental red tape has raised its ugly head. What you and I thought would be a very simple arrangement for your coming to work with us now turns out to be a matter of visas et al.

As I see it two alternatives exist to get you into this country and to allow you to work with us.

1. Come to this country as "Nonimmigrant temporary worker or trainee" (see form with this title, enclosed).
2. Apply for recognition as a graduate student at the University of Colorado, non-degree candidate.

Some of the considerations in choosing which of these two courses to follow - if you choose number 1 above then you will not have the opportunity to live in any of the University residence halls; whereas if you choose number 2 alternative you will have that opportunity as well as some other values such as unrestricted use of the library.

If I were making a choice myself (trying to equate my desires with yours) I would choose the first alternative because I do not believe that you are concerned with having any formal recognition with having worked with us. Certainly I would be glad to give you a letter ~~at~~ the end of your period here which documented your work with us. I would think that this would sufficiently well to establish this historically.

Whichever alternative you choose, will you please act upon it immediately. As I see it, it will be necessary for us here to fill in the U. S. Department of Justice form entitled "Petition to Classify Nonimmigrant as Temporary Worker or Trainee." However, please note in this form that some information is required from you and I will ask you to provide these pieces of information so that I may proceed with the filing of this form. I will ask you to fill out the numbered boxes 5, 12a, 13, 14, 15, 16, 17, 18 and 19. You will notice in the instructions on the back of the form that certain documents must accompany this application. Please provide me with these documents at your very earliest convenience.

To: F. A. Bisby

19 September

2.

I am sorry that this red tape has interfered with what otherwise would be a simple matter, but such is not possible, I fear. In answer to your query concerning what dates would be preferable I would suggest that you should try to be here by January 2 or 3, 1969.

Sincerely yours,

David J. Rogers  
Professor of Biology

DJR:gm  
Enc.

TELEPHONE:  
OXFORD 57891

DEPARTMENT OF FORESTRY  
COMMONWEALTH FORESTRY INSTITUTE  
UNIVERSITY OF OXFORD

28 August 1968

FW/C

Professor David J. Rogers, Taximetries Laboratory,  
Department of Biology,  
University of Colorado,  
Boulder,  
Colorado,  
U.S.A.

SEP 3 1968

Dear Dave,

Many thanks for your letter of 31 July.

The emendations you suggest to the manuscript of our paper for  
The New Phytologist are completely acceptable to me.

... When Mr. Bisby joins you at the beginning of next year he will  
bring with him a very clear statement (I hope) of what he would like  
to do while he is with you, and of what he has done so far. In the  
meantime I enclose a few notes on his programme for your information,  
and should be pleased to receive any comments if you think this is  
necessary.

Yours sincerely,

*Frank*

F.White

RESEARCH PROGRAMME OF MR. F.A. BISBY, St. John's College,  
University of Oxford

CROTALARIA

Mr. Bisby is concerned with the infra generic classification of the African species of Crotalaria (Leguminosae : Papilionatae, Genisteae). There are 550 species in this genus, of which approximately 400 occur in Africa. Most of the variation shown by the genus is found in that continent. The African species have been studied very carefully for about 20 years by Mr. E. Milne-Redhead of the Kew herbarium. Because of administrative duties Milne-Redhead has not got the time to complete his study and a few years ago handed over to ~~Richard~~<sup>Kipar</sup> Polhill who is one of our most capable younger taxonomists. The African species have now been studied as carefully and as intensively as is reasonably possible, using the traditional approach.

According to Polhill the reticulate nature of the variation pattern precludes simple division into sub-genera and tribes. Polhill recognizes 11 sections which are as natural as he can make them but are admittedly partly artificial.

If the computer has an important part to play in herbarium taxonomy, I think problems like that shown by Crotalaria will probably provide the most promising field.

Bisby has the advantage of beginning his investigation with his species properly sorted out. His chief concern is to compare available techniques, to learn what the computer can do, to learn how to write and adapt programmes, to get experience in the selection of characters and to test the application of available techniques to specific purposes. I also hope that as a result of his investigations he will be able to provide Milne-Redhead and Polhill with some useful insights into their own taxonomic problem.

Bisby is only concerned with the African species. So far he has scored

250 species and expects to bring this total up to about 300 by the end of the year. The remaining 100 species or so are either imperfectly known or are so closely related to species he has included that their exclusion should not seriously affect his results.

For each species he has scored 48 characters. I enclose a specimen ... score sheet. As you will see, for reasons of space the characters and character states are expressed in shorthand, which may not be self-explanatory. He has, however, written a full explanation of what these shorthand symbols mean.

A short while ago he made a few trial runs, using the data he had scored for 80 species. We do not expect this particular investigation to give any very meaningful taxonomic results. He is chiefly concerned with coming to grips with the methods and machinery. The methods he has used are as follows :-

Mixed mode Coefficient (Principal Co-ordinate Analysis)

Matching Coefficient, Single Linkage

" " Median Linkage

I hope that while he is with you in Boulder he will be able to use his full set of data on your programmes and will thereby become familiar with your methodologies.

#### DIOSPYROS.

I think that Bisby has sufficient material for his thesis, but if he can find sufficient time I should like him to subject some data I will give him on the genus Diospyros, to taximetric analysis. Diospyros is a large genus with about 500 species. Unlike Crotalaria its variation pattern is extremely diffuse, but nevertheless it seems extremely difficult to sub-divide it in any taxonomically meaningful way. I have worked on this genus for 20 years and have a number of specific problems to which I would like to know the answer. I shall send you further information about these in due course.

-

Collector's Number

Material

Crotalaria

No.

Kew/FHO

Sheet complete Card punched Card checked

Kew/FHO

F.A. Bisby, Score Sheet 1b

|             | 0                      | 1                     | 2                | 3               |    |
|-------------|------------------------|-----------------------|------------------|-----------------|----|
| STYLE       | glabrous               | hairs inside only     | hairs both sides | hairs in spiral | 1  |
|             | ascending from base    | curved tapered        | geniculate       |                 | 2  |
|             | simple                 | bifurcate tip         |                  |                 | 3  |
| ANTHERS     | not                    | spinulose             |                  |                 | 4  |
| KEEL        | rounded                | at right angle        |                  |                 | 5  |
|             | glabrous               | lateral surface hairy |                  |                 | 6  |
|             | upper margin glabrous  | hairs < 1 mm.         | hairs ≥ 1 mm.    |                 | 7  |
|             | not                    | prominent crest       |                  |                 | 8  |
|             | < 9 mm.                | 9-16 mm.              | > 16 mm.         |                 | 9  |
| beak        | not twisted            | circumflexed          | twisted          |                 | 10 |
| WINGS       | obovate                | oblong-ovate          |                  |                 | 11 |
|             | ≤ than keel            | longer than keel      |                  |                 | 12 |
| STANDARD    | oblate 0               | suborbicular 1        | obovate 2        | ovate 3         | 13 |
|             |                        |                       | elliptic 4       |                 |    |
| outside     | glabrous               | pubescent             | tomentellous     |                 | 14 |
| appendages  | decurrent              | restricted to blade   | absent           |                 | 15 |
| LEGUME      | glabrous inside        | hairy inside          |                  |                 | 16 |
|             | 2 seeds                | 4-8 seeds             | 8-many seeds     |                 | 17 |
| SEEDS       | circular               | oblique-cordiform     | reniform         |                 | 18 |
|             | not                    | flattened             |                  |                 | 19 |
|             | smooth                 | rugose                |                  |                 | 20 |
|             | non-arillate           | arillate              |                  |                 | 21 |
|             | Additional Information |                       |                  |                 |    |
| Stem hairs  | absent                 | brown                 | white            |                 | 49 |
| Seed        | red                    | brown                 | straw            |                 | 50 |
| Calyx lobes | erect                  | reflexed              |                  |                 | 51 |
| Keel lat.   | ridges prominent       | not                   |                  |                 | 52 |
|             |                        |                       | Widest Lflet.    | mm.             | 53 |
|             |                        |                       | Legume length    | mm.             | 54 |
|             |                        |                       | diam.            | mm.             | 55 |

|             |                              |                                     |                                                          |                                     |
|-------------|------------------------------|-------------------------------------|----------------------------------------------------------|-------------------------------------|
| HYIPANTHIUM | indistinct                   | distinct                            |                                                          | 22                                  |
| CALYX       | 0.5 x keel                   | 0.5-0.7 x keel                      | 0.7-1.3 x keel                                           | 23                                  |
|             | lobed equally                | protracted                          | 2-lipped                                                 | 24                                  |
| mature-     | not                          | deflexed                            |                                                          | 25                                  |
| -lobes      | triangular, subulate         | acuminate                           | lanceolate                                               | 26                                  |
| -lobes      | longer than tube             | ≤ then tube                         |                                                          | 27                                  |
| -lobes      | 5                            | 3-4                                 |                                                          | 28                                  |
| PETALS      | not                          | conspicuously lined                 |                                                          | 29                                  |
|             | not                          | yellow                              |                                                          | 30                                  |
| STIPE       | subsessile or symmetrical    | asymmetrical                        |                                                          | 31                                  |
| legume      | < calyx tube just protruding | > c-tube, < c-lobes much protruding | > calyx-lobes very much protruded                        | < calyx tube very much protruded 32 |
| LEGUME      | glabrous outside             | pubesc. outside                     | toment'llous outside                                     | 33                                  |
|             | cylindrical                  | oblong-clavate                      | ellipsoid                                                | subglobose 34                       |
|             | inflated                     | laterally compressed                |                                                          | 35                                  |
| BRACTEOLES  | absent 0                     | on pedicel 1 unexpanded             | 2 on pedicel / 3 on calyx 4 expanded/unexpanded/expanded | 36                                  |
| BUDS        | ascending                    | irregular                           | reflexed                                                 | 37                                  |
| BRACTS      | caducous                     | persistent                          |                                                          | 38                                  |
|             | longer than pedicel          | ≤ pedicel                           |                                                          | 39                                  |
| RACEMES     | terminal                     | axillary                            | Term'l augmented                                         | 40                                  |
|             | lax                          | dense                               | sub-umbelliform                                          | 41                                  |
|             | 1-8 fls.                     | 8-many flrs.                        |                                                          | 42                                  |
|             | not                          | spine-tipped                        |                                                          | 43                                  |
| LEAVES      | simple                       | all 1-foliolate                     | lower 3-5 foliolate                                      | 44                                  |
|             | not                          | in fascicles                        |                                                          | 45                                  |
|             | subsessile                   | petiolate                           |                                                          | 46                                  |
| STIPULES    | absent                       | linear-triangular                   | foliaceous                                               | 47                                  |
| PLANTS      | woody perennial              | herbaceous                          |                                                          | 48                                  |

Taximetrics Laboratory

16 July 1969

Armory 101

Mr. P. A. Bisby  
Forest Herbarium - Dept. of Forestry  
Commonwealth Forestry Institute  
University of Oxford  
Oxford, England

Dear Mr. Bisby:

We are pleased to offer you a standard graduate research assistant's grant at the rate of \$275 a month for the period January 1969 to June 1969. Your duties will be to carry out research under my direction during that period. This involves investigation of computer methodologies for taxonomic purposes. You will aid us in the gathering of and computation of data from various plant materials.

I suggest that when you come you bring with you satisfactory materials for your own investigations. If this involves plant materials I suggest that you inform me sufficiently well in advance so that we can make arrangements for the proper care and storage of these plant specimens. Office space and a very minimal supply of laboratory equipment will be available here.

We look forward to seeing you upon your arrival. Please let me know at your earliest convenience your requirements for living arrangements and so forth. We can help you to organize these things.

Sincerely,

David J. Rogers  
Professor of Biology

DJR:gm  
3 CC

Taximetrics Laboratory

Armory 101

16 July 1968

Dear Mr. Bisby:

In answer to the questions that you have about the computer facilities and various parts of our program, I have the following comments to make, separate from the other letter which you will probably wish to show to your various administrators there.

We have a CDC 6400 with the 120 k, 60 bit word internal store, drums and tapes, of course, as auxiliary storage are available. CDC FORTRAN IV is the basic language. I am sending under separate cover several reprints which will give you the basic understandings of our programs on the similarity clustering. Considering the size and complexity of the program, I have taken the route to not send you the program listing because we felt that it would be much more advantageous for you, at least at this stage of the game, to prepare data there and send it to run in our program here. Since this is a very large program, something like 1500 FORTRAN cards, it would take you a considerable amount of time to convert it to any machines that you have there. Why not just allow us to run any data or do any actual computation that you may require in advance of your arrival here and save the extra time of doing the converting that would be necessary.

I hope that this arrangement is satisfactory to you. We prefer it ourselves. Looking forward to seeing you in January.

Sincerely,

David J. Rogers  
Professor of Biology

DJR:gm

FAB/G

Forest Herbarium,  
Dept. of Forestry,  
Commonwealth Forestry Inst.,  
University of Oxford.

11 July 1968

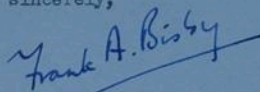
Dear Dr. Rogers,

I believe that Mr. White will be writing in the near future to discuss with you my work and, more particularly, the study that I am planning for the next year or so. In the meantime can you possibly confirm in writing the arrangements that you made verbally with Mr. White earlier this year, so that I may make arrangements for leave of absence from my college, from the University authorities and from the Fund that pays my grant here in Oxford?

I understand that you would be willing to have me under your supervision at Colorado for the 6 months from January 1969 to June 1969 and that a maintenance grant of the order of \$275 per month would be made available during this period.

It would also be very useful to me at this early stage to know what computing facilities you have available, as I imagine they will be very different from ours here. In particular, would you let me know what machines, what languages and what storage you are able to use? Could I also please have the programme write-up which you offer in Taxometrics II for the Similarity-Clustering Programme on Fortran 4 with a MAP subroutine? Can this subroutine be available in Fortran 4 to make a less efficient or more space-requiring programme, or, alternatively, does the subroutine consist of a standard library routine probably available here (such as Data packing, Shell sorting, Graph-plotter scheme, or Matrix inversion?)?

Yours sincerely,



F.A. Bisby

FW/C

*Pending*

Forest Herbarium, Dept. of Forestry,  
Commonwealth Forestry Inst.,  
University of Oxford.

7 May 1968

Professor David J. Rogers,  
Taximetries Laboratory,  
Dept. of Biology,  
University of Colorado,  
Boulder, Colorado.

Dear Dave,

I am writing to acknowledge your kind letter of 19 April and the enclosed introductory comments for our paper for The New Phytologist. I am actively engaged on this and hope to have it finished within a few days. I shall let you have a copy of the final draft as soon as it is ready.

As to my research student, Frank Bisby, I have confirmed with the university authorities that his release to visit your Laboratory for six months, would be in order. I think that the best time would be from January to June. By that time he should have assembled his raw material. I have asked him to prepare a brief account of what he has done already and what he would like to do when he is working with you, ~~as~~ I am sure it would be valuable if we could have your comments at an early stage. I hope to be able to let you have this very soon.

When we first discussed the possibility of Bisby joining you, at Prance's home in February, I believe you said that you would be able to provide Bisby with £275 a month. Have I, in fact, remembered this accurately?

With best wishes,  
Yours sincerely,

*Frank White*

F. White

URGENTConfidential

SEP 01 1976

19 Aug 76

Dear Dave,

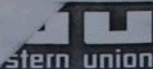
Could you possibly give me a hurried reference on Mrs. Nedret Settar, data management officer of the Aegean Regional Agricultural Research Inst. at Izmir? She has applied to do an M.Phil (masters research 2yr degree) here on "The numerical analysis of biological data". We would like to take her but are a little doubtful of her qualifications and use of English.

Could you possibly send me a quick, candid note of your impressions of her intelligence, motivation and use of English? Unfortunately I need to make a decision by Sept 3.

Thanks for your letter Dave. I'll write again soon.

Yours

y  
frank



# Telegram

WDS.-CL. OF SVC.

PD. OR COLL.

CASH NO.

CHARGE TO THE ACCOUNT OF

☐ OVER NIGHT TELEGRAMUNLESS BOX ABOVE IS CHECKED THIS  
MESSAGE WILL BE SENT AS A TELEGRAM

night letter

Send the following message, subject to the terms on back hereof, which are hereby agreed to

Sept. 2, 1976

TO Frank Bisby

CARE OF  
OR APT. NO.

STREET &amp; NO. Biology Dept., Bldg. 44

TELEPHONE

CITY &amp; STATE The University, Southampton, England, SO9 5NH

ZIP CODE

Re: Nedret Settar. Do not consider her qualifications satisfactory for  
proposed work with you. English understanding is poor. Skills are  
non-numeric and taxonomy nil.

signed: Dave

RS

Operator # 212

9/2 2:05  
Date/ TimeConfirmation *yes*

SENDER'S TEL. NO.

NAME &amp; ADDRESS

WU 1207 (R 5-69)

July 20, 1976

Dr. Frank Bisby  
Dept. of Biology  
Building 44  
The University  
Southampton SO9 5NH  
England

Dear Frank:

Thank you for your's of June 9. To answer your question specifically, I will try (as you are) to contact the publisher right away for advice and perhaps financial resources. There are probably other resources, however, that we should examine; and I will ask that Gil Hersh follow up on them so that even if we are not able to get funds from the book publishers directly, there may be other resources available to us to continue.

I do not believe at anytime in our correspondence that I mentioned that Lois Abbott, who is a Ph.D. degree candidate under my direction, is interested in assisting us with the book. Lois is quite an experienced individual, mathematically and biologically; and is much better off than the average student with a broad base of knowledge in many computer aided models, as well as well-founded in mathematics. She will be of great help to us in the development. She is occupied this summer with a course in California, but will be back in September when she will be able to participate with us more fully.

I plan to be away during the month of August, but hope to get out a more detailed outline for the proposed book. I really look forward to this work. And hope that you will continue to <sup>g<sup>n</sup></sup>chip-up more ideas for it.

Best regards,

David J. Rogers  
Director

DR:rs

DEPARTMENT OF BIOLOGY



BUILDING 44,  
THE UNIVERSITY,  
SOUTHAMPTON  
SO9 5NH

JUN 24 1976

TEL. 559122  
EXT. 2444  
TELEX 47661

FAB/AP

9th June 1976

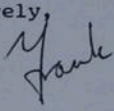
Dear Dave,

Thanks for your letter.

I confirm that I shall come to Boulder for the period 23rd April to 23rd May 1977. What kind of sources will you try for some finance? Do we prepare a more detailed draft and contact a publisher right away or leave all this until we have a few chapters written? I occasionally get circular letters from publishers looking for potential authors. Normally they go in the bin but I will start keeping them now.

Best wishes.

Yours sincerely,

  
F. A. Bisby

Dr. D. J. Rogers,  
Taximetrics Laboratory,  
1229 University Avenue,  
University of Colorado,  
Boulder,  
Colorado 80309,  
U.S.A.

DEPARTMENT OF BIOLOGY



BUILDING 44,  
THE UNIVERSITY,  
SOUTHAMPTON  
SO9 5NH

TEL. 559122  
EXT. 2444  
TELEX 47881

FAB/AP

17th February 1976

Dear Dave,

Thank you very much for entertaining me so handsomely in London, I was very happy to see you again. I didn't open your letter until mid January on returning from holiday. I've been dreadfully busy since then and delayed replying until I had time to tabulate at least an initial idea for planning the book. It is only a first idea, so do feel free to tear it up and make a fresh start! I think it important to show two attitudes which are missing from other works:-

- 1) Taxonomic services should be seen to service all biologists by attending to their special needs, encouraging them to contribute their own comparative information and arranging for regular feedback.
- 2) The principle information techniques should not be associated with particular taxonomic philosophies.

The techniques can prove useful across the whole spectrum of taxonomic philosophies. Their use is justified on grounds of automation - labour saving, accuracy and repeatability - and of scholastic precision - the ability to state explicitly what process of analysis was used.

Best wishes.

Yours sincerely,

F. A. Bisby

D. J. Rogers Esq.,  
University of Colorado,  
Taximetrics Laboratory,  
Department E.P.O. Biology,  
Boulder,  
Colorado 80302

*have used  
non-relative*

INFORMATION (OR COMPUTER) TECHNIQUES IN (TAXONOMY) BIOLOGY

1. FUNCTIONS OF TAXONOMY - THE INFORMATION SCIENCE FOR BIOLOGY

- (Could be several chapters - functions  
- analysis of present situation  
- future needs - input from all biologists  
- user feedback
- non-relative*

2. (TECHNIQUES FOR) GENERATING INFORMATION FROM OBSERVATIONS

- a) Observations, Characters, Sampling error, Partitioning ranges, Scaling  
b) Characters for particular motives - field identification, cladistic speculation etc.

3. (TECHNIQUES FOR) STORING AND RETRIEVING INFORMATION

- a) Conventional herbaria, Botanic Gardens  
b) TAXIR - for herbaria, monographic projects, gene banks etc  
c) Kew microfiche system  
d) Primary/Secondary information

4. (TECHNIQUES FOR) ASSESSING INFORMATION

Multiple regression,  $\chi^2$ , CHARANAL, PCA - *dividing measures - cluster analysis for pattern finding.*

*Relative between  
classification  
agreement  
- factors in data  
- field vs. lab  
- v.s. p. analysis -  
these 2 approaches*

5. (TECHNIQUES FOR) CLASSIFYING ORGANISMS

Methods - Single-linkage, GRAPH clustering etc.

Interpretation - Probabilistic vs Deterministic, Space-dilation, Detecting natural pattern vs Partitioning continua.

6. (TECHNIQUES FOR) IDENTIFYING ORGANISMS (GIVEN A CLASSIFICATION)

- a) KEY MAKING. POLYCLAVES,  
b) ON-LINE - KEYS, MULTIPLE ENTRY, MATCHING  
c) Discriminant functions, Canonical analysis.

7. (TECHNIQUES FOR) PHYLOGENETIC SPECULATION

- 7.
- a) Theory behind intuitive approaches
  - b) Parsimony approach
  - c) Character compatibility approach

8. Selected examples
- General purpose (i.e. morphological) taxonomy
  - Special purpose
  - Phylogenetic speculation etc.
- maybe also in 1976*

F. A. Bisby

17.2.76

DEPARTMENT OF ~~BOTANY~~  
BIOLOGY



BUILDING 44,  
THE UNIVERSITY,  
SOUTHAMPTON  
SO9 5NH

TEL. 59122  
EXT.  
TELEX 47661

Prof. D.J. Rogers,  
Taximetrics Laboratory,  
Hale Building,  
Dept. Of Biology,  
University of Colorado,  
Boulder, Colorado, 80302,  
U.S.A.

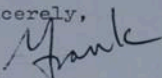
20th February 1973.

Dear Dave,  
I enclose a cheque for 25 dollars to cover your  
costs of postage, xeroxing and the tape you sent TAXIR on.  
You should be able to pay it straight into your own bank.

I've now read the TAXIR tape onto the CDC7600 in  
London and have started working on it. It doesn't compile  
(of course) but I don't think the FORTRAN changes needed  
are at all severe.

Last Friday Dr. Brennan (Keeper of the Herbarium  
at Kew) agreed to give me written support in applying for  
funds to employ a programmer on this job. He also took  
well to the idea of me trying to get TAXIR going and then  
helping others here use it.

Best wishes,  
Yours sincerely,

  
Frank Bisby.

May 24, 1976

Dr. F. A. Bisby  
Dept. of Biology  
Building 44  
The University  
Southampton SO9 5NH  
England

Dear Frank:

Thank you for your letter of April 15. The end of the semester caught me with too much to do to respond earlier.

With respect to your proposed visits, it is very likely that we will have to have more than one period together. But let us arrange that after we have had a one month session. I would suggest that you plan the second alternative mentioned in your letter, i.e. March 23, 1977 to April 23, 1977. I trust that this is agreeable to you.

In the meantime, I will proceed to uncover the necessary financial resources to accommodate your travel arrangements. I assume at the moment that we will be successful and we should not have to worry that we will or will not have those funds available. However, obviously during these times of financial restrictions we must also be prepared that that which we need may not be forthcoming. Sorry to have to put it on these terms, but c'est la vie.

If the above travel is agreeable to you, please let me know and then we will establish some sort of working procedure.

Sincerely yours,

David J. Rogers  
Director

DR:rs

MEMO

TO: Dave  
FROM: Gil  
DATE: May 21, 1976  
RE: Discussions on 5/19/76.

One point concerned the scheduling and funding of a work time to plan and develop the "Taximetrics Test". Our specific concern was to find the funds and time to bring together people from this group, Frank Bisby from UK and Lois Abbott.

It was my suggestion that if this piece of work was important enough we would reserve the funds necessary out of the general operating funds (for example, the GRCIDS budget) to bring Bisby to the United States and to support him here both at the cheapest possible rate. The same would be true of Abbott if she left after finishing her degree and before this meeting could take place.

It was discussed that other funds would be sought, for example from a book publisher who might be interested in doing this. I feel that we should in fact attempt to bring other funds in but that if its important enough we make contingency plans to use funds we have available.

With respect to scheduling, Bisby in his letter mentions a series of dates, if I'm not mistaken, they are January-February 1977, March-April 1977, or the Summer of 1977. Although it is not clear at the present time, the earlier date of January might be in conflict with our AC meeting. Other dates are entirely possible.

This is merely a summary of the conversation.

DEPARTMENT OF BIOLOGY



FEB 25 1976

BUILDING 44,  
THE UNIVERSITY,  
SOUTHAMPTON  
SO9 5NH

TEL 559122  
EXT. 2444  
TELEX 47661

FAB/AP

17th February 1976

Dear Dave;

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Best wishes.

Yours sincerely,

F. A. Bisby

D. J. Rogers Esq.,  
University of Colorado,  
Taximetrics Laboratory,  
Department E.P.O. Biology,  
Boulder,  
Colorado 80302

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- General purpose (i.e. morphological) taxonomy
  - Special purpose
  - Phylogenetic speculation etc.

F. A. Bisby

17.2.76

March 4, 1976

Dr. Frank A. Bisby  
Department of Biology  
Building 44  
The University  
Southampton, SO9 5NH  
England

Dear Frank:

I was pleased to get your letter of the 17th, with the very good set of suggestions for chapter headings for our projected book. About the only one I might argue with is #7, (Techniques for) Phylogenetic Speculation - but that is not a significant argument!

The next thing I think needs to be done is to ask you to propose the time you would like to spend with us on such a book, and what financial arrangements you would need. When you send this information, please also enclose a curriculum vitae. We may be able to spring loose some funds for this purpose from some granting agencies in the United States. The sooner we get started on this, the better; but I suspect that we can't get going on the work until next fall.

Please let me have your response at your earliest convenience.

Sincerely yours,

David J. Rogers  
Director

DR:rs

DEPARTMENT OF BIOLOGY



BUILDING 44,  
THE UNIVERSITY,  
SOUTHAMPTON  
SO9 5NH

TEL. 559122  
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TELEX 47661

FAB/AP

17th February 1976

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Best wishes.

Yours sincerely,

A handwritten signature in dark ink, appearing to read 'Frank'.

F. A. Bisby

D. J. Rogers Esq.,  
University of Colorado,  
Taximetrics Laboratory,  
Department E.P.O. Biology,  
Boulder,  
Colorado 80302

December 15, 1975

Frank A. Bisby  
Botany Department  
The University, Southampton  
SO9 5NH, UK

Dear Frank:

I am very glad that we had the chance to meet and I certainly appreciate the fact that you took time out from the visit with your parents to come into London on Saturday night. I am very excited about the opportunities for cooperation with you with respect to a textbook on taxonomy as the information science for biology. I hope we can proceed along to develop the concepts and ideas on this and get started with the work which is of mutual concern for us both.

I talked to Francis Lupton about you and your colleague's concern to do some work on Phaseolus. Lupton states that there are people at Cambridge also concerned with the same genus and that he would be pleased to introduce you to that group (unfortunately I do not remember their names), but that might be an interesting start if you have desires for a concerted effort for further studies in that highly significant group. I do not know yet how, but it seems to me that there should be some means to support the kinds of work that you care to do, inasmuch as there is worldwide interest in the crops derived from this genus.

I look forward to your recommendations with respect to an outline of the book as discussed above.

Thanks again for coming in to visit with me last Saturday night and best wishes for the Christmas season.

Sincerely,

David J. Rogers

DJR:hff

November 18, 1975

Dr. F. A. Bisby  
Department of Botany  
The University of Southampton  
Southampton SO9 5NH  
England

Dear Frank:

I hope to be in the UK on Saturday, December 6, and would like a chance to visit you either the evening of that day or the next, Sunday the 7th, before going to Cambridge to the Plant Breeding Institute. Will you be available then? I will try to call you from Rome before coming to London to give you final details of flights, times, etc.

Looking forward to seeing you.

Sincerely,

David J. Rogers

DJR:hcf

Mar. 7, 1973

Dr. Frank Bisby  
The University, Southampton SO9 5NH

Dear Frank :

Thanks for your letter of the 20th Feb., with enclosed check. I had quite forgotten that you were going to send any money--you could have saved yourself some cash!

I hope you can get TAXIR up and running over there--it would be nice to see it working there. In connection with the program, I am enclosing a program description of "TIDY" which might be helpful in cleaning up the program as it came to you, and sort out some of the problems. We have the program running here, and we might be able to get a listing for you, if you want it.

I am leaving tomorrow for Rome to participate in a Technical Conference on Genetic Resource Centers, at FAO. Hopefully, we will learn there whether there will be continuing action to establish these centers, and what fate, if any, there is for TAXIR as the IR system. When and if I learn anything of interest to you in this connection, I will certainly let you know.

We did get most of the work for a Pilot Study of potato data done, but not everything we wanted. However, we will demonstrate our results at the conference.

Let me hear how you're progressing with TAXIR, and if there are any problems. Just to keep me informed, I hope you will write me first about it, rather than any of the other members of the old team.

Thanks, and sincerely,

David J. Rogers  
Prof. of Biology

Encl.

Mr F. White, Forest Herbarium  
Dept. of Forestry  
Commonwealth Forestry Inst.  
University of Oxford, CWI 3RB

FW/C

12 January 1971

Professor David J. Rogers,  
Professor of Biology,  
Dept. of Biology,  
Armory 101,  
University of Colorado,  
BOULDER, Colorado 80302

Dear Dave,

If you have not already been told, I am sure you will be pleased to know that Frank Bisby has successfully completed the requirements for the Degree of Doctor of Philosophy of this University. His oral examination was held just before Christmas and his examiners, Professor A.J. Cain and Dr W.T. Stearn, were obviously very pleased with his thesis.

As his Supervisor, I would like to acknowledge the considerable stimulus and help he received from you and your colleagues when he visited your Department two years ago.

I hope all goes well with you.

With best wishes,

Yours sincerely,

*Frank*

F.White

TELEPHONES: OXFORD  
55757 PROFESSOR  
57891 DEPARTMENT  
FAB/C

DEPARTMENT OF FORESTRY  
COMMONWEALTH FORESTRY INSTITUTE  
UNIVERSITY OF OXFORD OXI 3RB  
10 September 1969

AIR MAIL

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

Dear *Dave*

Please give my thanks to Geneva or whoever it is that is dealing with my mail. I have now received a copy of the report that I wrote for you, all the parcels I left behind and a good deal of mail that was addressed to me at the Armory.

You did not include any comments with the copy of the report that was sent on to me. Does this mean that you don't have any? Please do let me know if there was anything in it that you would argue with.

Dare I ask what is the present situation for the Taximetrics Lab. ? Frank White sent an excellent letter of recommendation in response to your request. I hope it arrived in time.

... I am enclosing just one paragraph of the paper on character analysis that I am writing at the moment. I am trying to make the paper readable to botanists and have avoided undue reference to mathematical formulae or to programming and computer activities. I am doing this by referring to the mathematical appendix in George's paper (*Taxon* 1967) and separating the details of the CHARANAL programme into this appendix for this paper. Please would you help me by looking this through and checking some of the facts for me, possibly with George or Bob. The statements on the CHARANAL performance about 200 comparisons per minute of C.P.U. time is based on my memory alone. As far as I remember repeated runs of one experimental character against about 50 others each took about 15 seconds C.P.U. time. Could you also please confirm that your address is and will remain at the Armory building?

Could you also let me know whether acknowledgment for my finances at Boulder should be made to you or to some particular grant from the N.S.F.?

Do you remember the name of Dr. A.J. Richards in the Botany Department here with whom you planned to examine specimens here in Oxford? He is an

/over

expert in the genus Taraxacum and would like to use <sup>a</sup> the clustering technique for recognizing some groups in the progeny of some breeding experiments. I have told him that you will be willing to run his data on the Graph programme at Boulder. He says he doesn't see any reason why the Botany Department should not pay the bill in dollars. I shall endeavour to interest him in some preliminary Character Analysis but I am doubtful if this will meet with much response. Can you confirm that this will be O.K. and possibly send him the two pamphlets, one describing the deck set-up and the other describing the interpretation of the output. Could you also send to me (surface mail will do) two or three copies of these pamphlets so that I can give them to people interested in these methods?

Please give my best wishes and regards to Henry, George and Bob. and Gill!

Yours sincerely,

*F.A. Bisby*

F.A. Bisby

10      Appendix : CHARANAL, a computer programme for character analysis

This programme performs comparisons between pairs of characters. For each pair the following quantities are calculated and printed out :- Conditional probabilities; information content of each; information quantity held in common and information quantity held in common expressed as a fraction of the information content of each. The individuals missing data in one or both of the characters are listed and eliminated from the computation.

The user <sup>specifies</sup> ~~specifies~~ which of the characters he wishes to compare. In an initial character analysis this will usually be all of the possible  $\frac{n(n-1)}{2}$  comparisons amongst  $n$  characters. In subsequent runs one or a few experimentally formalised characters will be compared with the remainder.

The programme CHARANAL is written in FORTRAN for the C.D.C. 6400 and requires only a minimal amount of core storage. Details and a listing are available from :- Prof. D.J. Rogers, Taximetrics Laboratory, 101 Armory, University of Colorado, BOULDER, Colorado 80302, U.S.A.

Using the C.D.C. 6400, processing was at the rate of about 200 comparisons per minute of central processor time.

Forest Herbarium,  
Dept. of Forestry,  
Commonwealth Forestry Institute,  
University of Oxford.

Ox1 IRB October 9 1969

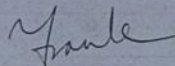
Professor David J. Rogers,  
Taximetrics Laboratory,  
Dept. of Biology,  
ARMORY 101,  
University of Colorado,  
BOULDER, Colorado 80302.

Dear Dave

I am now looking round for a job for next year and wondered if I could give your name as a referee? In particular there is one appointment for which the application has to go in by the 20 October. I have assumed that you will be willing to act as referee for this. I hope this is all right. It is a job on a research project concerned with information retrieval of biological abstracts from the literature.

The main work on the paper that I am writing on Character Analysis is complete but I am afraid it is taking much too long getting it approved by Mr. White. I have been trying my best to hurry him on this but it will certainly be some time yet before it can go to the press.

Yours sincerely,



F.A. Bisby

Summer 1969 Report  
By F. A. Bisby  
Taximetrics Laboratory - Armory

When I came to the Taximetrics Laboratory I had difficulty in envisaging the need for so many people to be careered with the taximetric activities. Taximetrics had been a one-man process in which I obtained a model or an algorithm derived from it, wrote or borrowed a programme based on the algorithm, ran the programme and data, and finally assessed and used the information obtained in its botanical context. Indeed I had made a point of concerning myself with every step of the process so that I should have a complete knowledge of the taximetric activities and thus make myself capable of thorough and meaningful comparison and assessment. Those user-oriented assessments that exist in the literature seem to be limited in value by the narrow disciplines of the authors. (For instance McNeill and Heywood or Prance are severely limited in their work by little familiarity with underlying mathematical models and conversely the work of Williams and Lance is widely criticised for the triviality and naivety of the taxonomic problems dealt with.)

So my first lesson was to learn that, despite the validity of my maxim that the complete taximetricist should comprehend all of his activities, their principles and consequences, he can hardly be sufficient to initiate, discover or invent at the various levels. Clearly a team of specialists, each an inventor in his own field, is very potent provided that there is a great deal of communication between them. In this way efficient programming, powerful mathematical models and competent biological theory can be brought together as never before.

Fairly quickly my study led me to the area of the mathematical models and their relationships with biology and taxonomy. Before coming here I knew that models existed but I had hardly touched on questions of their validity and inter-relationships. What knowledge I had was mostly concerned with multi-dimensional geometric models in Euclidean or other spaces. These originated from statisticians who seem to enjoy an unwarranted status in the eyes of many biologists. When the phenomenon of discrete or qualitative information caused concern, complex lattice representations, analogous to the Euclidean space of continuous variables, were

constructed and operations analogous to those of multi-variate statistics were invented for their manipulation. At Boulder I was able to discuss at great length with George Estabrook the form of the models on which work here is based.

The Information Theory model, on which the programme CHARANAL was discussed and the analogies between it and biological reality were found particularly useful. Not only does this provide a useful system based on discrete (qualitative) information, but it also provides insights into the nature of structure in taxonomic data and into the possible relationships between characters. Moreover the nature of characters is precisely recognised at the outset so that problems of inconsistent units and sealing are avoided.

In this model a character is a formal entity distinct from raw observational data. The character is a basis for comparison. For each character there exist character states which partition the objects being compared so that like objects are in the same state, unlike objects in different states. Given a particular set of observational data, say the leaf-forms of members of the Leguminosae, it is often possible to formalise different characters that include all or some of this information. In this example it is possible to formalise a character A with the following states -- simple, trifoliolately palmate, trifoliolately pinnate, pari-pinnate, impari-pinnate, or we can formalise another character B with; leaflets 1, leaflets 3, leaflets more than 3. By formalising the states of a character the objects have been partitioned and, as in this example, different formalisation of characters from the same raw observational data gives different partitions.

For each character there is a quantity called its information content which can be calculated as follows

$$-H = a \ln a + b \ln b + c \ln c \dots$$

where a is the fraction of the objects in state A, b the fraction in state B, etc. As with intuitive ideas of information it should be noted that this quantity rises with the number of states (for only one state  $-H = 1 \ln 1 = 0$  and there is no information) and is at a maximum for a given number of states when the distribution is equiprobable ( $a = b = c$  etc.)

If two characters divide the objects into the same partition so that all of the objects in the same state for the first

character are in the same state of the second character, then not only do they have the same quantity of information content, but also all of this information is identical in the two partitions and they are said to have all of it held in common. More commonly two characters will have a fraction of their information in common. The actual quantity is calculated from the conditional probabilities for the states of one character given which state of a second character that the objects are in.

In this model it is suggested that the "correlations" for which taxonomists search their data is in fact information held in common between characters. When a whole group of items are in the same state for one character and for another, the taxonomist says that he has found useful correlations which here are reflected by high information held in common. But in his search for useful characters the taxonomist looks for characters that are not only well-correlated in some areas, but also throughout the whole set of items to be classified. This same assessment can be obtained in the model by expressing the information in common between characters as a fraction of one or other of the characters concerned. These analogies lead to the conclusion that the structure the taxonomist is searching for is the underlying information (or partitioning) that is common to a large number of the characters. By summing the Fractional Information in Common values for one character and all remaining characters we obtain a total which is the overall fractional information contribution of that character to the system as a whole. In my Crotalaria study it was interesting to observe that of eleven characters with a fractional information contribution over 3.50 only one was not used by Polhill as a major character in delimiting his Sections and sub-sections.

The second model used at the taximetrics laboratory is the graph-theory model for clustering activity. On arrival at Boulder I was not very familiar with the notation and manipulations of set theory and finite mathematics so during the Spring Semester I attended and obtained Grade A on the Math 272 course on this subject. Fairly early in the course enough basic ground had been covered for me to understand the notation used in the Graph-theory development by Estabrook. Although the algorithm derived was not new to me I was delighted by its logical derivation from two stated taxonomic axioms.

- 1) A biological classification is a set of hierarchical partitions.
- 2) Classes of a partition are isolated by discontinuities, so that for a given partition similar objects are in the same class, dissimilar objects separated.

Many of the clustering algorithms used elsewhere do not conform with the second axiom (centroid, average linkage-type algorithms). The programme incorporating the algorithm from this graph-theory model (called GRAPH) is particularly well adapted to the biological user with information output in a way such that sub-graphs can easily be drawn for each clustering level.

Possibly more important than familiarisation with these two models was the realisation that most complex and seemingly contorted biological systems could be investigated by this method of building analogous mathematical models. In this respect the disciplines of finite mathematics may prove to be far more powerful than statistical analytical methods presently used in many biological fields.

In applying the Information Theory model to normal taxonomic problems several changes in procedure or changes in accentuation are indicated. Probably the most important one is the concept of iteration and experimentation in the actual formalisation of observational data into useful taxonomic characters. By selecting characters that have high fractional information contributions and by rejecting or improving others it is possible to increase the structure of the information system and consequently to lead to a more meaningful arrangement at the clustering stage. This process is analogous to a phase which the classical taxonomist has difficulty in recognising and describing. He makes a wide range of observations and during the course of this activity concentrates more and more on relatively few characters which he finds to be "good" or "well-correlated."

Another useful application of the model is that any partitions can be analysed for their information in common. This means that at the end of a taximetric study alternative arrangements (partitions) can be compared one by one with the taxonomic information used. The partition with the greatest fractional information in common with the characters may be selected. Alternatively the taxonomist may prefer the partition to which the distribution of fractional information held in common by individual characters is best correlated with the distribution of their fractional information contributions to the whole system. In the latter case it would be pleasing to see characters having fractional information in common with the selected arrangement (partition) in some direct proportion to their fractional information contributions.

CROTALARIA L.

Treatment of Crotalaria L. at the Taximetrics Laboratory, 1969

Recorded observations from plant material of 273 species of Crotalaria L. were analysed in two steps. First the observations were formalised into taxonomically meaningful characters and secondly this refined data was used to discover taxonomic groupings and hierarchies amongst these species.

In the first stage the programme CHARANAL was used. Initially the observations were arranged in forty eight qualitative characters and each of these was compared with every other so that their information relationship could be obtained. Conditional probabilities, information in common and fractional information in common were particularly useful quantities obtained.

By summing the fractional information in common values for a character with all other characters, a value was obtained which is the overall fractional information contribution of that character to the total shared information of the system. As discussed by Estabrook, this value would seem to be a good measure of the taxonomic usefulness of a character. Expressed as a fraction of the information in a character, this value compensates for the case of useful characters included for the occurrence of rare states in one particular sub-group. Characters with high values partition the species into groupings that occur in the partitions of other characters. In the terms of a taxonomist, these are highly correlated.

After this examination of 48 "initial" characters there followed an experimental phase. In this some of these 48 were altered in formal structure so that the formalisation from the observations yielded a different partition of the species. These experimental characters were then analysed with CHARANAL against the remaining initial characters. Where a marked increase in the fractional information contribution was obtained, the experimental formalisation was used to replace the initial one. Then some additional observations were used to formalise some additional characters and these too were tested for usefulness by running them on CHARANAL against all other characters.

In each of these CHARANAL analyses, comparisons were made with partitions derived from Polhill's classification of Crotalaria, one of these partitioning the species into Sections, the other into sub-sections. The results of these comparisons were used in

several ways. One of these was to check that the supposed botanical importance of certain characters (such as those introduced from the additional observations) was in fact due to correlation with other characters (detected by high fractional information contribution) and not biased by their apparent agreement with Polhill's scheme (detected by high fractional information in common with one or both of his partitions). Characters with low fractional information contribution but high fractional information in common with Polhill partitions were suspected of being formalised with a bias towards the Polhill schemes and were mostly rejected.

Finally a refined set of characters was selected. This consisted of initial characters, experimental characters which had replaced initial characters and one of the additional characters, all selected for high fractional information contribution values. The decision as to which characters with low values should be omitted was made with some reference to the nature of the characters themselves. Only those that were also of little importance from the intuitive standpoint were rejected, and of these only one (leaf form) was a character given significance by previous Crotalaria workers. [E. G. Baker used this for his major divisions]

The second stage of the study involved a search for useful taxonomic groupings using the programme GRAPH. This can be run in a variety of modes, but unfortunately is quite time-consuming with large numbers of items. Consequently before running this programme in any particular mode for all 273 species, several experimental runs were made using the 80 species sample which had previously been used for experimental runs in Britain.

The 80 species sample was run, first of all with the data for 48 initial characters, with and without certain of the 48 used as matrix characters. Then two more were made with data for 36 refined characters, again with and without some characters in matrix form.

The structure and arrangements produced by these 48 runs were compared. The last run (36 characters with matrices) was preferred for several reasons. The most important of these was that the groupings seemed consistently meaningful and recognisable in plant terms. In the other runs unsatisfactory groupings occurred, brought together by concurrence in those initial characters which were later eliminated from the refined data. The effect of these can be likened to "noise" blurring and distorting the meaningful picture. This preferred run also gave a tidier arrangement with less "chaining" by others.

Finally the complete set of data for 36 refined characters for all 273 species was run on GRAPH (with some matrix characters) and the resulting groups charted on hard-drawn sub-graph plots (not complete yet) and a "skyline" plot produced automatically by the computer.

In brief, the arrangements produced by this GRAPH run generally resemble Polhill's scheme in some areas. In structure the discontinuity between Sections 1 to 7 and ten to eleven is so great as to warrant the use of some categories above the sectional level. Sections that are not well defined by this run are Incanae (2), Chrysocalycinae (8) and Calycinae (9). The Hidnocarpae (5) is hardly separated from the Macrostachyae (6) and in later sub-graphs these together form a highly inter-connected group.

Thank you everybody for giving me such an exciting  
time over here. Good-luck in fund-hunting in the  
next few weeks. I have great memories of this place

Frank

12 May 1969

This is to certify that Mr. F. A. Bisby is in academical residence  
and is pursuing biological studies.

David J. Rogers  
Professor of Biology

REQUEST FOR APPOINTMENT, REAPPOINTMENT, OR CHANGE OF STATUS  
INSTRUCTIONS FOR PREPARATION: SEE REVERSE SIDE OF LAST COPY

|                                                                                                                             |  |                                                                                |                 |               |                        |                             |
|-----------------------------------------------------------------------------------------------------------------------------|--|--------------------------------------------------------------------------------|-----------------|---------------|------------------------|-----------------------------|
| <input type="checkbox"/> MR <input type="checkbox"/> MRS <input type="checkbox"/> MISS                                      |  | NAME (LAST IN CAPS) <b>BISBY</b> <b>FRANK</b>                                  | FIRST <b>A.</b> | MIDDLE/MAIDEN | SOCIAL SECURITY NUMBER | DATE <b>21 October 1968</b> |
| (a) RANK OR TITLE <b>Graduate student</b>                                                                                   |  | CITIZEN (SPECIFY COUNTRY) <b>England</b>                                       |                 |               |                        |                             |
| (b) DEPARTMENT OR PROJECT TITLE <b>Research Assistant</b>                                                                   |  | PRESENT MAILING ADDRESS <b>FOREST HERBARIUM, University of Oxford, England</b> |                 |               |                        |                             |
| (c) ACCOUNT NUMBER (DEPT. NO., SUB. B.C., OBJECT CLASS) <b>1708-48-2-200</b>                                                |  | POSITION NUMBER                                                                |                 |               |                        |                             |
| (d) (SUBMIT THE ABOVE INFORMATION IN ALL CASES, AND USE SPACE PROVIDED BELOW TO DESCRIBE SPECIAL CONDITIONS OF EMPLOYMENT.) |  |                                                                                |                 |               |                        |                             |

We recommend that the above named:

1. ☐ Be APPOINTED ☐ Be REAPPOINTED TO THE POSITION DESCRIBED ABOVE FOR THE PAY PERIOD AND DATE INDICATED BELOW AT A SALARY OF

PAY PERIOD

\$ **300/month** AT **50** % OF TIME [ EFFECTIVE DATE IF OTHER THAN BEGINNING OF PAY PERIOD (MONTH) (DAY) (YEAR) ]

|                                                                                                                                                                                                                                                                 |                                                                                                                                |
|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------|
| <input type="checkbox"/> ACADEMIC YEAR 19 _____                                                                                                                                                                                                                 | <input type="checkbox"/> FISCAL YEAR BEGINNING (MONTH) (DAY) (YEAR) AND ENDING (MONTH) (DAY) (YEAR)                            |
| <input type="checkbox"/> FALL SEMESTER 19 _____                                                                                                                                                                                                                 | <input checked="" type="checkbox"/> SPECIAL PERIOD BEGINNING <b>January 2, 1969</b> AND ENDING <b>June 30, 1969</b>            |
| <input type="checkbox"/> SPRING SEMESTER 19 _____                                                                                                                                                                                                               | <input type="checkbox"/> MONTHLY RATE BEGINNING (MONTH) (DAY) (YEAR) AND ENDING (MONTH) (DAY) (YEAR)                           |
| <input type="checkbox"/> 8 WEEK SUMMER HALF-SEMESTER 19 _____                                                                                                                                                                                                   | <input type="checkbox"/> SUMMER OTHER THAN 8-WEEK HALF-SEMESTER BEGINNING (MONTH) (DAY) (YEAR) AND ENDING (MONTH) (DAY) (YEAR) |
| INDICATE THE APPROPRIATE TERM OF APPOINTMENT: <input checked="" type="checkbox"/> SUMMER ONLY, OR ONE YEAR, OR LESS <input type="checkbox"/> 2 YEARS <input type="checkbox"/> 3 YEARS <input type="checkbox"/> WITH TENURE <input type="checkbox"/> OTHER _____ |                                                                                                                                |

2. ☐ Be TRANSFERRED FROM: (DEPARTMENT OR PROJECT TITLE) (ACCOUNT NUMBER) (POSITION NO.)
- TO: (DEPARTMENT OR PROJECT TITLE) (ACCOUNT NUMBER) (POSITION NO.)

AT A SALARY OF \$ \_\_\_\_\_ AT \_\_\_\_\_ % OF TIME PER \_\_\_\_\_ (ACADEMIC YEAR, SEMESTER, OR TERM)

AS OF (EFFECTIVE DATE) REASON \_\_\_\_\_

3. ☐ Be CHANGED IN RANK OR TITLE

AS OF (EFFECTIVE DATE) REASON \_\_\_\_\_

4. ☐ Be CHANGED IN SALARY FROM: \$ \_\_\_\_\_ AT \_\_\_\_\_ % OF TIME PER \_\_\_\_\_ (ACADEMIC YEAR, SEMESTER, OR TERM)
- TO: \$ \_\_\_\_\_ AT \_\_\_\_\_ % OF TIME PER \_\_\_\_\_ (ACADEMIC YEAR, SEMESTER, OR TERM)

AS OF (EFFECTIVE DATE) REASON \_\_\_\_\_

5. ☐ Be GRANTED LEAVE ☐ WITH PAY ☐ WITHOUT PAY FOR \_\_\_\_\_ (ACADEMIC YEAR, SEMESTER, OR TERM)

REASON \_\_\_\_\_

6. ☐ Be TERMINATED (SEMESTER, TERM OR LAST DAY OF SERVICE) REASON ☐ REASSIGNMENT WITHIN THE UNIVERSITY ☐ ACCEPTED A POSITION IN ANOTHER UNIVERSITY ☐ ACCEPTED A POSITION IN INDUSTRY ☐ OTHER (STATE IN SPECIAL CONDITIONS)

SPECIAL CONDITIONS: CONCURRENT APPOINTMENTS, FULL-TIME PROBATIONARY SERVICE AT OTHER INSTITUTIONS, ETC. (SEE INSTRUCTIONS.)

*non-degree graduate student*

|                     |                                                                                            |
|---------------------|--------------------------------------------------------------------------------------------|
| PROJECT DIRECTOR    | DEAN OR ADMINISTRATIVE OFFICER                                                             |
| DEPARTMENT CHAIRMAN | APPROVED FOR THE PRESIDENT OF THE UNIVERSITY <b>Emory E. Hallstrom</b><br><b>12-9-1968</b> |
|                     | FUNDS VERIFIED BY RESEARCH ACCOUNTANT                                                      |

January 2, 1969

The Secretary  
University Chest  
16/20 Wellington Square  
Oxford, England

Dear Sir:

This is to certify that F.A. Bisby has taken  
up academical residence at the University of  
Colorado, Boulder, Colorado, U.S.A.

Sincerely,

David J. Rogers  
Professor of Biology  
Project Director

1, Tregolls  
Avenue Road  
Farnborough  
Hants

20 Dec 1968

Dear Professor Rogers,

Thank you for your letter, which probably crossed mine in the post.

I should have mentioned in my previous letter that the University have accepted me as an International Student and put me in touch with the Foreign Student Center who have reserved me a room in a Hall of Residence.

I have booked a ticket on the TWA flight 155 Kennedy → Denver arriving at Denver 10.50 (M.S.T) Dec 31st. ~~and will keep~~ Thank you for offering to have someone meet me

Yours sincerely  
F.A. Bisby.

F.A. Bisby.

AEROGRAMME

2 December 1968

Mr. Frank A. Bishy  
Forest Herbarium, Dept. of Forestry  
Commonwealth Forestry Institute  
University of Oxford  
Oxford, England

Dear Mr. Bishy;

Since we haven't heard from you recently, we are assuming that the Admissions and Graduate School offices are taking care of you. Inter-campus communications do tend to get bogged down.

Regarding fees: a minimum tuition charge of \$39 permits you to take up to three credit hours, which can be independent study. The student fee is optional (\$46.20) but it includes the services of the student health service, insurance, and other fee-supported activities.

We understand that your housing in a university dormitory is being taken care of.

Let us know about your travel plans, when you have them confirmed, and we will try hard to have someone at the Denver airport to meet you.

Sincerely yours,

David J. Rogers  
Professor of Biology

DJR:gm

10 October 1968

Mr. Robert Hefling  
Regent 125  
Campus

Dear Mr. Hefling:

Enclosed is the application from Mr. F. A. Bisby for recognition as a non-degree graduate student here. Mr. Bisby, who is at present enrolled at Oxford University, England, has been accepted by us as a graduate research assistant for six months beginning January 2 through the end of June 1969. His objective in being here is to work in our laboratory discovering computer methods for biology.

Would you be kind enough to process his papers and send him the necessary visa application forms? If more information is needed please let me know.

Thank you for your efforts.

Sincerely,

David J. Rogers  
Professor of Biology

DJR:gm

*Oct 18 - accepted, immigration form sent*

*6463*

Forest Herbarium, Dept. of Forestry,  
Commonwealth Forestry Inst.,  
University of Oxford.

1 October 1968

Professor David J. Rogers,  
Taximetrics Laboratory,  
Dept. of Biology,  
University of Colorado,  
BOULDER, Colorado, U.S.A.

Dear Dr. Rogers,

Thank you for your letter and enclosures. We too have red tape and it has taken me a week to obtain a degree certificate and a College letter, the nearest Oxford equivalent to a transcript. There are no such things as "semester hours" or "grade points" at English Universities so I have had to leave this part of the form empty.

From reading the various pamphlets that you have sent, it is clear that I am eligible to apply to be a non-degree student, so obtaining library and student facilities (this is important for cheap travel facilities) and avoiding income tax difficulties. I decided to send the forms to you so that before sending them in you could perhaps add a note to the effect that you are going to pay me a graduate research assistant's grant. (They should go direct to the Graduate School, Regent 125, University of Colorado, etc., and not through the Biology Dept.) Could you please send these on?

I have assumed in my budgeting that I shall have to pay the student's fee for the Spring semester, but that I shall not have to pay tuition fees unless I am obliged to sign on for courses, in which case I pay at the resident student rate. Can you please confirm this and let me know if I have overlooked any other fees (such as Health Scheme?).

As a result of my decision to apply for recognition as a student I have not filled in the Petition form. Instead I shall need "Immigration and Naturalization Service" Form I-20A from your Admissions Office. This will enable me to go to the U.S.A. Embassy in London and obtain a student's visa fairly easily.

Yours sincerely,

F.A. Bisby

10 October 1968

Dean Lawson Crowe  
Regent Hall  
Campus

Dear Dean Crowe:

I have agreed to have Mr. Frank A. Bisby as my graduate research assistant at the rate of \$300 a month, chargeable to my research grant, account #1708-48, for the period January 1, 1969 to June 30, 1969.

Mr. Bisby will be working on problems in computer methods for Biology.

I have known Mr. Bisby's major professor for some time and have the highest confidence in his ability.

Sincerely,

David J. Rogers  
Professor of Biology

DJR:gm

9.15.68. 11:25 Am.

Dave,

The Naturalization and Immigration service  
(Denver, 297-3526) will send us ~~an~~  
• Form I 29 B which we must return to  
• them.

the person for whom we apply must be  
one of exceptional and scarce "talents".

Instructions should also be included.

JH

P.S. 11:45. <sup>ref.</sup> Mrs. Owen

ref:

1. if person to be employed as  
"Graduate Research Assistant"  
must be student  
enrolled with course load.  
~~and~~ "Independent" study a possibility.

P.

Forest Herbarium,  
Dept. of Forestry,  
Commonwealth Forestry Inst.,  
University of Oxford.

28 August 1968

Dear Dr. Rogers,

Thank you for your letter and duplicate official grant offer, which I am pleased to accept.

It is most kind of you to offer to help me in organising my accommodation. I have little idea of what arrangements are normal for a Boulder graduate student, what to expect or how much to pay. If I write down here what I do and prefer in Oxford, I'm sure you can deduce what sort of arrangement I should prefer at Boulder, bearing in mind that I shall be living on \$275 per month January to June.

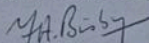
In Oxford the price of rooms is inflated by excessive demand and consequently it is much cheaper to live in a college (vaguely equivalent to a Hall of Residence) or a college-owned house, than in rented flats or bed-sitting rooms. In addition, I am reasonably sociable, like to meet people and prefer eating cheaply in student restaurants, to cooking for myself. So I think, if at all possible, my first choice would be to live in a Hall of Residence (not necessarily restricted to graduates), and only if this is not possible, in a rented bed-sitting room. In the latter case proximity to the Biology Department and to the Campus or student restaurant facilities would be more important than the quality of the rented room. (For instance, cooking, and laundry facilities, or telephone, not necessary).

At the moment I am paying about one quarter of my student grant for a rented room, as I have already had my quota of 2 years in college. This is on the cheap side.

Is this information sufficient to guide you? Let me know if there are any queries about this.

Could you please let me know on what date you would like me actually to start work in the Biology Dept.? I ask this as I'm not quite sure whether to cross the Atlantic before or after Christmas.

Yours sincerely,



F.A. Bisby

19 September 1968

Mr. F. A. Bisby  
Forest Herbarium  
Dept. of Forestry  
University of Oxford  
Oxford, U.K.

Dear Mr. Bisby:

Governmental red tape has raised its ugly head. What you and I thought would be a very simple arrangement for your coming to work with us now turns out to be a matter of visas et al.

As I see it two alternatives exist to get you into this country and to allow you to work with us.

1. Come to this country as "Nonimmigrant temporary worker or trainee" (see form with this title, enclosed).
2. Apply for recognition as a graduate student at the University of Colorado, non-degree candidate.

Some of the considerations in choosing which of these two courses to follow - if you choose number 1 above then you will not have the opportunity to live in any of the University residence halls; whereas if you choose number 2 alternative you will have that opportunity as well as some other values such as unrestricted use of the library.

If I were making a choice myself (trying to equate my desires with yours) I would choose the first alternative because I do not believe that you are concerned with having any formal recognition with having worked with us. Certainly I would be glad to give you a letter at the end of your period here which documented your work with us. I would think that this would sufficiently well to establish this historically.

Whichever alternative you choose, will you please act upon it immediately. As I see it, it will be necessary for us here to fill in the U. S. Department of Justice form entitled "Petition to Classify Nonimmigrant as Temporary Worker or Trainee." However, please note in this form that some information is required from you and I will ask you to provide these pieces of information so that I may proceed with the filing of this form. I will ask you to fill out the numbered boxes 5, 12a, 13, 14, 15, 16, 17, 18 and 19. You will notice in the instructions on the back of the form that certain documents must accompany this application. Please provide me with these documents at your very earliest convenience.

To: F. A. Bisby

19 September

2.

I am sorry that this red tape has interfered with what otherwise would be a simple matter, but such is not possible, I fear. In answer to your query concerning what dates would be preferable I would suggest that you should try to be here by January 2 or 3, 1969.

Sincerely yours,

David J. Rogers  
Professor of Biology

DJR:gm  
Enc.

TELEPHONE:  
OXFORD 37891

DEPARTMENT OF FORESTRY  
COMMONWEALTH FORESTRY INSTITUTE  
UNIVERSITY OF OXFORD  
28 August 1968

FW/C

Professor David J. Rogers, Taximetries Laboratory,  
Department of Biology,  
University of Colorado,  
Boulder,  
Colorado,  
U.S.A.

SEP 3 1968

.Dear Dave,

Many thanks for your letter of 31 July.

The emendations you suggest to the manuscript of our paper for  
The New Phytologist are completely acceptable to me.

... When Mr. Bisby joins you at the beginning of next year he will  
bring with him a very clear statement (I hope) of what he would like  
to do while he is with you, and of what he has done so far. In the  
meantime I enclose a few notes on his programme for your information,  
and should be pleased to receive any comments if you think this is  
necessary.

Yours sincerely,

*Frank*

F.White

RESEARCH PROGRAMME OF MR. F.A. BISBY, St. John's College,  
University of Oxford

CROTALARIA

Mr. Bisby is concerned with the infra generic classification of the African species of Crotalaria (Leguminosae : Papilionatae, Genisteae). There are 550 species in this genus, of which approximately 400 occur in Africa. Most of the variation shown by the genus is found in that continent. The African species have been studied very carefully for about 20 years by Mr. E. Milne-Redhead of the Kew herbarium. Because of administrative duties Milne-Redhead has not got the time to complete his study and a few years ago handed over to <sup>K. J. S.</sup> ~~Richard~~ Polhill who is one of our most capable younger taxonomists. The African species have now been studied as carefully and as intensively as is reasonably possible, using the traditional approach.

According to Polhill the reticulate nature of the variation pattern precludes simple division into sub-genera and tribes. Polhill recognizes 11 sections which are as natural as he can make them but are admittedly partly artificial.

If the computer has an important part to play in herbarium taxonomy, I think problems like that shown by Crotalaria will probably provide the most promising field.

Bisby has the advantage of beginning his investigation with his species properly sorted out. His chief concern is to compare available techniques, to learn what the computer can do, to learn how to write and adapt programmes, to get experience in the selection of characters and to test the application of available techniques to specific purposes. I also hope that as a result of his investigations he will be able to provide Milne-Redhead and Polhill with some useful insights into their own taxonomic problem.

Bisby is only concerned with the African species. So far he has scored

250 species and expects to bring this total up to about 300 by the end of the year. The remaining 100 species or so are either imperfectly known or are so closely related to species he has included that their exclusion should not seriously affect his results.

For each species he has scored 48 characters. I enclose a specimen ... score sheet. As you will see, for reasons of space the characters and character states are expressed in shorthand, which may not be self-explanatory. He has, however, written a full explanation of what these shorthand symbols mean.

A short while ago he made a few trial runs, using the data he had scored for 80 species. We do not expect this particular investigation to give any very meaningful taxonomic results. He is chiefly concerned with coming to grips with the methods and machinery. The methods he has used are as follows :-

Mixed mode Coefficient (Principal Co-ordinate Analysis)

Matching Coefficient, Single Linkage

" " Median Linkage

I hope that while he is with you in Boulder he will be able to use his full set of data on your programmes and will thereby become familiar with your methodologies.

#### DIOSPYROS.

I think that Bisby has sufficient material for his thesis, but if he can find sufficient time I should like him to subject some data I will give him on the genus Diospyros, to taximetric analysis. Diospyros is a large genus with about 500 species. Unlike Crotalaria its variation pattern is extremely diffuse, but nevertheless it seems extremely difficult to sub-divide it in any taxonomically meaningful way. I have worked on this genus for 20 years and have a number of specific problems to which I would like to know the answer. I shall send you further information about these in due course.

Collector's Number

Material

Crotalaria

No.

Kew/FHO

Sheet complete ☐ Card punched ☐ Card checked ☐

Kew/FHO

F.A. Bisby, Score Sheet 1b

|             | 0                             | 1                     | 2                | 3               |    |
|-------------|-------------------------------|-----------------------|------------------|-----------------|----|
| STYLE       | glabrous                      | hairs inside only     | hairs both sides | hairs in spiral | 1  |
|             | ascending from base           | curved tapered        | geniculate       |                 | 2  |
|             | simple                        | bifurcate tip         |                  |                 | 3  |
| ANTHERS     | not                           | spinulose             |                  |                 | 4  |
| KEEL        | rounded                       | at right angle        |                  |                 | 5  |
|             | glabrous                      | lateral surface hairy |                  |                 | 6  |
|             | upper margin glabrous         | hairs < 1 mm.         | hairs ≥ 1 mm.    |                 | 7  |
|             | not                           | prominent crest       |                  |                 | 8  |
|             | < 9 mm.                       | 9-16 mm.              | > 16 mm.         |                 | 9  |
| boak        | not twisted                   | circumflexed          | twisted          |                 | 10 |
| WINGS       | obovate                       | oblong-ovate          |                  |                 | 11 |
|             | ≤ than keel                   | longer than keel      |                  |                 | 12 |
| STANDARD    | oblate 0                      | suborbicular 1        | obovate 2        | ovate 3         | 13 |
|             |                               |                       | elliptic 4       |                 |    |
| outside     | glabrous                      | pubescent             | tomentellous     |                 | 14 |
| appendages  | decurrent                     | restricted to blade   | absent           |                 | 15 |
| LEGUME      | glabrous inside               | hairy inside          |                  |                 | 16 |
|             | 2 seeds                       | 4-8 seeds             | 8-many seeds     |                 | 17 |
| SEEDS       | circular                      | oblique-cordiform     | reniform         |                 | 18 |
|             | not                           | flattened             |                  |                 | 19 |
|             | smooth                        | rugose                |                  |                 | 20 |
|             | non-arillate                  | arillate              |                  |                 | 21 |
|             | <u>Additional Information</u> |                       |                  |                 |    |
| Stom hairs  | absent                        | brown                 | white            |                 | 49 |
| Seed        | red                           | brown                 | straw            |                 | 50 |
| Calyx lobes | erect                         | reflexed              |                  |                 | 51 |
| Keel lat.   | ridges prominent              | not                   |                  |                 | 52 |
|             |                               |                       | Widest lfl.let.  | mm.             | 53 |
|             |                               |                       | Legume length    | mm.             | 54 |
|             |                               |                       | diam.            | mm.             | 55 |

|            |                              |                                     |                                   |                                     |
|------------|------------------------------|-------------------------------------|-----------------------------------|-------------------------------------|
|            | indistinct                   | distinct                            |                                   | 22                                  |
| CALYX      | 0.5 x keel                   | 0.5-0.7 x keel                      | 0.7-1.3 x keel                    | 23                                  |
|            | lobed equally                | protracted                          | 2-lipped                          | 24                                  |
| mature-    | not                          | deflexed                            |                                   | 25                                  |
| -lobes     | triangular, subulate         | acuminate                           | lanceolate                        | 26                                  |
| -lobes     | longer than tube             | ≤ than tube                         |                                   | 27                                  |
| -lobes     | 5                            | 3-4                                 |                                   | 28                                  |
| PETALS     | not                          | conspicuously lined                 |                                   | 29                                  |
|            | not                          | yellow                              |                                   | 30                                  |
| STIPE      | subsessile or symmetrical    | asymmetrical                        |                                   | 31                                  |
| legume     | < calyx tube just protruding | > c-tube, < c-lobes much protruding | > calyx-lobes very much protruded | < calyx tube very much protruded 32 |
| LEGUME     | glabrous outside             | pubesc. outside                     | toment'llous outside              | 33                                  |
|            | cylindrical                  | oblong-clavate                      | ellipsoid                         | subglobose 34                       |
|            | inflated                     | laterally compressed                |                                   | 35                                  |
| BRACTEOLAS | absent 0                     | on pedicel unexpanded 1             | 2 on pedicel / 3 on calyx 4       | expanded / unexpanded / expanded 36 |
| BUDS       | ascending                    | irregular                           | reflexed                          | 37                                  |
| BRACTS     | caducous                     | persistent                          |                                   | 38                                  |
|            | longer than pedicel          | ≤ pedicel                           |                                   | 39                                  |
| RACEMES    | terminal                     | axillary                            | Term'l augmented                  | 40                                  |
|            | lax                          | dense                               | sub-umbelliform                   | 41                                  |
|            | 1-8 fls.                     | 8-many flrs.                        |                                   | 42                                  |
|            | not                          | spine-tipped                        |                                   | 43                                  |
| LEAVES     | simple                       | all 1-foliolate                     | lower 3-5 foliolate               | 44                                  |
|            | not                          | in fascicles                        |                                   | 45                                  |
|            | subsessile                   | petiolate                           |                                   | 46                                  |
| STIPULES   | absent                       | linear-triangular                   | foliaceous                        | 47                                  |
| PLANTS     | woody perennial              | herbaceous                          |                                   | 48                                  |

Taximetrics Laboratory

Armory 101

16 July 1969

Mr. P. A. Bisby  
Forest Herbarium - Dept. of Forestry  
Commonwealth Forestry Institute  
University of Oxford  
Oxford, England

Dear Mr. Bisby:

We are pleased to offer you a standard graduate research assistant's grant at the rate of \$275 a month for the period January 1969 to June 1969. Your duties will be to carry out research under my direction during that period. This involves investigation of computer methodologies for taxonomic purposes. You will aid us in the gathering of and computation of data from various plant materials.

I suggest that when you come you bring with you satisfactory materials for your own investigations. If this involves plant materials I suggest that you inform me sufficiently well in advance so that we can make arrangements for the proper care and storage of these plant specimens. Office space and a very minimal supply of laboratory equipment will be available here.

We look forward to seeing you upon your arrival. Please let me know at your earliest convenience your requirements for living arrangements and so forth. We can help you to organize these things.

Sincerely,

David J. Rogers  
Professor of Biology

DJR:gm  
3 CC

Taximetrics Laboratory

Armory 101

16 July 1968

Dear Mr. Bisby:

In answer to the questions that you have about the computer facilities and various parts of our program, I have the following comments to make, separate from the other letter which you will probably wish to show to your various administrators there.

We have a CDC 6400 with the 120 k, 60 bit word internal store, drums and tapes, of course, as auxiliary storage are available. CDC FORTRAN IV is the basic language. I am sending under separate cover several reprints which will give you the basic understandings of our programs on the similarity clustering. Considering the size and complexity of the program, I have taken the route to not send you the program listing because we felt that it would be much more advantageous for you, at least at this stage of the game, to prepare data there and send it to run in our program here. Since this is a very large program, something like 1500 FORTRAN cards, it would take you a considerable amount of time to convert it to any machines that you have there. Why not just allow us to run any data or do any actual computation that you may require in advance of your arrival here and save the extra time of doing the converting that would be necessary.

I hope that this arrangement is satisfactory to you. We prefer it ourselves. Looking forward to seeing you in January.

Sincerely,

David J. Rogers  
Professor of Biology

DJR:gm

FAB/C

Forest Herbarium,  
Dept. of Forestry,  
Commonwealth Forestry Inst.,  
University of Oxford.

11 July 1968

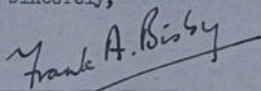
Dear Dr. Rogers,

I believe that Mr. White will be writing in the near future to discuss with you my work and, more particularly, the study that I am planning for the next year or so. In the meantime can you possibly confirm in writing the arrangements that you made verbally with Mr. White earlier this year, so that I may make arrangements for leave of absence from my college, from the University authorities and from the Fund that pays my grant here in Oxford?

I understand that you would be willing to have me under your supervision at Colorado for the 6 months from January 1969 to June 1969 and that a maintenance grant of the order of \$275 per month would be made available during this period.

It would also be very useful to me at this early stage to know what computing facilities you have available, as I imagine they will be very different from ours here. In particular, would you let me know what machines, what languages and what storage you are able to use? Could I also please have the programme write-up which you offer in Taxometrics II for the Similarity-Clustering Programme on Fortran 4 with a MAP subroutine? Can this subroutine be available in Fortran 4 to make a less efficient or more space-requiring programme, or, alternatively, does the subroutine consist of a standard library routine probably available here (such as Data packing, Shell sorting, Graph-plotter scheme, or Matrix inversion)?

Yours sincerely,



F.A.Bisby

Forest Herbarium, Dept. of Forestry,  
Commonwealth Forestry Inst.,  
University of Oxford.

7 May 1968

Professor David J. Rogers,  
Taximetries Laboratory,  
Dept. of Biology,  
University of Colorado,  
Boulder, Colorado.

Dear Dave,

I am writing to acknowledge your kind letter of 19 April and the enclosed introductory comments for our paper for The New Phytologist. I am actively engaged on this and hope to have it finished within a few days. I shall let you have a copy of the final draft as soon as it is ready.

As to my research student, Frank Bisby, I have confirmed with the university authorities that his release to visit your Laboratory for six months, would be in order. I think that the best time would be from January to June. By that time he should have assembled his raw material. I have asked him to prepare a brief account of what he has done already and what he would like to do when he is working with you, as I am sure it would be valuable if we could have your comments at an early stage. I hope to be able to let you have this very soon.

When we first discussed the possibility of Bisby joining you, at France's home in February, I believe you said that you would be able to provide Bisby with £275 a month. Have I, in fact, remembered this accurately?

With best wishes,  
Yours sincerely,

*Frank White*

F.White

UNIVERSITY OF COLORADO  
AT  
BOULDER, COLORADO 80309

Department of Environmental,  
Population and Organismic Biology

31 January 1979

Dr. Ralph Ockerse, Chairman  
Department of Biology  
School of Science  
Indiana Univ.-Purdue Univ. at Indianapolis  
1201 E. 38th St.  
Indianapolis, Indiana 46205

Dear Dr. Ockerse:

Dr. David Boyce has asked me to support his application for your announced position as a botanical ecologist. I have known Dave Boyce for about seven years, as graduate student, graduate teaching assistant, and thesis advisor. His major professor was Dr. John Marr, whose students are primarily plant ecologists, but with good training in other botanical and biological disciplines.

Dave Boyce was a good student and a hard worker. In my course on biological data management he did a student project that was associated with his major interest--an ecological description of a western Colorado mountain valley. He proved to be a thorough investigator, one who employs much of his training focusing on the problems at hand.

Dave was a graduate teaching assistant in my course, Plants and Man. He was one of the best assistants I have had because he had great sympathy for students and their problems and worked very well with them. He did very well in presenting some material in a couple of lectures I invited him to give in the course. I think he has outstanding qualities as a teacher, particularly with undergraduates.

Boyce's Ph.D. thesis dealt with an ecological region of importance, and his studies provided the backbone for an environmental impact study made of a river system that was projected for dams. He was able to marshall a very large data base into a competent and very useful ecological study of a region that will be impacted by man's activities. I consider his thesis as both highly competent and useful.

Dave's personality is excellent. Though he may appear diffident at first, he is really a very committed young man with high ideals and a warmth and friendliness that are so important in teaching. He is widely liked by all who come into contact with him. I recommend him highly.

Sincerely,

David J. Rogers  
Professor of Biology

DJR/pch

David A. Boyce, Ph.D.  
857 N. Woodstock St.  
Philadelphia, PA. 19130  
25 January 1979

Dear Dr. Rogers,

Thanks for all the letters and your thoughtful post card indicating that all the letters had been sent. I certainly appreciate the time and effort which you folks put forth on my behalf.

Although there are a few institutions which screen applications prior to asking for references, there are still more letters which I request from you at this time:

✓ 1/31/79 Botanical ecologist- assist. <sup>prof.</sup> <sup>2500</sup> level; teach both grad. and undergrad. courses in area of specialty; develop individual research program.

Due 31 Jan. or ASAP: Dr. Ralph Ockerse, Chairman  
Department of Biology  
School of Science  
Indiana Univ.-Purdue Univ. at Indianapolis  
1201 E. 38th St.  
Indianapolis, Ind. 46205

✓ 1/31/79 Botanist/Ecologist-assist. <sup>prof.</sup> <sup>2500</sup> level, 15-18 hrs/wk but no specific courses were listed.

Due ASAP: Dr. R. Hogg, Head of Natural Sciences Dept.  
Florida Institute of Technology  
1707 N.E. Indian River Drive  
Jensen Beach, Florida 33457

1/31/79 Biologist- assist. <sup>prof.</sup> <sup>2500</sup> level; 2 yr apt. to teach intro. biology lab. course as well as an intro. course for non-majors.

Due 15 Feb: Search Committee  
Department of Biology  
Kenyon College  
Gambier, Ohio 43022

✓ Thanks very much.

Sincerely,

Dave

UNIVERSITY OF COLORADO  
AT  
BOULDER, COLORADO 80309

Department of Environmental,  
Population and Organismic Biology

9 January 1979

Dr. Jan Sairtz, Chairman Search Committee  
Biology Department  
Loyola University of Chicago  
6525 N. Sheridan Rd.  
Chicago, Illinois 60626

Dear Dr. Sairtz:

Dr. David Boyce has asked me to support his application for your announced position in plant ecology. I have known Dave Boyce for about seven years, as graduate student, graduate teaching assistant, and thesis advisor. His major professor was Dr. John Marr, whose students are primarily plant ecologists, but with good training in other botanical and biological disciplines.

*a student and*  
~~As a student Dave Boyce was good, though not the most outstanding student I have had. He is a hard worker and his efforts for me were very good and worthwhile. He worked on a student project that was associated with his major interest--an ecological description of a western Colorado mountain valley. This study which he started under the tutelage of Dr. Marr was furthered in his course in data management techniques under my direction. He is a thorough investigator, one who employs much of his training focusing on the problems at hand.~~

*In my course on biological data management he did*  
Dave was a graduate teaching assistant in my course, Plants and Man. He was one of the best assistants I have had because he had great sympathy for students and their problems and worked very well with them. He did very well in presenting some material in a couple of lectures I invited him to give in the course. I think he has outstanding qualities as a teacher, particularly with undergraduates.

Boyce's Ph.D. thesis dealt with an ecological region of importance, and his studies provided the backbone for an environmental impact study made of a river system that was projected for dams. He was able to marshall a very large data base into a competent and very useful ecological study of a region that will be impacted by man's activities. I consider his thesis as both highly competent and useful.

Dave's personality is excellent. Though he may appear diffident at first, he is really a very committed young man with high ideals and a warmth and friendliness that are so important in teaching. He is widely liked by all who come into contact with him. I recommend him highly.

Sincerely,

David J. Rogers  
Professor of Biology

DJR/pch

The following are positions for which I've applied. I would appreciate letters of reference on my behalf, thank you.

- ✓ Botany position with teaching emphasis in plant anatomy, plant physiology, and general biology, plus other courses consistent with ones interests. Jan. 15 deadline.  
1/9/79 Dr. G.L. Bintz  
Department of Biology  
Eastern Montana College  
Billings, Montana 59101
- ✓ Plant Ecology, Assistant Prof., with broad ecology background. They desire either terrestrial or aquatic background with possible emphasis on physiological ecol.  
1/9/79 Dr. Jan Saitz, Chairman, Search Committee  
Biology Department, Loyola Univ. of Chicago  
6525 N. Sheridan Rd.  
Chicago, Ill. 60626
- ✓ Biology, Assist. Prof. with broad background, to teach general biol. and develop courses in botany (including Plant Physiology) plus teach in ones specialty. I'd love to get this one! Deadline 30 Jan.  
1/9/79 Dr. James Watrous, Chairman  
Department of Biology  
St. Joseph's University  
54th. St & City Ave.  
Philadelphia, PA. 19131
- ✓ Biological Resource Ecologist, to teach biol. resource management, general ecology, and either general biol., cell biol., or genetics.  
1/9/79 Deadline 15 Jan.:  
Search Committee Chairman  
Biology Department  
George Mason University  
Fairfax, Virginia 22030
- ✓ Biologist/Botanist, Assist. Prof.; teach field botany course, plant anatomy, general botany, ecology, and general biol.  
1/10/79 Dr. Inez Hull, Chairperson  
Biology Department, Whittier College  
Whittier, CALIF. 90608
- ✓ Botanist, Assist. Prof. with emphasis on Plant Ecology and some background in geology and zoology.  
1/10/79 Donald J. Ziegler, Vice President for Academic Affairs  
Doane College  
Crete, Nebraska 68333
- ✓ Biologist, Assist. Prof. to coordinate and teach introductory biology.  
1/10/79 Dr. Walter C. Biggs, Chairman of the Search Committee  
Department of Biology  
University of North Carolina at Wilmington  
Wilmington, N.C. 28406
- ✓ Biologist (Ph.D.) to teach general biology sequence  
1/10/79 Dr. Steve Chalgren, Chairman  
Biology Department, Radford College  
Radford, Va. 24142
- ✓ Biologist, Assist. Prof. to teach intro. biology, cell biology, genetics.  
1/10/79 Dr. Stuart Goff, Assistant Dean of Sciences  
Keene State College  
Keene, New Hampshire 03431
- ✓ Plant Ecologist, Assist. Prof. with broad base in ecology and interest in physiological plant ecology. (Exercise in futility?) 15 Jan. dead  
1/9/79 H.G. Baker, Chairperson  
Ecologist Search Committee  
Dept. of Botany, University of California  
Berkeley, California 94720

November 10, 1978

Prof. Jean Kerschner  
Department of Biology  
Western Maryland College  
Westminster, Maryland 21157

Dear Prof. Kerschner:

Dr. David Boyce has asked me to support his application for your announced position as biologist at the level of assistance professor. I have known Dave Boyce for about seven years, as graduate student, graduate teaching assistant, and thesis advisor. His major professor was Dr. John Marr, whose students, as you probably know, are very well grounded in plant ecology.

As a student Dave Boyce was good, though not the most outstanding student I have had. But he more than made up for the brilliance by hard work, and his work for me was very good and worthwhile. He worked on a student project that was associated with his major interest--an ecological description of a western Colorado mountain valley. This work, which he started under the tutelage of Dr. Marr, was furthered in his course in data management techniques under my direction. He is, therefore, very well prepared both in theoretical as well as in practical levels of environmental biology.

As a graduate teaching assistant, Dave worked in my course Plants and Man. He was one of the best assistants I have had because he had great sympathy for students and their problems and worked very well with them. He did very well in presenting some material in a couple of lectures I invited him to give in the course. I think he has outstanding qualities as a teacher, particularly with undergraduates.

Boyce's PhD thesis dealt with an ecological region of importance, and his studies provided the backbone for an environmental impact study made of a river system that was projected for dams. He was able to marshall a very large data base into a competent and very useful ecological study of a region that will be impacted by man's activities. I consider his work both highly competent and useful.

Dave's personality is excellent. Though he may appear diffident at first, he is really a very committed young man with high ideals and a warmth and friendliness that are so important in teaching. He is widely liked by all who come into contact with him. I recommend him highly.

Sincerely,

David J. Rogers  
Professor of Biology

David A. Boyce, Ph.D.  
857 N. Woodstock St.  
Philadelphia, PA. 19130  
December 20, 1978

Dr. David J. Rogers  
E.P.O. Biology Dept.  
Univ. of Colo.  
Boulder, CO. 80309

Dear Dr. Dave,

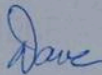
Hello again. The search goes on, and as you might expect gets rather depressing at times. I again need letters of reference for the institutions on the enclosed list. I have listed deadline dates where appropriate. One never knows exactly where to draw the line as to which positions to go after-needless to say I feel a little overwhelmed applying to Berkeley but ya never know.

I'm particularly interested in the position at St. Joseph's here in Philly. Apparently Dr. Marks is no longer chairman there, you'll recall that he was my "in" because he knew you. Ah well, I'm going to go all out for it anyway.

Thanks for your letter. I trust you are now back in colorful Colorado and have to face the throngs in the classroom again. I hope your stay in Fla. was enjoyable and the research fruitful!

Hello to all my friends in Boulder, and Happy New Year and Merry Christmas.

Best regards,



November 9, 1978

Dr. G. Fred Somers  
School of Life and Health Sciences  
University of Delaware  
Newark, Delaware 19711

Dear Dr. Sommers:

Dr. David Boyce has asked me to support his application for your announced position as botanist at the assistant professor level. I have known Dave Boyce for about seven years, as graduate student, graduate teaching assistant, and thesis advisor. His major professor was Dr. John Marr, whose students, as you probably know, are very well grounded in plant ecology.

As a student Dave Boyce was good, though not the most outstanding student I have had. But he more than made up for the brilliance by hard work, and his work for me was very good and worthwhile. He worked on a student project that was associated with his major interest-- an ecological description of a western Colorado mountain valley. This work, which he started under the tutelage of Dr. Marr, was furthered in his course in data management techniques under my direction. He is, therefore, very well prepared both in theoretical as well as in practical levels of environmental biology.

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Sincerely,

David J. Rogers  
Professor of Biology

October 30, 1978

Dr. S. K. Shapiro, Head  
Department of Biological Sciences  
University of Illinois, Chicago  
Box 4348  
Chicago, Illinois 60680

Dear Dr. Shapiro:

Dr. David Boyce has asked me to support his application for your announced position as plant ecologist at the assistant professor level. I have known Dave Boyce for about seven years, as graduate student, graduate teaching assistant, and thesis advisor. His major professor was Dr. John Marr, one of the country's outstanding plant ecologists.

As a student Dave Boyce was good, though not the most outstanding student I have had. But he more than made up for the brilliance by hard work, and his work for me was very good and worthwhile. He worked on a student project that was associated with his major interest--an ecological description of a western Colorado mountain valley. This work, which he started under the tutelage of Dr. Marr, was furthered in his course in data management techniques under my direction. He is, therefore, very well prepared both in theoretical as well as in practical levels of environmental biology.

As a graduate teaching assistant, Dave worked in my course Plants and Man (that may be described as a practical human and plant ecology course). He was one of the best assistants I have had because he had great sympathy for students and their problems and worked very well with them. He did very well in presenting some material in a couple of lectures I invited him to give in the course. I think he has outstanding qualities as a teacher, particularly with undergraduates.

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Sincerely,

David J. Rogers  
Professor of Biology

October 30, 1978

Professor Harry Hamilton  
c/o Leon Calhoun, Director of Personnel  
State University of New York, Albany  
1400 Washington Avenue  
Albany, NY 12222

Dear Professor Hamilton:

Dr. David Boyce has asked me to support his application for your announded position as assistant professor in an environmental studies program. I have known Dave Boyce for about seven years, as graduate student, graduate teaching assistant, and thesis advisor. He major professor was Dr. John Marr, one of the country's outstanding plant ecologists.

As a student Dave Boyce was good, though not the most outstanding student I have had. But he more than made up for the brilliancy by hard work, and his work for me was very good and worthwhile. He worked on a student project that was associated with his major interest--an ecological description of a western Colorado mountain valley. This work, which he started under the tutelage of Dr. Marr, was furthered in his course in data management techniques under my direction. He is, therefore, very well prepared both in theoretical as well as in practical levels of environmental biology.

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Dave's personality is excellent. Though he may appear diffident at first, he is really a very committed young man with high ideals and a warmth and friendliness that are so important in teaching. He is widely liked by all who come into contact with him. I recommend him highly.

Sincerely,

David J. Rogers  
Professor of Biology

David A. Boyce  
857 N. Woodstock St.  
Phila., PA. 19130  
11 Oct. 1978

Dr. David J. Rogers  
E.P.O. Biology Dept.  
University of Colorado  
Boulder, CO. 80309

Dear Dr. Rogers,

I'm back in the job market again, but this time outside of the Philadelphia area. Thus far I've not located a position in Philly, but since Joyce is undecided on her residency for next year I've decided that it would be wise to broaden my search. Enclosed is a list of five positions for which I am applying. I would greatly appreciate it if you would provide letters of recommendation on my behalf.

In addition to these five, I've also applied to the State Univ. of N.Y. at Buffalo; however, as far as I could tell from their listing, they wanted names of potential references rather than letters at this time. You may hear from them in the future if they like my C.V.

I visited Dr. Ruth Patrick at the Academy of Nat. Sci. recently and found her to be very busy, but receptive. She directed me to Dr. Jim Peterson with whom I visited today. Prospects don't seem real good there but one never knows what may turn up.

In reference to our discussion last April about the Dept. Head at St. Josephs College here in Philly who knows you, his name is Louis Marks. Furthermore, I've recently been to Longwood Gardens and you were right, they are magnificent!

Thank you very much for your help.

Sincerely yours,

*Dave Boyce*

The following information pertains to positions for which I am applying. I've ordered the list by due date for application materials and reference letters.

1. Assistant professor for an environmental studies program. duties include teaching and research in an environmentally related field, and would also include advising students with their research projects and helping to develop an M.S. program.  
15 October is the requested completion date (sorry to short you on time); letters directed to:  
    Professor Harry Hamilton  
    % Leon Calhoun, Director of Personnel  
    State University of N.Y., Albany  
    1400 Washington Ave.  
    Albany, N.Y. 12222
2. Plant ecologist at the assistant professor level. This position at the Univ. of Illinois, Chicago includes teaching graduate and undergraduate ecology and supervision of M.S. and Ph.D. candidates.  
Due date is 20 October 1978, with letters directed to:  
    Dr. S.K. Shapiro, Head  
    Department of Biological Sciences  
    University of Illinois, Chicago  
    Box 4348  
    Chicago, Illinois 60680
3. Botanist at the level of assistant professor, University of Delaware. They're interested in someone to teach biology of terrestrial plants, field botany and population biology. They prefer someone with an interest in field oriented problems.  
Application date is 1 Dec. 78 and letters should be directed to:  
    Dr. G. Fred Somers  
    School of Life and Health Sciences  
    University of Delaware  
    Newark, Delaware 19711
4. Biologist for a tenure track position at the level of assist. prof. Teaching duties to include ecology, perspectives in biology & principles of biology. They're looking for someone with a concentration in ecology but with a sound botanical background. 30 Nov. 78 is the due date, letters to:  
    Jean Kerschner  
    Department of Biology  
    Western Maryland College  
    Westminster, Maryland 21157
5. Botanist to teach botany and plant physiology as well as other courses in ones area of interest. I believe they're after someone who is primarily a plant physiologist, but since it's advertised as a one yr. apt. I thought I'd take a long shot that they'd settle for less.  
Due date 1 Feb. 79, letters to:  
    Dr. John G. New, Chairman  
    Biology Department  
    State University College at Oneonta  
    Oneonta, N.Y. 13820

UNIVERSITY OF COLORADO  
AT  
BOULDER, COLORADO 80309

Department of Environmental,  
Population and Organismic Biology

February 11, 1977

Chairman  
Department of Biology  
Grinnell College  
Grinnell, Iowa 50112

Dear Sir:

I write to support the application of Mr. David A. Boyce, for your position to teach botany. I have known Dave as a graduate student in one course in quantitative biology and as a teaching assistant in my botany course. In both circumstances he has performed very well. He is competent, persevering and of very fine character. I have no doubt that he will be a challenging teacher, and one with whom students can easily identify. Amongst TA's that I have known, I rate him near the top. His experience in botany is sufficiently broad to give an enriched picture of plant life in several subjects. He has been a consistent, willing student, and I feel sure, a competent researcher in his chosen discipline, plant ecology. He has certainly had one of the outstanding teachers of ecology in John Marr, who will, I am certain, give Dave a good recommendation.

Sincerely yours,

David J. Rogers  
Professor of Biology

DJR:js

UNIVERSITY OF COLORADO  
AT  
BOULDER, COLORADO 80309

Department of Environmental,  
Population and Organismic Biology

March 22, 1977

Dr. Robert G. Franke  
Chairman, Search Committee  
Department of Botany & Plant Pathology  
Iowa State University  
Ames, Iowa 50011

Dear Dr. Franke:

I write to support the application of David Boyce, who has applied for the position of Assistant Professor in your Department. Mr. Boyce has been a student in my course in taximetrics, has been a teaching assistant for me in general botany (survey of plant kingdom), and in Economic Botany. I presently serve on his thesis committee. Mr. Boyce has had a good general program in botany, both here and in Michigan, that gives him the necessary scope in a formal sense to teach a wide variety of courses. He has pursued his goals to become a plant ecologist in a consistent, effective manner. He has shown evidence, both in course work and in research endeavor to indicate a competence that is above the average, in the top 10 to 15% of students I have known over the years.

In his teaching activities, Mr. Boyce has a personality that is outstanding for the needs of teaching both at the undergraduate and graduate level. He is quiet, but assertive, confident, but not cocky, friendly, but firm. These qualities, backed up by his scientific knowledge, make him a sure bet to be a fine teacher, and faculty member.

With all of these qualities, I do not yet detect in Mr. Boyce any attributes that would mark him as the leading edge scientist of the next generation. But I do not say this as detrimental. I doubt that any of us has sufficient foresight to really distinguish that quality--certainly I do not. I merely indicate that he is well-rounded, and not over-specialized. I recommend him highly.

Sincerely,

David J. Rogers  
Professor

DJR:js

David A. Boyce  
Hale Science, E.P.O.B.  
Campus  
Feb. 7, 1977

Dr. David J. Rogers  
E.P.O.B., Hale Science Bldg.  
Campus

Dear Dr. Rogers,

I've applied for a teaching position at Grinnell College and appreciate your sending a letter of recommendation on my behalf. The position is for teaching introductory and advanced botany courses to undergraduates, including such courses as anatomy and morphology. The letter should be directed to the Chairman, Department of Biology, Grinnell College, Grinnell, Iowa 50112, and should speak to the applicants training, teaching ability, and personal character."

I've included for your reference, a current listing of science courses taken and a curriculum vitae so as to provide you with information on my background, over and above that which may have been ascertained from our course<sup>only</sup> or teaching associations.

Your response to this request is greatly appreciated.

Sincerely yours  
David A. Boyce

## CURRICULUM VITAE

### PERSONAL

Name: David A. Boyce  
Home Telephone: (303) 442-4739  
Home Address: 845 15th Street, Boulder, Co. 80302  
Business Telephone: (303) 492-6547  
Business Address: Department of Environmental, Population, and Organismic  
Biology, University of Colorado, Boulder, Co. 80309  
Date of Birth: October 1, 1945  
Place of Birth: Milwaukee, Wisconsin  
Marital Status: Married, no children

### EDUCATION

B.S., Biology major, group science minor. 1967. Grand Valley State College,  
Allendale, Michigan  
M.A., Biology. 1969. Western Michigan University, Kalamazoo, Michigan  
Currently a candidate for the Doctor of Philosophy Degree in Environmental  
Biology at the University of Colorado, Boulder, Colorado. Degree  
expected in May 1977.

### PROFESSIONAL EXPERIENCE

#### Teaching:

Teaching Assistant in Introductory Biology, Western Michigan University.  
Two Semesters, 1967-1968.  
Teaching Assistant in Plant Biology, Western Michigan University.  
Two Semesters, 1968-1969.  
Teaching Assistant in Introductory Biology, University of Colorado.  
Three Semesters, 1972-1974.  
Teaching Assistant in Economic Botany, University of Colorado.  
One Semester, 1973.  
Teaching Assistant in Principles of Ecology, University of Colorado.  
One Semester, 1974.  
Teaching Assistant in Dynamics of Mountain Ecosystems, University of  
Colorado. Two Semesters, 1975-1976.  
Teaching Assistant in Plant Ecology, University of Colorado.  
One Semester, 1975.

David A. Boyce - Curriculum Vitae

Teaching (cont.):

Teaching Assistant in The Plant Kingdom, University of Colorado.  
One Semester, 1973.

Research:

Undergraduate Research Assistant, Grand Valley State College.  
Two Quarters, 1965-1966.  
Undergraduate research on the water quality of the Grand River,  
Ottawa County, Michigan. 1966-1967.  
Graduate research on vegetational analysis of several oak forests  
of Allegan County, Michigan. 1968.  
Graduate research on foliage production and consumption in oak forests  
of Allegan County, Michigan. 1968-1969.  
Graduate research on the ecosystems adjacent to the South Fork of the  
White River, Garfield and Rio Blanco Counties, Colorado. 1974-1977.

Applied Ecological Research:

I have been involved in a number of studies under contract to industry and governmental agencies to provide ecological information and analyses for use in Environmental Impact Statements and planning. These studies were undertaken through the Laboratory of Mountain Ecology for Man, Department of Environmental, Population, and Organismic Biology, University of Colorado, under the direction of Dr. John W. Marr. My responsibilities during these studies varied between those of laboratory assistant, field assistant, and researcher. The duties of a field assistant include the collection and analysis of ecological data, whereas those of a laboratory assistant only encompass analysis of such data. The duties of a researcher include those of field and laboratory assistants, plus experimental design, overseeing logistics and assistants, ecosystem mapping and report writing.

Researcher on The South Fork Project, Garfield and Rio Blanco Counties, Colorado, for the Colorado River Water Conservation District.  
Ecological inventory and impact analysis for a proposed dam and reservoir. 1974-1976.

Field assistant on the Colony III Project, for the Colony Development Operation, western Colorado and Wyoming. June 1974.

Researcher - The Red Cliff Project, Eagle County, Colorado, for the Colorado River Water Conservation District. Ecological inventory and impact analysis for a proposed dam and reservoir. Jan.-July 1973, July 1976.

David A. Boyce - Curriculum Vitae

Applied Ecological Research (cont.):

Field assistant - The Alpine Project, for confidential employers, western Colorado. Ecological inventory and impact analysis for a residential development. May-September, 1973.

Laboratory assistant on the Colony Pipeline Corridors Project, for Colony Development Operation. Ecological analyses of potential oil shale products pipeline corridors in Colorado and Utah. January 1973.

Laboratory assistant on the Vail-Beaver Creek Project, for Vail Associates, Eagle County, Colorado. An interdisciplinary study to design and predict the impact of a major ski resort. 1973

Field assistant on the Blue River Valley Powerline Project, for the Public Service Company of Colorado, Summit County, Colorado. A study to design, route, and predict the impact of a powerline in western Colorado. August 1972.

Applied Research:

Biological Laboratory Assistant, Toxicology Branch, Medical Research Laboratory, Edgewood Arsenal, Maryland. A broad spectrum of biological research conducted while a member of the Chemical Corps, U.S. Army. September 1969-June 1971.

PROFESSIONAL SOCIETIES

Colorado-Wyoming Academy of Sciences

Ecological Society of America

Sigma Xi, The Scientific Research Society of North America

PROFESSIONAL ACTIVITIES

Awards:

Francis Ramaley Fund research grant, University of Colorado

Conservation Organizations:

Colorado Native Plant Society

ADDITIONAL EMPLOYMENT, EXPERIENCE, AND SKILLS

Employment:

Sales person for photographic equipment and supplies. 1964.

Experience and Skills:

I have had the opportunity to conduct field trips for youth groups,

David A. Boyce - Curriculum Vitae

Experience and Skills (cont.):

provide tutorial and recreational activities for culturally deprived children, participate in high school and collegiate varsity athletics, participate in amateur bicycling competition, and to function in a leadership capacity in athletic and social organizations. My travel experience within the continental U.S. has been extensive. In addition, I have visited many parts of Canada, Alaska, Hawaii, and Europe. I have a fair speaking and reading ability in the French language. Skills in which I am proficient include photographic and darkroom techniques, oxyacetylene welding, sailing, canoeing, skin and scuba diving, bicycle repair, sewing, downhill and x-country skiing, and "back country" travel and camping. I also have had experience in advanced first aid as a senior rated member of the National Ski Patrol System, avalanche rescue techniques, amateur radio operation, and in general aviation flight training.

BIBLIOGRAPHY

Publications:

Brewer, Richard, D.A. Boyce, J.R. Hodgson, J.D. Wenger, M.H. Mills, and M.M. Cooper. 1973. Composition of Some Oak Forests in South-western Michigan. *The Michigan Botanist* 12:217-234.

Abstracts:

Boyce, David A. 1976. A preliminary description of the ecosystems adjacent to the South Fork of the White River, Rio Blanco and Garfield Counties, Colorado. *The Journal of the Colorado-Wyoming Academy of Sciences* 8(1):45.

Theses:

Boyce, David A. 1969. Foliage Production and Consumption in an Oak Forest. Master's Thesis, Western Michigan University, Kalamazoo, Michigan. 57pp.

Research Reports:

Marr, John W. and D.A. Boyce. 1973. Vegetation Report on The Red Cliff Project. Unpublished manuscript prepared for the Colorado River Water Conservation District.

Marr, John W., R.W. Pennak, D.A. Boyce, J.R. Clinebell, and S.L. Telleen. 1976. Inventory of Ecological Resources and Analysis of Environmental Impact in The South Fork Project Area of Garfield and Rio Blanco Counties, Colorado. Unpublished manuscript prepared for the Colorado River Water Conservation District.

College and/or University Science Courses  
for  
David A. Boyce

I. Undergraduate

A. Biology

1. General Zoology 101 - U.M.
2. Genetics 210 - G.V.S.C.
3. Systematic Botany 303 - G.V.S.C.
4. Ecology 320 - G.V.S.C.
5. Morphology of Green Plants 203 - G.V.S.C.
6. Cytology, Cell Physiology 310 - G.V.S.C.
7. Plant Physiology 403 - G.V.S.C.
8. Animal Behavior 342 - G.V.S.C.
9. Aquatic Ecology 440 - G.V.S.C.
10. Independent Study, Forest Ecology 499 - G.V.S.C.
11. Independent Study, Forest Soils 499 - G.V.S.C.
12. Independent Study, Phytosociology 499 - G.V.S.C.
13. Independent Study, Water Quality Studies 499 - G.V.S.C.

B. Chemistry

1. Fundamentals of Chemistry 201 - G.V.S.C.
2. Organic Chemistry 202 - G.V.S.C.
3. Organic Chemistry 203 - G.V.S.C.

C. Physics

1. Introductory Physics 102 - G.V.S.C.
2. Classical Physics 221 - G.V.S.C.
3. Introduction to Contemporary Physics 222 - G.V.S.C.
4. Physics 125 - G.R.J.C.

D. Geology

1. Principles of Physical and Historical Geology 220 - G.V.S.C.
2. Geomorphology 420 - G.V.S.C.

E. Mathematics

1. Introduction to College Mathematics 101 - G.V.S.C.
2. Algebra and Trigonometry 121 - G.V.S.C.
3. Calculus and Analytical Geometry 201 - G.V.S.C.
4. Introduction to Statistics 215 - G.V.S.C.

II. Graduate

A. Biology

1. Comparative Animal Physiology 519 - W.M.U.
2. Biology of Non-vascular Plants 528 - W.M.U.
3. Plant Ecology 522 - W.M.U.
4. Seminar-Plant Growth Regulators 602 - W.M.U.
5. Seminar-Plant and Animal Paleocology 602 - W.M.U.
6. Seminar-Plant Morphogenesis 602 - W.M.U.
7. Independent Research-Forest Vegetational Analysis - W.M.U.
8. Master's Thesis-Foliage Production and Consumption in an Oak Forest - W.M.U.

David A. Boyce-College and/or University Science Courses (cont.)

9. Tundra Ecology 522 - C.U.
  10. Lichenology 555 - C.U.
  11. Seminar-Environmental Impact Analysis 633 - C.U.
  12. Seminar-Soil/Organism Interactions 633 - C.U.
  13. Dynamics of Mountain Ecosystems 521 - C.U.
  14. Plant Evolution and Biogeography 590 - C.U.
  15. Quantitative Plant Ecology 624 - C.U.
  16. Independent Study-Animal Ecology 539 - C.U.
  17. Seminar-Environmental Impact Analysis 633 - C.U.
  18. Seminar-Dendrochronology 663 - C.U.
  19. Computer Assisted Quantitative methods in Biology 505 - C.U.
  20. Grass/Sedge Field and Museum Methods 446 - C.U.
  21. Taximetrics 573 - C.U.
  22. Independent Study-Moss Taxonomy 599
  23. Doctor's Thesis-Vegetation of the South Fork of the White  
River Valley, Garfield and Rio Blanco Counties, Colorado
- B. Chemistry
1. Biochemistry 551 - W.M.U.
- C. Geology
1. Invertebrate Paleontology 533 - W.M.U.
  2. Glacial Geology 536 - W.M.U.
  3. Morphology and Genesis of Soils 544 - C.U.

Key to College and/or University abbreviations:

University of Michigan - U.M.  
Grand Valley State College - G.V.S.C.  
Grand Rapids Junior College - G.R.J.C.  
Western Michigan University - W.M.U.  
University of Colorado - C.U.

Research Objectives and Progress Report  
on the  
Vegetation of the South Fork of the White River Valley,  
Garfield and Rio Blanco Counties, Colorado

David A. Boyce

February 17, 1977

## INTRODUCTION

The current and/or projected increase in the use of natural resources in western Colorado has necessitated a better understanding of the ecosystems of the region, so as to more intelligently use or preserve these resources. The proposed development of a dam and reservoir on a portion of the South Fork of the White River in Garfield and Rio Blanco Counties is an example of one such resource utilization which provided the impetus for this research. *Define*

*more heading needed*  
The White River is the primary river draining a large portion of the White River Plateau in northwestern Colorado. The Plateau is the prominent physiographic feature of the region and is composed of Paleozoic sedimentary rock overlain by lava and igneous rock of Tertiary and/or Quaternary age (Cronic & Cronic, 1972; Boyd, 1970). From its headwaters at approximately 3300 meters, the South Fork bisects the Plateau as it flows westward for about 50 km. to where it joins the North Fork near Buford, elevation 2110 meters.

There is relatively little information on the diversity of ecosystems in western Colorado. The work done by Langenheim (1962), Brown (1958), Morgan (1969), Miller (1964, 1970), Marr et al. (1973), and Bunin (1975) is representative of the types of information available. Of these studies, Bunin's work on west slope vegetation in the Park Range includes habitats and vegetation types which most nearly approximate those of the South Fork valley. There are, however, a number of studies concerned with the White River Plateau adjacent to the South Fork valley. These include the early surveys of Sudworth (1898); range management studies by Turner and Dortignoc (1954), Klemmedson (1956), and Boyd (1970); and, considerations of vegetation pattern on the Plateau (Miller 1964, 1970). These studies provide little information on the ecosystems of the South Fork valley and thus do little to describe the diversity of vegetation in the region.

Studies were begun during the summer of 1974 for the purpose of inventorying the ecological resources to provide information pertinent to the synthesis of an Environmental Impact Statement. Reconnaissance of the valley and sampling within the area of proposed disturbance was undertaken during June-August. Five broad vegetation types, based on physio-

gnomically dominant tree and shrub communities, were identified, sampled quantitatively, mapped, and described for inclusion in an unpublished research report for the Colorado River Water Conservation District. This preliminary study, at mid-elevation within the valley, did not deal with the vegetation of the entire valley and, consequently, did not provide a clear picture of the region's vegetation. The following observations and hypotheses, based on the preliminary data, were proposed, and provided the focal point for the continued research throughout the South Fork Valley:

#### I. Observations

- A. The area's vegetation varied in physiognomy, species composition, species coverage, and topographic setting.
- B. The complex vegetation was susceptible to subdivision into stands and similar stands could be aggregated into stand-type synthetic units.
- C. The pattern of stands of the initial study area, at intermediate altitudes in the valley, was different from that at both higher and lower altitudes.
- D. The vegetation of the South Fork Valley was different from that described in publications on other parts of western Colorado.

#### II. Hypotheses

- A. The variations in the vegetation noted in the initial studies are so great that subdivision into associations (Daubenmire, 1952) is required in order to achieve units with an acceptable degree of homogeneity.
- B. The above variations in both the pattern of associations and within the associations is related to a topography-soil-moisture gradient. The relationships were hypothesized to result in the following distribution of vegetation units in the entire valley:

- How many sp?* 1. Oak stands, in the initial study area, are confined to situations where exposure, slope, and soil depth, texture, and rockiness result in limited moisture availability. Oak probably approaches an upper elevational limit in the vicinity of the initial study area, so that increased

elevation would result in diminished occurrence, and then only on southern exposures with soil conditions similar to those in oak stands from the initial study area. Decreased elevation would result in increased distribution of oak stands, which would not be confined to southern exposures or to situations with as shallow or rocky a soil as in the initial sample sites. Within the more moderate sites expected in lower portions of the valley, one would hypothesize increased oak shrub and herb coverages.

what species?  
are there differences  
due to species  
differences?

2. Sage vegetation is confined to deep, fine textured soils of valley bottom situations in the initial study area. Sage and herbaceous vegetation in these sites would be expected to exhibit increased coverages where sample sites are adjacent to north-facing slopes and consequently have more moisture available than those on the opposite side of the valley. Sage stands would continue to be confined to valley floodplain situations in lower portions of the valley; however, with decreased moisture both sage shrub and herb coverages would be expected to decrease. Increased elevation should result in sage stands being confined to more southerly exposures, with resultant increased rockiness and decreased soil depth and moisture availability being associated with reduced shrub cover. With continued elevational increases, grass species would be expected to replace sage in both valley bottom and south-facing slope situations.

what genera, species?

3. Coniferous vegetation, excluding Ponderosa and Douglasfir, is contingent on moisture and temperature regimes found primarily on steep, north-facing slopes, regardless of soil depth, texture, or rockiness, within the initial study area. Mature Ponderosa and Douglasfir, on the other hand, are found exclusively on south-facing talus slopes with limited soil and a preponderance of exposed rock. Coniferous vegetation would be expected to occur at

increasingly higher elevations on north-facing valley sides in down-valley areas, and conversely, nearer the valley bottoms and onto south-facing slopes at higher elevations up-valley. Coniferous vegetation would continue to be dependent primarily on moisture and temperature regimes, regardless of soil depth, texture, or rockiness.

4. Within the initial study area, differences within the Aspen stand-type, in both numbers of stems per unit area and in herbaceous cover, correspond to variations in moisture availability. It is expected that coverages would increase as one progressed from south-facing colluvial deposits to valley bottom alluvial-colluvial deposits, and that this progression would continue as valley bottom sites approached north-facing valley sides. Aspen stands would be expected to occur at increasingly higher elevations on valley sides, or on more northerly exposures, in down-valley areas, and conversely, near the valley bottom and on south-facing valley sides at higher elevations up-valley. Where topographic position results in differences in substrate, it would be expected that changes in cover would follow the trends of increased coverage where site and soil characteristics allow for adequate moisture availability.

- C. The associations present within the valley of the South Fork of the White River differ from those reported in other areas of western Colorado which have similar ranges in site variability.

Therefore, the objectives of this study are to identify and classify the vegetation units of the valley of the South Fork of the White River, to determine if these units thus categorized can be shown to correspond, as hypothesized, to factors related to a topographic-soil-moisture gradient, and to determine if these units differ from those reported elsewhere in western Colorado.

What  
man-made  
facilities  
are found  
here?  
METHODS

How much  
mining was, or is,  
done in this area?

The vegetation in ninety-six quadrats was sampled during the 1974 and 1975 field seasons using the methods of Daubenmire (1952). Sample sites were selected subjectively so as to include those which typified the range of variation in stands of each vegetation type. Thus, it was hoped that the entire spectrum of vegetation within the valley would be included in the study. However, those areas used exclusively for grazing or grass production and willow communities immediately adjacent to the river were not considered. In much of the lower part of the valley the above communities overlapped to a great extent, and were subject to such great disturbance that the natural character of the vegetation was obliterated, and as such was deemed not worthy of consideration. Throughout the remainder of the valley willow communities were of such density and stature that quantitative samples were prohibited and these were sampled only superficially for species present. For all of the other sample sites the following information was either recorded in the field or determined in subsequent laboratory analysis of the data:

- I. Site Data
  - A. Elevation
  - B. Slope
  - C. Exposure
  - D. Topographic position
- II. Soil Data
  - A. Solum thickness (depth to "C" horizon)
  - B. Bulk density
  - C. Textural classification and moisture retention capacity
  - D. Organic content
  - E. pH
- III. Vegetation Data
  - A. Trees
    - 1. Species present
    - 2. Diameters and basal areas at breast height
    - 3. Density
    - 4. Canopy height
    - 5. Ages of representatives of various size classes
  - B. Shrubs

1. Species present
  2. Species cover
- C. Herbs
1. Species present
  2. Species frequency
  3. Species cover

From these vegetation data association determinations will be made on the basis of tabular comparison of constancy and cover values for tree, shrub, and herb dominants (Daubenmire, 1952; Daubenmire & Daubenmire, 1968). Successional status of the stand, as based on field observation and age structure, will also aid in association determinations. Although all species present will be used in comparing associations, only species exhibiting at least 40% constancy and coverages of at least 1% will be used in association determinations.

7 7  
Once association determinations have been made, these vegetation units will be compared with those set forth during the initial study. These associations, based on the consideration of a number of unions rather than only the physiognomically dominant one, are expected to differ from those of the preliminary study and provide a more accurate description of the vegetation both within the initial study area and throughout the remainder of the valley.

Site and soils data will serve to indicate if the hypothesized inter- and intra-association variations are related to factors associated with a topographic-soil-moisture gradient. By plotting inter- or intra-association variation relative to observed environmental gradients one will be able to test the validity of the hypothesized variations. Both simple gradient transect and environmental pattern analyses, as described by Shimwell (1972), will be used.

Comparison of the vegetation of the South Fork Valley with that of other regions in western Colorado will be undertaken as the final segment of this research. Comparisons will be based on data collected in this project plus additional published and unpublished materials available to the author, and will be directed toward study of basic association similarity and difference as determined by tree, shrub and herb dominants.

## RESEARCH PROGRESS

Refinement of field data is complete. Species identifications have been made and verified when possible, and tabular comparison of similar vegetation types is underway. Upon completion of this comparison, associations will be proposed and will be subjected to analysis via direct gradient techniques.

It is expected that progress will be such that completion and defense of this research will be possible by June 1977.

## PROPOSED FORMAT

- I. Introduction
  - A. Background and Objectives
  - B. Location of Study Area
  - C. Literature Review
- II. Description of the Study Area
  - A. Geology
  - B. Climate
  - C. Stream Biology
  - D. Terrestrial Fauna
  - E. Disturbance
- III. Methods
  - A. Data Collection
    - 1. Selection of sample sites
    - 2. Sampling methods for vegetation
    - 3. Sampling methods for environmental factors
  - B. Analysis of Data
    - 1. Association classification
    - 2. Direct Gradient analyses
    - 3. Taxonomic considerations
- IV. Results and Discussion
  - A. Vegetation Types
    - 1. Pinus ponderosa Association
      - a.) characterization of vegetation

b.) environmental factors

c.) relationship between vegetation and environmental factors

2. Pinus contorta/Amelanchier alnifolia Association

a.) ...

B. Vegetation Pattern

1. Inter-association comparison of vegetation

a.) dominant species or unions

b.) species cover

c.) species richness

2. Inter-association comparison of environmental factors

a.) elevation

b.) slope

c.) exposure

d.) solum thickness

e.) soil texture, moisture retention capacity, and bulk density

f.) soil pH and organic matter

3. Environmental pattern analysis of associations

C. Comparison with other areas

V. Summary

VI. Literature Cited

VII. Appendix

A. Species List

B. Site Location Data

C. Complete Vegetation Data

D. Soils Data

6 Jan 1978

Dear Dr. Rogers,

Happy New Year & greetings from Philadelphia. Yes, you're right, I do want something! I've applied to the Community College of Philadelphia for a teaching position in the Biology Dept. and <sup>would</sup> greatly appreciate your contributing a letter of reference in support of my application. There is no definite position available at this time but I hope to pick up full or part time work when their new semester begins in the middle of Jan. Therefore, I'd appreciate your response at your earliest convenience. The community college offers a number of courses for which I'd be qualified. These include General biology, General botany, Man & Environment & field ecology. So, if you would direct your comments toward my ability in introductory biology and botanical and/or ecological courses, I'd certainly appreciate it.

I never did get the address of your contact at the Franklin Institute & would appreciate getting that so as to have someone or somewhere to start at that institution.

I've met and discussed consulting job possibilities with Jack McCormick who apparently knows you from your days at NY Bot. Gardens. This spring Jack McCormick & Associates are doing some work on grapes & their response to radiation in France. Knowing your interest in the area (subject matter), you might want to get in touch with him. His current <sup>home</sup> address is: 8038 Fenway Rd.

Bethesda, MD, 20034

phone 301-365-3180

Please send the letter of reference to:

R. R. Fenstermaker  
Head, Biology Department  
Community College of Philadelphia  
34 South 11th Street  
Philadelphia, Penna. 19107

My address, should you need it, is:

801 Cherry St., Apt 707  
Philadelphia, Penna. 19107

Should you be concerned that you've not received a copy of my thesis, fear not, but don't hold your breath. Apparently the copy center in Regent is a little slower than they anticipated. Dave Backner is taking care of that little matter & will drop off a copy when they're ready.

Thanks much.

Sincerely,

Dave Boyce

Dr. R. R. Fenstermacher  
Head, Biology Department  
Community College of Philadelphia  
34 South 11th Street  
Philadelphia, PA 19107

Dear Dr. Fenstermacher:

I write to support the application of Dr. David Boyce for a position in your Department. I have known Dave since 1972, as a graduate student and as a teaching assistant in my <sup>one-semester</sup> course in Economic Botany, EROB 315. I served as a member of his graduate committee. I know him, therefore, much better than I know the average graduate student in our department.

You will learn that he has had considerable experience in teaching undergraduates, having served as a teaching assistant in several courses. Here, we put considerable responsibility on our grad student assistants, and they are well experienced. My own reaction is that he did an outstanding job with students in my course, and he performed well in all parts of the course.

Boyce also took two of my graduate courses, and in both of these he was a good, though not outstanding, student. He was always well-prepared and carried out his assignments with skill and willingness. His performances, both as a student and teacher are, therefore, very good. His only tendency that might be improved was that he tended to be a bit superficial in some of his own research preparation. I think he did correct himself when told that this was true, which is a good characteristic--he takes criticism in good grace.

Dave is a very likeable individual. He should relate well to students, and with his background, I think you will find him a very good instructor. I recommend him highly.

Sincerely,  
David H. Boyce  
Professor of Botany

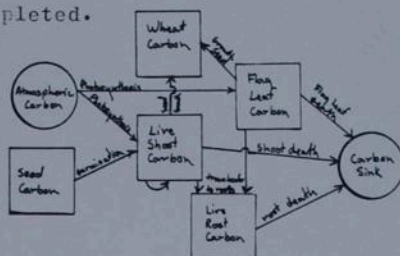
### Simulation Modeling of Spring Wheat

#### Objectives:

- 1) My first objective is to better understand the role of simulation modeling in ecology, illuminating where and when modeling is or is not useful.
- 2) My primary objective is to develop an agro-ecosystem model as a vehicle for organizing information about spring wheat.
- 3) It is not one of my objectives to develop a simulation model with projective value; although I believe this is possible with further work supported by another degree or internship.

#### Time Schedule:

- 1) Build conceptual model (involves deciding on important variables and flows)-completed.



- 2) Search literature for information about the variables and flows-completed.
- 3) Formulate mathematical expression for flows-(Dec. 76-Jan. 77).
- 4) Construct computer program to simulate flows-(Jan.-Feb.).
- 5) Adjust model (Feb.-March).
- 6) Link carbon flow model with IBB abiotic model-(March).
- 7) Adjust full simulation model (April-May).
- 8) Verify model with complete data set (May-June).
- 9) Summarize and write (July-Aug.).

I believe that attempting a simulation model of an agro-ecosystem is the best way to learn about the utility of modeling ecosystems. Simulation models have been proven to be useful tools providing a simplified abstraction of an ecosystem. Simulation models provide a method of organizing large quantities of information about an ecosystem and testing the usefulness of that information.

## SIMULATION MODELING OF SPRING WHEAT

### Major Topics Discussed:

- The place of simulation modeling in biology.
- Agricultural modeling.
- Progress and procedures for proposed simulation modeling of spring wheat.

William S. Boyd

November 15, 1976

## SYSTEMS SIMULATION IN BIOLOGY

Simulation involves extracting information about a system; constructing a model of the system; and testing how well the model accounts for the behavior of the system. Of central importance to any simulation is a model. A model is a conceptual framework usually expressed in mathematical terms. More precisely, a model is an orderly set of hypotheses with numerous variables which express the condition or state of the system of any given point in time. When a system is simulated, the initial state of the system is defined, usually from observation; then the model is applied, changing the state of the system through time. If successful, the simulation will account for the behavior of the system.

Systems simulation is a relatively recent activity in biology. The creation of models of biological systems which underly all simulation is not new. The most notable, early examples from modeling population phenomena are the logistic equations formulated by Verhulst, Pearl, and Reed in the mid-twenties, and the population competition model formulated in the late twenties by Lotka and Volterra.

Models of ecological systems are considerably more complex than the early population models. While simple models may be developed and verified on paper, large models of ecosystems require computer storage and organization of information.

Only recently has the mathematical and computer technology become available to the biologist. With these new techniques, ecosystem modeling is possible for the first time (Watt, 1969); whereas, modeling population phenomena has been possible since the turn of the century. A few of the important characteristics which make ecosystem models more complex than other biological models are the great number and complexity of independent variables; the different causal pathways; the cumulative pathways; the cumulative effects; the time lags; and the thresholds.

In the past two decades systems ecology was born and has since undergone tremendous growth. A systems analysis approach to

understanding ecosystems was pioneered by Odum (1971), Patten (1975), and Watt (1969). They pointed out that due to the complexity of ecological and economic systems, system analysis, modeling, and simulation were not possible before the advent of large computers. Watt (1969) showed that these fields of ecology are on the increase (Table I).

Table I

|                                     | 1920-1935 | 1945-1965 |
|-------------------------------------|-----------|-----------|
| Systems measurement                 | .80       | .63       |
| Systems analysis                    | .09       | .27       |
| Systems description                 | .09       | .08       |
| Systems simulation and optimization | .00       | .00       |
| Writing                             | .02       | .02       |

Watt and Patten speculated that modeling and simulation will be of central importance in ecology as hardware, software, and conceptual techniques are improved. The Battelle (1975) study showed that improvements in modeling and simulation are a major contribution of the International Biome Program.

Prior to 1965 (Table I) there was little effort devoted to the simulation of biological systems. Watt (1969) believes that in the future ecosystem simulation will be the primary tool for resource management.

Modern models and simulation fall into two major categories: deterministic and stochastic. Stochastic models and simulations are commonly used when probabilistic events contribute significantly to phenomena under study. Monte Carlo Simulation and models based on Markovian processes are most common (Chorafas, 1965). If a phenomena is not well enough understood to be parameterized, statistical models such as regression models are used for initial description of the phenomena. Simulation is not possible at this level of understanding.

Deterministic models and simulations are used to describe systems when probabilistic events contribute little to the overall

system dynamics and when the system is well enough understood to be accurately described mathematically.

The first step in constructing a simulation is to build a mathematical model which accurately represents the system. To do this, important objects and properties of the system must be identified with mathematical variables, and relationships must be described by mathematical or logical functions.

The next step in constructing a simulation is to write a computer program to carry out the model and to change results from the sequence of events which effect the system (Gordon, 1966). The intention of a simulation language is to simplify a problem by facilitating the programming aspect of the simulation. The modeler should be able to focus his effort on the modeling rather than on computer programming.

#### AGRICULTURAL MODELING

The largest modeling projects in the United States arose from the International Biological Program (IBP). Experience gained in the U.S. IBP has shown that computer models can be useful tools for integrating information about a complex ecosystem. The IBP modelers' primary objective was to produce a projective model of an ecosystem. They fell short in obtaining this goal. They found that projective ecosystem models had major deficiencies because of a lack of data about certain components of the ecosystem. The most significant result of the IBP modelers' efforts was to show that simulation models are a useful pedagogic tool for increased understanding of a complex ecosystem.

The ultimate goal of all simulation modeling is to develop predictive models to be used as a tool for resource management and to assess the environmental impacts of natural and man-made changes on an ecosystem. Before these goals can be achieved it is necessary to develop models as pedagogic tools for understanding the present dynamics of ecosystems.

Some of the most promising simulation models have been developed for agro-ecosystems. Agricultural systems are intentionally simplified

for economic reasons. Agricultural crops are grown as vast monocultures eliminating consumers, symbionts, and parasites, as well as possible human intervention. The dynamics of the nitrogen and phosphorus cycles are simplified by the addition of fertilizers. Decomposers play a small role in the agro-ecosystem during crop production. Decomposers are important when the land lays fallow between periods of production.

There are two reasons why modeling agro-ecosystems has the greatest potential for producing predictive models. First, the ecosystem has been vastly simplified by man. Secondly, because of the economic importance of agricultural crops, there is a wealth of data about physiological and ecological processes. There are several simulation models which have predictive value for a few agro-ecosystems.

Baker, Hesketh, and Duncan (1972), have developed a preliminary simulation model for cotton yield. Duncan (1973) developed a simulation model SIMMAIZ for simulating the growth and yield of corn. Mill, Hank, Keller, and Rasmussen (1974) have developed a small-scale regression model of corn growth. Rickman, Ramig, and Allmaras (1975) developed a simulation model for dry matter accumulated in dry land, winter wheat driven by abiotic parameters. The Rickman *et al.* model is the only simulation model presently available for wheat. There is no complete simulation model for spring wheat growth and yield. Regression models that correlate wheat yield with abiotic variables are available for spring and winter wheat.

Regression models have been developed primarily by meteorologists and not biologists. The model reflects this. The major emphasis is on the prediction of yield as a dependent variable of meteorological parameters. McQuigg (1974,1975) gives a clear review of this approach to modeling in the Economic Impacts of Weather Variability. As the title indicates, these models are centered around a meteorological event and not around an organism. This is a major deficiency of this approach. One of the most successful attempts of this approach is by Williams's (1972) regression model. It can be criticized from two different points of view. The geo-

graphical area is too large and the model does not center around the organism. His model deals with a vast geographical area including many different varieties of wheat and many different agricultural techniques. Predictive modeling of large geographical areas (the size of states) shows little regard for the organism. Another criticism is his use of driving variables. William's regression model, like similar models, uses the extremes and the mean of meteorological events. The timing of a meteorological event is very important to the life history of any organism. Often the timing is more important than the magnitude.

As a biologist, I believe that the major deficiency of present regression models of wheat is the disregard for the organism; yield, and not the growth and yield, of the wheat plant is being modeled. This results in two major problems: the models do not take into account the timing of meteorological events and the models are made for such a large geographical scale that they have no utility for systematic resource management. A meteorological criticism of the regression model approach was made by Dr. E. Zipser from N.C.A.R. (G.A.T.E. group). He believes that it is tenuous to use synoptic meteorological measurements to predict wheat yield because wheat yield is determined by the micro-meteorological events surrounding the field. The link between synoptic meteorology and micro-meteorology is not well understood.

An agro-ecosystem-level model is needed for spring wheat. The specific objective of such a model would be to simulate the dynamics of spring wheat growth and crop yield as a function of daily rainfall, air temperature, nitrogen fertilizer, and water. The first step toward such a model is the creation of a simulation model as a tool to better understand the present dynamics of wheat growth and yield from the orientation of the organism.

#### THESIS PROJECT

For my thesis, I will attempt to develop a simulation of wheat growth and yield based on a carbon-flow model. I am interested in modeling ecosystems; as mentioned previously, agro-ecosystems are a good place to begin because they are simplified ecosystems

maintained in a stage of secondary succession. Wheat is a particularly good organism to simulate because of its economic importance. Because of this fact there have been volumes of data collected on the physiology and ecology of the plant. There is also a practical need for a good simulation model of wheat. I chose medium-yield spring wheat to model because the new varieties of dwarf spring wheat have not had their physiology and ecology worked out. There also is more data on medium-yield spring wheat to test the model.

My objective is to simulate spring wheat growth and yield on a daily basis during a complete growing season. The simulation will be centered around a carbon-flow model for wheat. Once developed, this model will be driven by a modified version of the Grassland LBP abiotic submodel. The important nitrogen and phosphorous flows of wheat will not be attempted at this time, but once the carbon-abiotic flow model is perfected the nitrogen flow could be added. For my thesis I will assume that nitrogen is always in non-damaging excess of the optimum due to fertilization.

My model will not take into account decomposers, consumers, parasites, or diseases. Decomposers do not make a major contribution to the carbon-flow during the growing season. They do alter the initial condition of the soil after the land has laid fallow. Consumers, parasites, and diseases are eliminated by man and therefore under normal conditions they do not severely disrupt the carbon-flow, although they do have a great impact on the economics of production. These assumptions are often met in modern agriculture.

My model will not be a predictive model; its primary purpose will be to lead to a better understanding of the spring wheat agro-ecosystem. If the simulation project is successful, my model may be integrated with a nitrogen-flow which together may give a predictive value for agriculture management.

## PROCEDURE FOR PRODUCING SPRING WHEAT SIMULATION MODEL

The basic conceptual framework underlying my wheat simulation model is that of Patten, Odum, and Watt. It will trace the flow of a resource through an ecosystem. Such an approach utilizes a deterministic model based on a set of finite difference equations or differential equations which are stepped through time by some iterative technique.

One of the major contributions of the Grassland IBP was to develop a set of useful techniques and tools for flow simulation. The IBP models developed a FORTRAN computer program which is a simulation precompiler. It allows a modeler to set up a model in a way which facilitates a biologist's work with the model and the ecosystem being modeled. The language is an extension of FORTRAN IV, keeping FORTRAN as a subset of the language. There are two versions of the precompiler available: SIMCOMP 3.0, which is machine-specific for CDC 6400 operating under SCOPE, and SIMCOMP 2.1 which is a portable precompiler written in a CDC dialect of ANSI FORTRAN. SIMCOMP is a continuous simulation language. A continuous process is approximated by a set of first-order difference equations.  $TIME\ K$  depends only on the preceeding time,  $TIME\ J$ , and the rates of change over the time interval.  $JK(K=J+DT)$ , where  $DT$  is a standard time step. SIMCOMP is a flow-oriented language.

The primary design consideration of SIMCOMP was effective communication which is the most important aspect of any simulation language. Models and simulations are used by investigators to better understand systems. The modeler's knowledge of the nature of the system or of some of the specific data in the system is revealed by his model. Deficiencies are always present. Often, simulation is used to resolve unknown factors by testing hypotheses about the processes involved or testing unknown data. Model building involves a learning process in which not one, but a series of models are developed by the modeler to become more familiar with a system. Gordon (1966) stated that to be effective, a simulation language must enable an investigator to visualize the system under study. SIMCOMP is one of the better simulation languages presently available which permits a modeler to visualize and better understand

a system during the process of constructing a model.

With a simulation language like SIMCOMP it is possible to construct an ecosystem flow model with limited computer programming experience. The procedure for developing a simulation model involves deciding on what state variables are important; constructing flows between the state variables; collecting data on the state variables and flows; mathematically describing the flows; writing a program which steps the flows through time; and calibrating and verifying the model. The following is the procedure which will be used to develop the model, and the progress already made:

1. Decide what the important state variables are (completed).
  - a) photosynthesis
    - 1) flag leaf
    - 2) shoots and leaves
  - b) translocation to roots
    - 1) flag leaf
    - 2) shoots and leaves
  - c) growth of wheat seed
    - 1) flag leaf
    - 2) shoots and leaves
  - d) germination of seed
  - e) death of shoots and leaves
  - f) death of roots
  - g) feedback during growth
2. Identify variables which the state variables depend on (completed).
  - a) life history-phenologic variable
  - b) leaf area index
  - c) leaf angle (distribution or mean)
  - d) accumulation of dry matter
  - e) precipitation
  - f) temperature
  - h) humidity
  - i) soil water supply
  - j) nitrogen nutrition
  - k) solar radiation

3. Identify known relationships between the state variables: flows (completed). (See flow chart.)
4. Search literature for experimental studies which relate the state variables or flows (nearly completed).

I) Photosynthesis and the growth of wheat seed:

a) Campbell et al. (1969)

-Mean leaf area index decreased and mean net assimilation rate and relative growth rate increased linearly with increases in the log of light intensity.

-In two moist years grain yields decreased linearly with a decrease in light intensity. In the three dry years yield was unaffected by a decrease in light intensity (illustrates Liebig's Law of the Minimum).

b) Connor and Cartledge (1970)

-A simple photosynthetic model considering the community as a single horizontal leaf does not work. A photosynthetic model must include either the mean leaf angle or a distribution of leaf angles.

c) Connor and Cartledge (1971)

-CO<sub>2</sub> uptake by a leaf is approximately proportional to light intensity.

d) Evans and Raoult (1970)

-Flag leaf, stem and ear are the major source of carbon in grain.

e) Lupton (1968)

-Photosynthetic activity was not limited by the size of the "sink" to which photosynthates were translocated.

f) Milthorpe and Moorby (1974)

-There is an interaction between source and sink. Removal of the head reduces photosynthesis by 40%.

- Flag leaf contributes a major part of its photosynthate to the grain.

g) Luckridge (1971)

-No difference between varieties with respect to photosynthesis per unit of dry weight was found.

-A mathematical relationship between LAI and anthesis and between solar radiation and  $CO_2$  was found.

h) Thorne (1965)

-Budget of net photosynthesis  $M = I_e - R_d - R_u + S$ .

i) Voldeng and Simpson (1967)

-Flag leaf contributes from 85% to 60% of the carbon in the grain (mean 80%).

II) Photosynthesis, the growth of wheat seed, and life history:

a) Evans and Rauson (1970)

-Dark respiration peak occurs twelve days after anthesis and then declines.

b) Fischer (1975)

-Photosynthesis rate is depressed around anthesis.

c) Luckridge (1968)

-Yield is affected by the light environment of the shoot at any stage before ear emergence.

d) Lupton (1968)

-Carbohydrate translocated to the grain was very small at and before anthesis but increased rapidly afterwards.

e) Wardlaw (1967)

-A mathematical relationship between the net photosynthesis and water stress was found.

III) Translocation (more data is needed).

a) Milthorpe and Moorby (1974)

-Carbon translocation budget of the flag leaf.

b) Wardlaw (1967)

-Carbon translocation budget for flag leaf and secondary leaves in control plants and water-stressed plants.

IV) Germination (completed)

a) Milthorpe and Moorby (1974)

- minimum temp. 4 C
- optimum temp. 25 C
- maximum temp. 32 C

b) Read and Benton (1963)

- Data on days to germination and % germination at different temperatures, and moisture tensions.

c) Wellington (1966)

- Comprehensive review with some data.

V) Death of shoot (no data).

VI) Death of root (no data).

VII) Feedback during growth (no data).

VIII) Life history (completed)

a) Bunting (1966)

- Comprehensive life history of vegetative phase.

b) Friend (1966)

- Life history during growth phase.

c) Thorne (1966)

- Comprehensive life history of reproductive phase.

5. Mathematically define flows (just begun).

example: From the literature search one knows the minimum, maximum, and optimum temperatures for germination. Parton (1975, 1974) found that for several grasslands germination is a hyperbolic function. Knowing the function and the minimum, maximum, and optimum one can solve for the germination function of wheat.

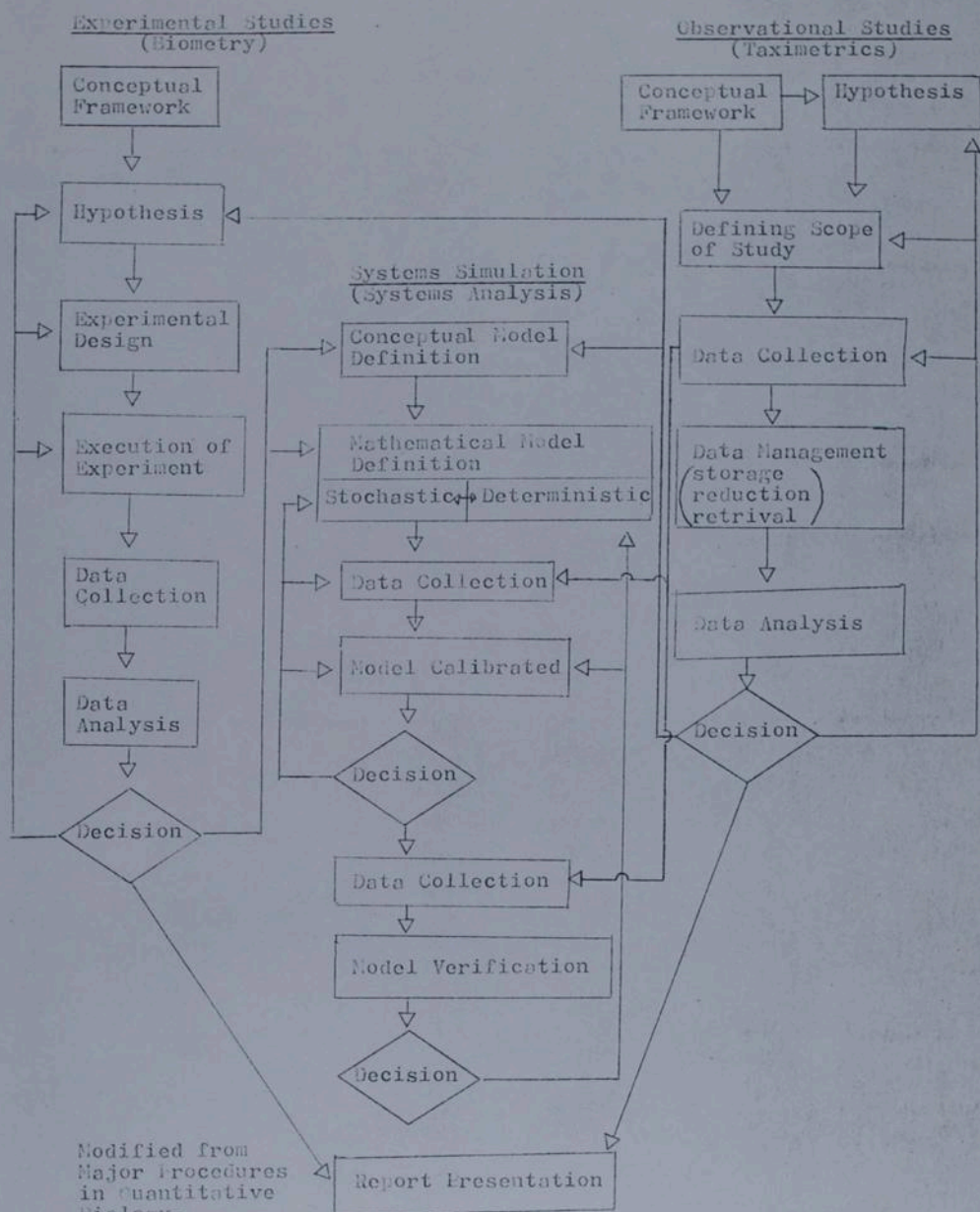
The most complex of the flows is photosynthesis which is presently being worked on. The general approach is to find from the literature previously cited the optimum net photosynthesis and then subtract from this rate as driving variables like temperature and moisture deviate from the optimum until a threshold is reached where the process does not work.

6. Write computer program to simulate flows (using SINCOMP 2.1). This involves putting SINCOMP 2.1 on the CU CDC-6400.
7. The carbon-flow model must be calibrated with the assumption that water and temperature are not limiting factors.
8. Once the carbon-flow model works autonomously it will be linked with Parton's (in press) abiotic model which was the abiotic model used in the Grassland IBP Ecosystem Level Model.
9. Using a complete data set, the simulation model now composed of the carbon-flow model and the abiotic model is calibrated. Paltridge et al. (1972) published a complete set of data throughout an entire growing season. This data set includes all the necessary biotic and abiotic variables. This data will be used to calibrate or "tune" the model (i.e., solve for unknown constants).
10. The final step is to validate the model. This is achieved by running the simulation model with initial conditions and meteorological data from an area and an investigator independent of the data upon which the model has been constructed and calibrated.  
I will use data from the experimental agronomy station at C.S.U. Data from one or several growing seasons will be used in the simulation. Results of the simulation will be compared to the actual results from the station.

#### CONCLUSION

I believe that attempting a simulation model of an agro-ecosystem is the best way for me to learn about modeling ecosystems. Simulation models have been proven to be useful tools providing a simplified abstraction of an ecosystem. It is important to keep in mind that all models represent a collection of hypotheses and assumptions. Every equation is a hypothesis because it is based partially on data, partially on the literature, and partially on inferences. The primary aim of simulation modeling is to systematically organize information about the system and to ultimately bring about a better understanding of the system. Once this is achieved, and more is known about the system, the simulation model can be refined, resulting in a model with a predictive value which may be used for better resource management.

# THE PLACE OF SYSTEMS SIMULATION IN BIOLOGY



Modified from  
Major Procedures  
in Quantitative  
Biology-  
Dr. D. Rogers

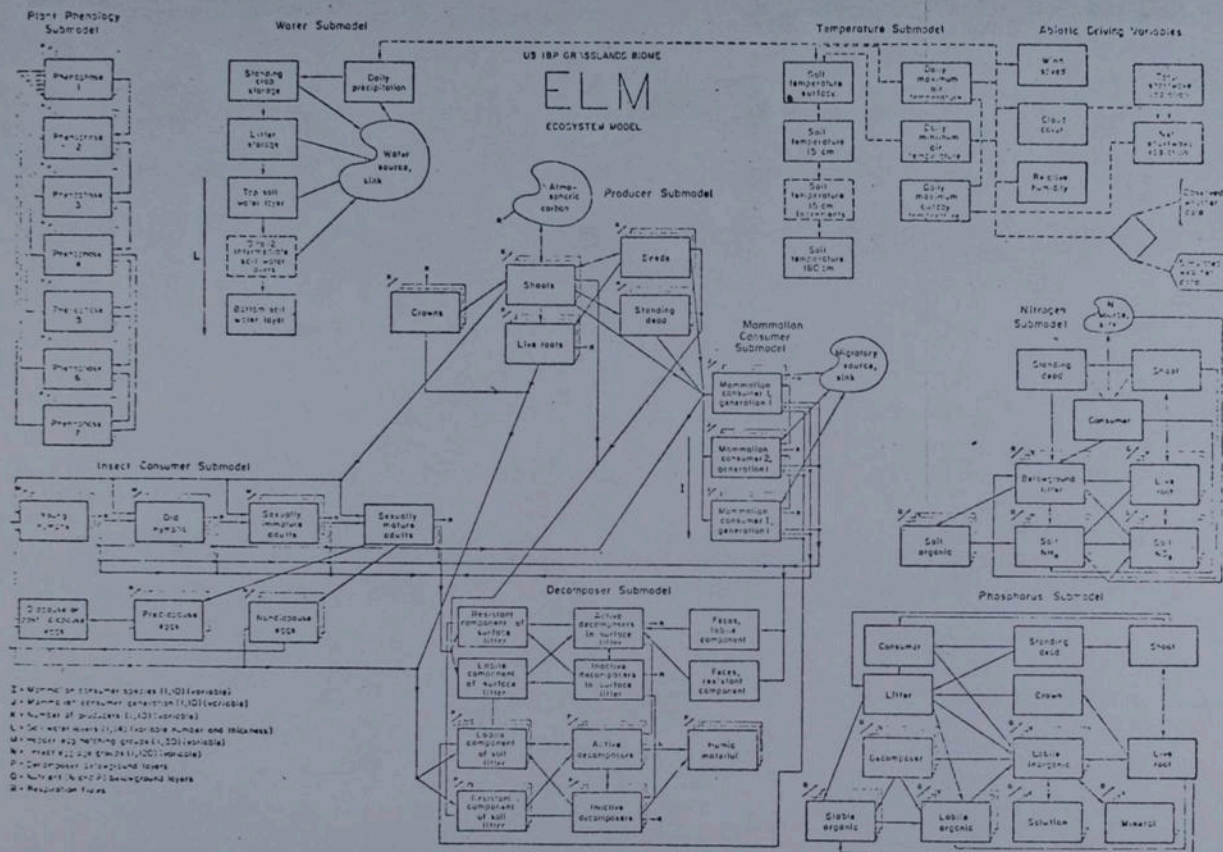
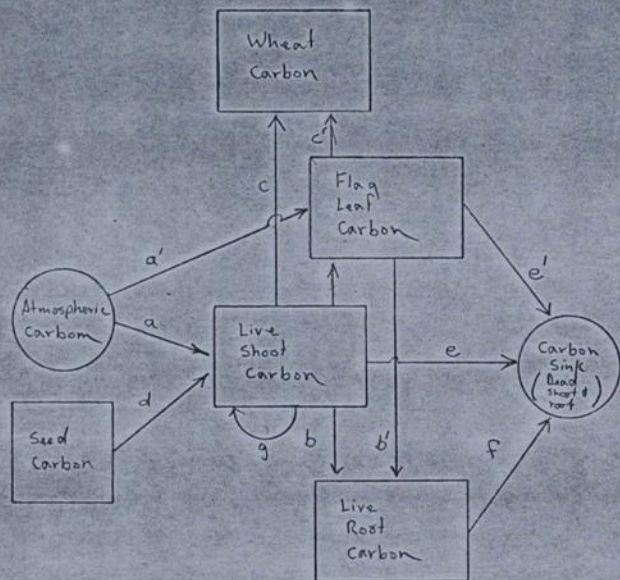


Fig. 2. U.S. IBP Grasslands Biome ELM Ecosystem Model, Flow Diagram.



Wheat Model - Carbon Flow  
Producer Submodel

- a) photosynthesis
- b) translocation to roots
- c) growth of wheat seed
- d) germination
- e) death of shoot
- f) death of root
- g) feedback during growth

REFERENCES  
&  
BIBLIOGRAPHY

- Baker, D. N., J. D. Hesketh, and W. J. Duncan. 1972. Simulation of growth and yield in cotton: I. Gross photosynthesis, respiration and growth. *Crop Sci.* 12:131-135.
- Battelle Laboratories. 1975. Evaluation of three of the biome studies programs funded under the foundation's International Biological Program (IBP). Battelle Columbus Laboratories, Columbus, Ohio.
- Bibliography of Wheat. 1971. International Maize and Wheat Improvement Center, Mexico. The Scarecrow Press, Inc., Metuchen, N.J. 3 vols.
- Bunting A. H. and D. S. H. Drennan. 1966. Some aspects of the morphology and physiology of cereals in the vegetative phase. Pages 20-38. In F. L. Milthorpe and J. D. Ivins (eds.) *The growth of cereals and grasses*. Butterworth. Inc. Washington.
- Calponzos, L., A. P. Roelfs, M. E. Madison, F. B. Martin, J. R. Welsh, and R. D. Wilcoxson. 1976. A new model to measure yield losses caused by stem rust in spring wheat. *Univ. of Minn. Agr. Exp. Station Tech. Bull.* 307.
- Campbell, C. A., W. L. Felton, and R. F. Neilson. 1969. Influence of solar radiation and soil moisture on growth and yield of Chinook wheat. *Can. J. Plant Sci.* 49:685-699.
- Cole, G. W. 1976. Nutrient submodels. Pages 304-334. In G. W. Cole (ed.), *ELM: Version 2.0*. Range Sci. Dept. Colo. State Univ.
- Connor, D. J. and O. Cartledge. 1970. Observed and calculated photosynthetic rates of Chloris gayana communities. *J. Appl. Ecol.* 7:353-362.

- Conner, D. J., and O. Cartledge. 1971. Structure and photosynthesis of wheat communities. *J. Appl. Ecol.* 8:469-475.
- Cowan, I. R. 1968. The interception and absorption of radiation in plant stands. *J. Appl. Ecol.* 5:367-379.
- Day, A. D., and S. Intalap. 1970. Some effects of soil moisture stress on the growth of wheat. *Agron. J.* 62:27-29.
- Duncan, W. G. 1973. SIMALZ: A model simulating growth and yield in corn. In D. N. Baker (ed.). The application of systems methods to crop production. *Proc. Symp. Mississippi State Univ.* (June 7 to 8).
- Evans, L. T., and H. N. Rawson. 1970. Photosynthesis and respiration by the flag leaf components of the ear during grain development in wheat. *Aust. J. Biol. Sci.* 23:245-254.
- Fischer, R. A. 1975. Yield potential in a dwarf spring wheat and the effect of shading. *Crop. Sci.* 15:607-613.
- Friend, D. J. C. 1966. The effects of light and temperature on the growth of cereals. Pages 181-198. In F. L. Milthorpe and J. D. Ivins (eds.). *The growth of cereals and grasses.* Butterworth Inc., Washington.
- Gordon, G. 1966. Simulation languages for discrete systems. *Proc. IBM Sci. Comp. Sym. Simulation Models and Gaming.* Pages 101-118.
- Gustafson, J. D., and G. S. Innis. 1973. SIMCOMP version 2.1 user's manual. US/IBP Grassland Biome Tech. Rep. No. 217. Colorado State Univ., Fort Collins. 96pp.
- Gustafson, J. D., and G. S. Innis. 1973. SIMCOMP version 3.0 user's manual. US/IBP Grassland Biome Tech. Rep. No. 218. Colorado State Univ., Fort Collins. 149pp.

- Hill, R. W., R. J. Hanks, J. Keller, and P. V. Rasmussen. 1974. Predicting corn growth as affected by water management: an example. Dept. of Agr. and Irr. Eng. Utah State Univ., Logan, Utah. 211(d):6.
- Krasnow, H. S. 1969. Simulation languages. Pages 320-346. In Naylor, T. H. (ed.). The design of computer simulation experiments. Duke Univ. Press, Durham, N.C.
- Lupton, F. G. W. 1968. The analysis of grain yield of wheat in terms of photosynthetic ability and efficiency of translocation. Ann. Appl. Biol. 6(L):109-119.
- McQuigg, J. D. 1974. Meteorological variability and economic modeling. Proc. Sterling Forest Conf. on World Food Supply in Changing Climate. Sterling Forest, New York.
- McQuigg, J. D. 1975. Economic impacts of weather variability. Wheat Research Report, Atmos. Sci. Dept., Univ. Missouri, Columbia.
- Milthorpe, F. L. and J. Moorby. 1974. An introduction to crop physiology. Cambridge Univ. Press, London. 202pp.
- Monteith, J. L. and K. Yabuki. 1965. Crop photosynthesis and the flux of carbon dioxide below the canopy. J. Appl. Ecol. 1:321-337.
- Munn, R. E. 1966. Descriptive micrometeorology. Academic Press, New York. 245pp.
- Munn, R. E. 1970. Biometeorological methods. Academic Press, New York. 336pp.
- Nolan, R. L. 1972. Verification/validation of computer simulation models. Pages 1254-1265. In Proceedings of the 1972 Summer Computer Simulation Conference. Vol. II. Simulation Councils, Inc., La Jolla, California.

- Kaltridge, G. W., A. C. Dilley, J. R. Garrat, G. I. Pearman, W. Shepherd, and D. J. Connor. 1972. The Rutherglen experiment on Sherpa wheat: environmental and biological data. Division of Atmospheric Physics Technical Paper No. 22, CSIRO, Australia, 155pp.
- Parton, W. J. (1974). Abiotic section of the ELM grass-land ecosystem model. Ecol. Monogr. (in press).
- Parton, W. J., and J. R. Marshall. 1973. MODENV: a grassland ecosystem model. Pages 769-776. In Proceedings of the 1972 Summer Computer Simulation Conference. Simulation Councils, Inc., La Jolla, California.
- Parton, W. J. and F. M. Smith. 1974. Exploring some possible effects of potential SST-induced weather modification in a shortgrass prairie ecosystem. In Proceedings of the Sixth National Conference on Aerospace and Aeronautical Meteorology. Amer. Meteor. Soc., Boston, Mass.
- Parton, W. J. and F. M. Smith. 1974. Simulating the effects of growing season rainfall enhancement and hail suppression on the production, consumption, and decomposition functions of a native shortgrass prairie ecosystem. In Proceedings of the Fourth National Conference on Weather Modification., Amer. Meteor. Soc., Boston, Mass.
- Patten, B. C. 1975. Systems analysis and simulation in ecology. Academic Press, New York. 3 vols.
- Platt, R. B. and J. F. Griffiths. 1964. Environmental measurement and interpretation. Reinhold Publishing Corp., New York. 235pp.
- Puckridge, D. W. 1968. Competition for light and its effect on leaf and spikelet development of wheat plants. Aust. J. Agr. Res. 19(2):191-201.

- Luckridge, D. W. 1971. Photosynthesis of wheat under field conditions. 111. Seasonal trends in CO<sub>2</sub> uptake of crop communities. Aust. J. Agric. Res. 22:1-9.
- Luckridge, D. W. and C. M. Donald. 1967. Competition among wheat plants sown at a wide range of densities. Aust. J. Agr. Res. 18(2):193-211.
- Quisenberry, K. S. and L. P. Reitz, (eds.). 1967. Wheat and wheat improvement. American Society of Agronomy, Inc., Madison, Wis. 560pp.
- Read, D. W. L. and J. D. Benton. 1963. Effect of fertilizer, temperature, and moisture on germination of wheat. Agron. J. 55:287-290.
- Rickman, R. W., R. E. Ramig, and R. R. Allmaras. 1975. Modeling dry matter accumulation in dryland winter wheat. Agron. J. 67:283-289.
- Robinson, L. F. 1972. How GASP, SIMULA, and DYNAMO view a problem. Pages 167-214. In Gohring, K. W., N. D. Swain, and R. L. Sander (eds.). Progress in simulation vol. 2 fifth annual simulation symposium. Gordon and Breach, Science Publishing, New York.
- Thompson, L. M. 1962. Evaluation of weather factors in the production of wheat. Journal of Soil and Water Conservation. 17:147-156.
- Thorne, G. N. 1965. Photosynthesis of ears and flag leaves of wheat and barley. Ann. Bot. 29(115):317-329.
- Thorne, G. N. 1966. Physiological aspects of grain yield in cereals. Pages 88-105. In Milthorpe, F. L. and J. D. Ivins (eds.). The growth of cereals and grasses. Butterworth, Inc., Washington.
- Voldeng, H. D., and G. M. Simpson. 1967. The relationship between photosynthetic area and grain yield per plant in wheat. Can. J. Plant Sci. 47:359-363.

- Walton, P. D., and I. V. Hsu. 1971. Relationships between yield and its components and structures above the flag-leaf node in spring wheat. *Crop. Sci.* 11:190-193.
- Wardlaw, I. F. 1967. The effect of water stress on translocation in relation to photosynthesis and growth. 1. Effect during grain development in wheat. *Aust. J. Biol. Sci.* 20:25-39.
- Watt, K., (ed.). 1969. *Systems analysis in ecology*. Academic Press, New York. 275pp.
- Willey, R. W. and K. Holliday. 1971. Plant population, shading, and thinning studies in wheat. *J Agric. Sci. Camb.* 77:453-461.
- Williams, G. D. V. 1971-72. Geographical variations in yield-weather relationships over a large wheat growing region. *Agricultural Meteorology*. 9:265-283.

## BACKGROUND

### IMPORTANT UNDERGRADUATE COURSE WORK

#### Biology

Intro. to Evolution  
Field Botany  
Animal Physiology  
Plant Physiology  
Genetics  
Ornithology  
Mammalogy  
Ind. Study-Palynology  
Arctic-Alpine Environments  
Dynamics of Mtn. Ecosystems

#### Math and Computer Sciences

Analytic Geometry and Calculus  
Intro. to Computer Science  
Psychological Research Methods-Statistics

### SPECIAL STUDENT COURSE WORK (HOURS COUNT TOWARDS MASTER DEGREE)

#### Biology

Tundra Ecology  
Adv. E.P.O. Biology  
Biogeography

### GRADUATE SCHOOL COURSE WORK

#### Biology

Ecological Genetics  
Seminar-Population Studies  
Biometry  
Seminar-Environmental Studies  
Thesis Hours (3 hrs.)  
(Spring, 1977:  
Population Genetics  
Thesis Hours-3 hrs.)

#### Math (N.C.)

Linear Algebra  
Stochastic Population Models  
Numerical Analysis

#### IMPORTANT NON-ACADEMIC EXPERIENCE

Summer intern-Chesapeake Bay Biological Laboratory-work involved:

- data cleaning
- deterministic population models
- computer modeling of estuarian ecosystem
- error and stability analysis of a modeling algorithm
- publication: Boyd, W. S. 1974. The effect of noise on the recovery of model parameters. C.B.L. Tech. Ref. No. 74-138.

Research Asst.-National Center for Atmospheric Research (Jan., 1975-Oct., 1976)-work involved:

- computer programming
- statistical analysis
- time-series analysis
- error analysis
- acknowledged for computational work in Grossman, R. L. 1976. A simple procedure for the correction of bias in winds measured from aircraft. Global Atm. Res. Prog.: G.A.T.E. Info. Bul. No. 11.

READINGS FOR COMPREHENSIVE EXAM (FEB. 1977)

Four Exam Categories:

1. General Biology-review: Biological Science by Keeton  
read: Origins of Modern Biology by Lanham
2. Ecology-review: Fundamentals of Ecology by Odum  
Description and Classification of Vegetation by  
Shimwell  
Biogeography by Dansereau  
read: The Ecology of North America by Shelford
3. Genetics and Evolution-review: Processes of Organic Evolution  
by Stebbins  
Genetics of the Evolutionary Process by Dob-  
zhansky  
Evolution in a Changing Environment by Levins  
read: The Major Features of Evolution by Simpson
4. Biometry- review: Biometry by Sokal and Rohlf  
Statistics and Data Analysis in Geology by  
Davis  
The Use of Special Matrix Operators in Statistical  
Calculus by Beaton