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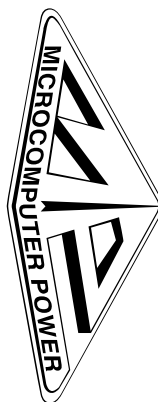
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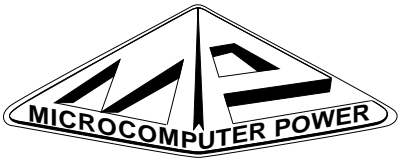
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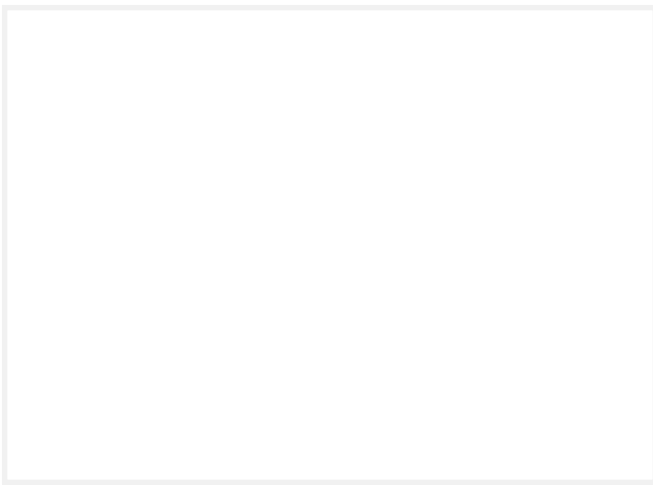
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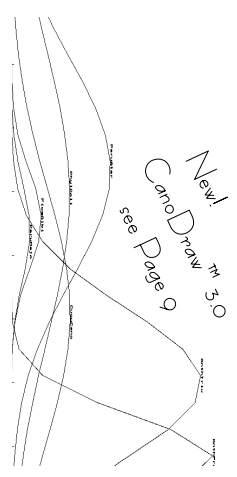
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Software Catalog including  
 CANOCO™, CanoDraw™  
 and  
 The Cornell Ecology Programs



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The Cornell Ecology Programs (CEP) were developed under the leadership of the late Dr. Robert H. Whittaker to facilitate the analysis of ecological data. These FORTRAN IV programs were distributed by the department of Ecology and Systematics (E&S) at Cornell to run on mainframe computers.

In 1986, editor Hugh G. Gauch and Dr. Richard E. Furnas arranged with E&S to assure continued distribution of the CEP series.

Mr. Gauch is one of the original authors of the early programs in the series and now works in Cornell's Department of Soil Crop and Atmospheric Sciences. His current work is represented by his program MAT-MODEL also featured in this catalog.

Dr. Furnas has a Ph.D. in Ecology from Cornell, having taken courses under Dr. Whittaker, teaches during the academic year in the Department of Mathematics at Cornell and is proprietor of Microcomputer Power.

Our agreement to assure continued distribution of the programs has also allowed us to produce microcomputer versions. The more important programs are now available for MS-DOS computers.

The CEP series emphasizes techniques of indirect ordination and classification. Typical input data consists of species abundance information for a number of sites.

Since 1989, we have been happy to offer the program CANOCO™ by Dr. Cajo J.F. ter Braak of the Agricultural Mathematics Group — DLO at Wageningen in The Netherlands. CANOCO™ is a major extension of

DECORANA (available as part of the CEP series) which allows the incorporation of environmental information directly in the analysis. Dr. ter Braak has done a remarkable service to ecologists. He has developed a sound mathematical foundation for many of the useful but sometimes rather ad-hoc methods which ecologists developed. He has then extended the methods into significant new areas and implemented them in his computer program CANOCO™.

An important consequence of this more recent research is that CANOCO™ is able to detect relationships between species and external (environmental) variables. These relationships need not be linear, as was required for many of the older techniques, but can be "unimodal", rising and falling again as the optimum environmental conditions for a species are approached and passed.

The available data can be explored to isolate the more important environmental factors. CANOCO™ represents a next generation in software for ecological data analysis. Dr. ter Braak is actively developing it, adding new capabilities, refining existing ones, and improving its ease of use.

New to this catalog is CanoDraw™ 3.0, by Petr Smilauer. CanoDraw™ 3.0 makes the output of CANOCO™ accessible in graphic form adding significant exploratory and analytical power to CANOCO™. Exploring your data has never been so direct.

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CAN-31r1	Retail License single copy	1	499.00	499.00
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CAN-31rt	Ret. Site 10-seat Addl (LAN/WAN)	1	1799.00	1799.00
CAN-31e1	Educational License single copy	1	249.00	249.00
CAN-31ee	Edl Additional copies to a site	1	149.00	149.00
CAN-31es	Edl Site license / (LAN)	1	1499.00	1499.00
FORTRAN source code for: <input type="checkbox"/> Generic Mainframe; <input type="checkbox"/> IBM Mainframe; <input type="checkbox"/> VAX; <input type="checkbox"/> PC*; <input type="checkbox"/> Mac* OS/2* * Also require purchase of single copy executable				
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CAN-31ec	Educational Institution FORTRAN code	1	299.00	299.00
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Cornell Ecology Programs (for PC only)				
H6G-P	Gauch, H.G. (1982) Multivariate Analysis in Community Ecology (paperbound)	1	29.95	29.95
CEP-Pce1	MS-DOS™ Microcomputer Package	1	295.00	295.00
CEP-Pcea	additional copies (all with COMPOSE)	1	175.00	175.00
CEP-Pces	Site license / (LAN)	1	1750.00	1750.00
CEP-SD	Database of Simulated Test Data	1	49.00	49.00
CEP-IVrc	Mainframe FORTRAN IV Source Code	1	250.00	250.00
CEP-CP	Mainframe Programs Documentation	1	119.95	119.95
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CLM-CM1	COMPOSE	1	97.50	97.50
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**MATMODEL™** offers new and exciting possibilities for effective research strategies involving two-way data tables, with or without replication.

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worthy of renewed attention.

**Version 2.0** represents a considerable improvement over earlier versions, allowing and imputing missing data. It also provides tools for optimal model selection from among the family of **AMMI** models, including assessment of predictive accuracy using data splitting and validation. Efficient memory utilization allows for processing about 30,000 observations, depending on system configuration and details of the analysis.

**MATMODEL™** is available to run under **MS-DOS™** and **Apple™ Macintosh™**. The **MS-DOS™** version requires at least 512K of RAM, a floppy disk drive and **MS-DOS™ (PC-DOS™)** version 2.1 or higher. A hard disk and numeric coprocessor (8087, 80287, or 80387) are recommended. The Mac version requires a Mac Plus or later model. A version using a numeric coprocessor is included in the package.

The **MATMODEL™** Version 2.0 package includes:

- The executable program running under **MS-DOS™**, distributed on both 720K 3.5" and Industry Standard 360K (PC) format 5.25" floppy disks.
- The ability to compute ANOVA, PCA, Finlay-Wilkinson linear regression, and joint regression (concurrency) models.
- Several sample input data files and sample output files.

• A detailed manual explaining the **MATMODEL™** program and its application.

**MATMODEL™** Program for **AMMI** analysis

- MAT-20R1** Single License
- MAT-20E1** Educational and Government License

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## Site Licenses

**Site licenses** are an option more and more of our customers have requested. Many of our customers have found our programs increasingly important in their work and have wanted to make the capabilities available to their colleagues or students. This is often done by having a computer set up in a lab with the software installed on it. Users come in to analyze their data sets. While this method works, it is often inconvenient, especially as individuals now commonly have their own computer on which they work.

With our first implementation for microcomputers we offered a reduced price for additional copies of our programs to help address this problem. More and more of you are looking for an even more cost-effective way to make the programs available to a broader constituency at your institutions. Site licenses are now available for each of our major programs for ecologists.

**Site licenses** provide, at modest cost, convenient access to the programs and near-zero liability for illegal copying or other unauthorized use of the software.

The site-license/LAN includes 10 copies of the documentation and two sets of master disks together with permission to duplicate the disks as desired for further use at the site. This allows ultimate freedom to install on a network server regardless of copy privileges or requirements to track number of active users. Installation on laptops for

## Site Licenses

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Data Analysis in Community and Landscape Ecology

by R.H.G. Jongman, Cajo J.F. ter Braak, and O.F.R. van Tongeren

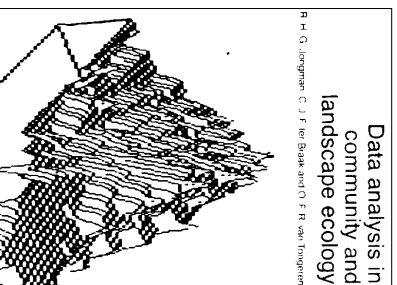
Computer techniques are being used increasingly by ecologists to analyze field data on plant and animal communities and their environment.

This book provides a new synthesis of methods that have proven to be most useful for such analyses. There are chapters on data collection, regression analysis, calibration, ordination, cluster analysis and spatial analysis.

Examples and exercises (with solutions) complete most chapters. Three case studies are also included. Only simple mathematics is used, making the methods accessible to most ecologists and geographers. In the selection of methods, due attention is paid to the special properties of ecological data:

- numerous species recorded as present/absent or on a semi-quantitative abundance scale
- the non-linear relationships between species and environmental variables that often exist
- the high inter-correlations among species and among environmental variables.

In addition to the more traditional ordination and cluster techniques, this is the first textbook to explain to ecologists in an elementary way such powerful data-analysis techniques as logit regression (a regression technique appropriate for analyzing



presence-absence data), canonical correspondence analysis (a canonical ordination technique especially designed to relate species communities to environmental variables) and kriging (a sophisticated spatial-interpolation technique).

**Readership** The book is primarily directed to post graduate students in ecology, geography, and environmental sciences, and to professional ecologists, who want to better understand the methods they are already using and are eager to learn new, more powerful methods.

- Contents:
1. Introduction
  2. Data Collection
  3. Regression
  4. Calibration
  5. Ordination
  6. Cluster Analysis
  7. Spatial aspects of ecological data
  8. Numerical methods in practice – case studies
  9. Literature
  10. Index

**Pudoc** Data Analysis in Community and Landscape Ecology

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Ecology, by Hugh G. Cauch, Jr. (Cambridge University Press, 1982). Users of the CEP programs who are new to multivariate analysis may find this text a useful starting point.

The format for entering data matrices is explained most fully in the manual for ORDIFLEX.

Numerous convenient formats are allowed. More recent programs, CEP-30 to CEP-41, use a single standardized format, but a utility program, CONDENSE, can copy any ORDIFLEX format into the standard format. The older programs, CEP-1 to CEP-21, use a slightly different format than ORDIFLEX, involving only a few trivial changes in a few lines.

MAINFRAME PROGRAMS

FORTRAN IV Source

This is the FORTRAN-IV source code as distributed by Cornell for compilation by a FORTRAN-IV compiler on a mainframe computer. This product has not been altered from that originally distributed by Cornell except to make it available as ASCII files on floppy diskettes in either PC or Macintosh™ TEXT format. The intention is that the source be uploaded to the mainframe. The package includes source code for:

- DECORANA, TWINSPAN, ORDIFLEX, and COMPCCLUS as described above. Also included are the data editing utilities, CONDENSE, and DATAEDIT; the

simulation programs *Coenocline Simulation*, *Data Screening and Gaussian Ordination*, *Fit Gaussian or Normal Curve*, and *Coenoplane Simulation*, as well as the program UNIVAR for Univariate and Bivariate statistics for a matrix of a few variables and many individuals (many thousands).

The package also includes the collection of simulated data sets we sell separately as **CEP - SD**.

Please note that the simulation programs have a random number generator which is machine specific to the IBM™ 360 and 370 computers for which the programs were originally written. This routine must be replaced with an appropriate alternative (typically a library routine will do) in any current installation.

**CEP - IVrc** Machine Readable FORTRAN IV source

Mainframe Documentation Package

Because of the multi-user nature of Mainframe installations, the documentation for the Mainframe package is sold separately so the desired number of copies may be purchased to suit the installation. This package includes a complete set of documentation for all of the FORTRAN-IV (mainframe) Cornell Ecology Programs, including the simulation programs.

**CEP - CP** Complete Mainframe Programs Documentation Package

Introduction to the Cornell Edition

## Catalog of the Cornell Ecology Programs

### The purpose of the Cornell

Ecology Programs (CEP) series is to make public a number of computer programs used in our ecology research, dealing mainly with ordination and classification. The following list of programs is updated as new programs are completed. It is hoped that this series will save other ecologists the labor and expense of developing programs for these computations, many being rather routine. All programs are in IBM™'s FORTRAN-IV. A subset of FORTRAN-IV has been used, intending to minimize conversion problems with other computers, and experience has indicated that most computer installations have minimal difficulties.

The CEP programs operate as regular, individual FORTRAN programs on mainframe computers. There is no supervisor program, no complex operating system, and no complex disk or tape usage. The programs place their data in high speed memory rather than on disk.

Consequently, a mainframe computer is required to analyze large data sets having thousands of species and samples, but a small computer with 256K to 512K bytes of memory can handle small to medium data sets having a few hundred species and samples. Most microcomputer compilers implement FORTRAN-77 or a modification of FORTRAN-77, so some

work must be expected to convert these programs for use with microcomputers. [Newer development: see our CEP-PC MS-DOS™ microcomputer package which is ready to run and includes FORTRAN-77 source.-ed]

### An exceptional feature of several

recent programs in the CEP series is that the computing workload rises approximately linearly with the amount of data. Most multivariate algorithms and programs have workloads rising as the square, cube, or higher power of the amount of data. Because of their linear workload, these CEP programs are readily applied to enormous data sets having thousands of species and samples. Frequently the computing time is on the order of the time required merely to read the data, or within a small constant times the reading time. The robustness and quality of the results have not been compromised in the effort to offer improved computing speed. These programs have been tested in relation to numerous other programs on a broad test data base with scores of simulated and field data sets. As shown in the articles cited under each program, the robustness and quality of the results are exceptional. Individual topics such as non-hierarchical classification, hierarchical classification, and ordination are treated in the various articles cited here as well as in the program documentation. The general topic of multivariate analysis, however, is treated in an integrated manner in Multivariate Analysis in Community

## CANOCO™

- a FORTRAN program for *canonical community ordination* by [partial] [detrended] [canonical] correspondence analysis, principal components analysis and redundancy analysis (version 3.1).

by *Cajo J. F. ter Braak*

Airm

A common problem in community ecology and ecotoxicology is to discover how a multitude of species respond to external factors such as environmental variables, pollutants and management regime. Data are collected on species composition and the external variables at a number of points in space and time. Statistical methods available so far to analyze such data either assumed linear relationships or were restricted to regression analysis of the response of each species separately. To analyze the generally non-linear, non monotone response of a community of species, one had to resort to the data-analytic methods of ordination and cluster analysis - "indirect" methods that are generally less powerful than the "direct" statistical method of regression analysis. Five years ago, regression and ordination were integrated into techniques of *multivariate* direct gradient analysis, called canonical (or constrained) ordination. The use of canonical ordination greatly improves the power to detect the specific effects one is interested in. One of these techniques, canonical correspon-

dence analysis, escapes the assumption of linearity and is able to detect unimodal relationships between species and external variables. The computer program CANOCO is designed to make these techniques available to ecologists studying community responses. CANOCO can carry out most of the multivariate techniques described in Ter Braak (1987a) and Ter Braak and Prentice (1988) using a general iterative ordination algorithm.

Researchers in other fields may find CANOCO useful as well, for example, to analyze percentage data / compositional data, nominal data or (dis-)similarity data in relation to external explanatory variables. Such use is explained in separate sections in the manual. CANOCO is particularly suited if the number of response variables is large compared to the number of objects.

Version 3.10 of CANOCO extends and enhances many of the features for version 2.1. Most importantly, the program is easier to use for the novice to ordination.

### Techniques covered

CANOCO is an extension of DECORANA (Hill, 1979). CANOCO formerly stood for canonical correspondence analysis (Ter Braak, 1986, 1987b) and included weighted averaging, reciprocal averaging, [multiple] correspondence analysis, detrended correspondence analysis and canonical correspondence analysis. The program has been extended to cover also principal components

One of these

techniques, canonical correspondence analysis,

escapes the assumption of linearity and is able to detect unimodal relationships

between species and external variables.

See our  
CEP-PC  
MS-DOS™  
microcomputer  
package which  
is ready to run  
and includes  
FORTRAN-77  
source

analysis (PCA) and the canonical form of PCA, called redundancy analysis (RDA). Redundancy analysis is also known under the names of reduced-rank regression (Davies and Tso, 1982) and PCA of  $y$  with respect to  $x$  (Robert and Escoufier, 1976). For these linear methods there are options for centering/standardization by species and by sites and for the method of scaling the species and site scores for use in the biplot. Principal coordinates analysis and canonical variates analysis are also available.

**2** .CANOCO can also carry out "partial" analyses in which the effects of particular environmental, spatial or temporal "covariables" are eliminated from the ordination. A partial analysis allows one to display the residual variation in the species data and to relate the residual variation to the variables one is specifically interested in. Partial canonical correspondence analysis is the appropriate technique for the analysis of permanent plot data or for the joint analysis of data from several locations.

**3** .CANOCO allows one to test statistically whether the species are related to supplied environmental variables. The test provided is a Monte Carlo permutation test (Manly, 1990). The effect of a particular environmental variable can be tested after elimination of possible effects of other (environmental) variables by specifying the latter as covariables. For the analysis of randomized-block experiments or data from several locations, there is an option to restrict the permutation to

permutations among samples-within-blocks or samples-within-locations. Valid permutation methods are included for time series, line transect and rectangular grids and repeated measurement designs, e.g. the Before-After-Control-Impact design.

**4** .CANOCO can perform a forward selection of environmental variables in order to determine which variables best explain the species data. At each step, a Monte Carlo statistical test can be carried out to judge the significance of the selected variable.

#### Data input

CANOCO uses ASCII files as input. CANOCO can read species data, environmental variables and covariables that are either in free format or in Cornell condensed format or in full format. The solution file of the analysis cannot only be used for graphics programs, but also be used as input for subsequent analyses. This possibility allows one, for example, to use principal components extracted from environmental data as input for a later canonical analysis of species data.

#### Output options

The CANOCO solution file is standard input for the program CANOPILOT that produces printed ordination diagrams or, on MS-DOS computers, for CanoDraw™ that produces ordination diagrams, biplots and triplots on the screen and

#### Cornell Ecology Programs

#### MS-DOS™ Microcomputer

#### Package

prepared by Charles L. Mohler  
© 1987-1991 Microcomputer Power

The most popular of the Cornell Ecology Programs have been translated into FORTRAN-77 and adapted to run on MS-DOS™ microcomputers. Array sizes have been made as large as possible within the limit of running on a machine with 512K of RAM. This choice is a compromise between the DOS limit of 640K and the many machines readily expandable to only 512K of RAM. For those of you with 640K or more this means that your favorite RAM-resident utilities and device drivers can be installed while running the programs without reconfiguring your system.

This handy package provides an excellent collection of programs of value to investigators in Ecology. If you are interested in any one of the programs for your research, you will likely find the others of real value as your research proceeds further.

The package includes executable modules for: COMCLUS, DECORANA, ORDIFLEX, TWINSpan, and COMPOSE, described in more detail above.

The new utility, COMPOSE, written for this release of the programs by Charles Mohler, totally replaces CONDENSE and provides some of the functionality of DATAEDIT from the

original mainframe version of the series.

Sample data sets allow you to run the programs at once. A complete set of printed manuals is included in the purchase price along with special supplementary manuals which give specific details for using the microcomputer version of the programs.

The executable modules were compiled with the MICROSOFT™ FORTRAN optimizing compiler for MS-DOS™. This compiler allows arrays and COMMON blocks larger than 64 Kilobytes and the array sizes in the executable modules are larger than the common PC limit of 64K (see specifications at left).

Source code for the programs is also available. Unfortunately, in the MS-DOS™ environment, the syntax for using large arrays and COMMON blocks is not standardized. Even different versions of the MICROSOFT™ compiler used different syntax so the source code we ship is "generic" FORTRAN-77 for the PC. No arrays or COMMON blocks are larger than 64K. This should provide a good starting point for adapting the programs to whichever FORTRAN compiler you may be using.

#### Cornell Ecology Programs

#### MS-DOS™ Microcomputer Package

- CEP - P C e l** Single License
- CEP - P C e a** Additional License
- CEP - P C e s** Site License



The most popular of the Cornell Ecology Programs have been adapted to run on MS-DOS™ computers.

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(1) the original FORTRAN-IV version of the programs.

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**The Cornell Ecology Programs with COMPOSE MS-DOS™ Microcomputer Package Specifications:**

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System Requirements and Compatibility:

- MS-DOS™ Operating System Version 2.0 or higher.
- 512K RAM.
- Numeric Coprocessor optional (will use if present).
- DOS text display (there should be no problem running the programs on any model MS-DOS™ machine).

Array Dimensions of the Executable modules:

**Nonzero**

Program	Species	Samples	Array Elements
DECORANA	500	800	38,000
TWINSPAN	800*	500	30,000
COMPClust+	3,000	5,000	27,000
ORDIFLEX#	100	270	----
COMPOSE	1,000	1,200	27,000

\* Pseudospecies (see TWINSPAN manual).

† COMPClus is also dimensioned for 2500 clusters.

# ORDIFLEX stores data as rectangular arrays which include zeros.

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on some of the most common hard-copy devices.

CANOCO can also supply:

- means, variances and correlations of environmental variables,
- eigenvalues and percentages of variance accounted for,
- diagnostics for the fit of species and samples in the ordination,
- canonical coefficients or regression coefficients of environmental variables with associated t-values,
- correlations of environmental variables with the ordination axes,
- centroids (weighted averages) of environmental variables in the ordination diagram. In particular, classes of nominal environmental variables are more naturally displayed by their centroid in the ordination diagram than by arrows. This option is also useful for displaying the results of a cluster analysis in an ordination diagram.

CANOCO allows interactive data analysis: results of an analysis can be displayed at the terminal and after inspection the analysis can be pursued. e.g.:

- by changing from an indirect gradient analysis to a direct gradient analysis,
- by dropping environmental variables or by turning them into covariables,
- by reading other environmental variables to be related to the current ordination axes or to be used in further canonical analyses,
- by extracting more than the default four ordination axes.

PC and Macintosh

Ready-to-use versions are available for MS-DOS computers and

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the Apple Macintosh. On an MS-DOS PC with 405 Kb free memory, CANOCO 3.1 can analyze 500 samples, 500 species, 100 covariables and 58 environmental variables, but with some additional limitations on the number of species occurrences and environmental and covariable values (total data space 45000 reals). An 80x87 coprocessor is optional. More demanding in terms of system requirements is CanoDraw™ LITE, which is included with the PC package. It has the same system requirements as the CanoDraw™ program itself detailed elsewhere in this catalog. On a PC with math coprocessor or on a standard Apple Macintosh, CANOCO 3.1 can analyze at most 1000 samples, 700 species, 75 environmental variables and 100 covariables, (total data size <80000). The Macintosh version supports the Macintosh user interface only in file launching from the Finder and the standard open file dialog box from within the program. For use on a PC or Macintosh, the source code is also available at extra cost.

Mainframes and Workstations

CANOCO has been successfully implemented on various mainframe computers. For implementation on VAXen or mainframes, the FORTRAN 77 source code of CANOCO can be supplied together with detailed compilation notes and a demonstration version of the program on a PC or Apple Macintosh diskette.

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Analyze at most 1000 samples, 700 species, 75 environmental variables and 100 covariables, (total data size <80,000 reals).

## License options

The one-time costs for single licenses, multiple licenses and Site licenses /LAN (local area network) are specified on the order form. Documentation (a manual and a booklet with relevant reprints) is sent with each license of the program. The Site license /LAN includes 10 copies of the documentation and permission to duplicate the program further for use at the site. The license based on the FORTRAN source code gives permission to install the Program on a single (main frame) processor. If the licensee is unable to install the program, a refund can be obtained after all the material has been returned. An Educational discount is also available to University shipping addresses.

## Caroco Licenses

- CAN-3Jr1** CANOCO™
  - CAN-3Jra** additional copies
  - CAN-3Jrs** site license
  - CAN-3Jrc** source code
- Caroco Educational Licenses
- CAN-3Jle1** educational licenses
  - CAN-3Jlea** additional copies
  - CAN-3Jles** site license
  - CAN-3Jlec** source code

©

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- ter Braak, C. J. F. (1987b). The analysis of vegetation-environment relationships by canonical correspondence analysis. *Vegetatio*, **69**, 69-77.
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## COMPOSE

by Charles L. Moller

COMPOSE is a data management program which checks errors, edits and formats data for use by other programs in the Cornell Ecology Programs series. As with all programs in the CEP series, COMPOSE is designed to operate on a two dimensional data array. Typically such an array will consist of abundance values of species measured at a number of sample locations. Occasionally one may have data of three or more dimensions. In ecological applications these are commonly encountered when several attributes are measured on each species in several samples, or when species are sampled repeatedly at several locations. COMPOSE has editing capabilities which can reduce such three dimensional data to a two dimensional structure suitable for processing with the other programs. COMPOSE accepts data in many varieties of two basic formats: Full Matrix and Condensed. These are ASCII text files with data in columns such as a Lotus™ .PRN file, dBase™ or FoxBase™ SDF file. COMPOSE converts these to the restricted condensed format which is acceptable to all programs in the Cornell Ecology Programs MS-DOS™ microcomputer package. In addition to producing the edited and reformatted data matrix, the program produces a session listing which echoes all discussion appearing on the screen, as well as listing useful information about the data.

COMPOSE has a variety of editing functions. It automatically adds together all occurrences of a species within each sample. At the users request it will merge any number of data sets. It will eliminate species and samples at the users request. It can add together species and assign a new name to the resulting entity (if, for example, you want to merge species within a genus), and it can form composite samples from groups of samples. The program can also apply a variety of statistical and ecological transformations to the data.

COMPOSE checks for and flags errors in the data and accompanying lists of names and parameters. For this reason we recommend that you run data sets through COMPOSE even if they have been entered in a restricted condensed format and no editing is desired. The Cornell Ecology Programs are quite easy to use, but in the interest of maximizing array space for analyses, they do minimal checking of the structure of the data set at run time. Most of the problems people encounter with the programs involve improperly structured data sets. COMPOSE is a valuable tool for avoiding such problems.

The MS-DOS™ executable module is dimensioned for 1,000 Species, 1,200 Samples, 27,000 non-zero array elements.

COMPOSE is included with **CEP-PC**. It is also available separately as:

- CLM-CMe1** COMPOSE™ program for data preparation

COMPOSE is included with **CEP-PC**.

To minimize problems with CEP data sets, we recommend that you process data sets with COMPOSE to be sure they are properly formatted, even if no further editing is desired.

COMPOSE sets with COMPOSE to be sure they are properly formatted, even if no further editing is desired.

COMPOSE sets with COMPOSE to be sure they are properly formatted, even if no further editing is desired.

mon data matrix transformations. Species and samples may be identified by user-supplied 8-character alphanumeric names.

Ordination results may be graphed. Also, the data matrix can be printed as one-character declive values, with rows and columns arranged according to the rank of ordination scores.

WA and PO may be done by species or by samples; PCA and RA do both simultaneously, PO endpoints may be specified by the user, or supplied automatically by three alternative procedures.

Any number of ordinations may be applied in a single run to any data set, but only one editing and transformation is allowed for each data set (although it may be read in several times to allow several transformations).

The manual includes a chapter on ordination theory, explaining the purpose and process of ordination, with recommendations on all steps from collection of field data to final presentation of results.

The ORDIFLEX manual also describes 24 supplementary data sets for use in gaining familiarity with RA results for a variety of data set properties.

The MS-DOS™ executable module is dimensioned for 100 Species, 270 Samples, 27,000 array elements.

### Database of

### Simulated Test Data

The CEP Series offers two extensive files of simulated test data sets that have been presented and analyzed in numerous articles.

These simulated data sets vary in several properties, including level of heterogeneity, number of underlying gradients, noise level, sample number and distribution, and the presence of partial or complete disjunction and of outliers of two types.

The variety of test data sets included is deliberately intended to reveal the performance of multivariate methods under a wide variety of circumstances in order to facilitate a balanced assessment of the merits of new multivariate methods.

A file with 24 data sets is described in the documentation for ORDIFLEX and is included with both the mainframe and microcomputer versions of that program.

A larger group of 30 data sets is included at no charge with any order for the machine readable source of the FORTRAN-IV versions of the CEP programs. For PC users and other interested individuals, these data sets are also available separately.

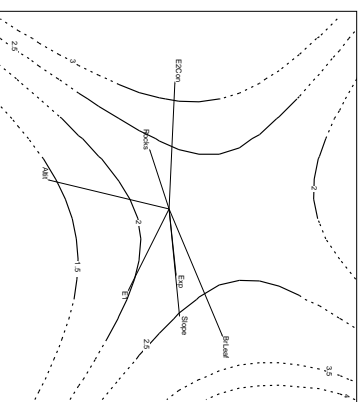
These data sets are of great interest to understand how multivariate analyses treat various data sets of known underlying structure.

**CEP - SD** Database of Simulated Test Data

### CanODraw™ 3.0

by Petr Šmilauer

CanODraw™ 3.0 is a PC program which intelligently produces high quality graphics from the



numerical output of CANOCO. This new version sports an all new interface which allows rapid mouse selection of features, intuitive adjustment of data and simplified selection of the many new presentation options. PC users receive a LITE version of CanODraw™ 3.0 with the CANOCO package but the exciting development is the full version 3.0 program

### System Requirements

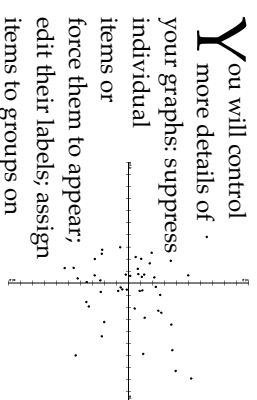
for CanODraw™ 3.0

- PC Graphics Cards:
 

Type	Colors	Res.
EGA	16	640x350
EGA	b/w	640x350
VGA	16	640x480
MCGA	b/w	640x480
ATT400	b/w	640x400
IBM 8514A	16	1024x768
- AT Class PC or better
- (80286, 80386, 80486 or fully

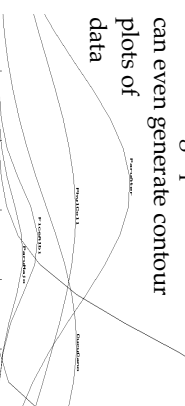
now sold separately.

Open New Vistas as you Explore your Data



you will control more details of your graphs: suppress individual items or force them to appear; edit their labels; assign items to groups on screen or from a file and give them different colors or shadings.

Even more significant for the serious investigator are the modeling tools and new types of graphics available in CanODraw™ 3.0. You can model species response curves and graph them. You can even generate contour plots of data



onto map coordinates or into ordination space.

compatible processor including SoftPC or SoftWindows on the Mac)

- MS-DOS 3.1 or higher
- EMS version 3.0 (LIM EMS) or higher or
- XMS version 2.0 or later
- PC Graphics/Device Formats:
 

Adobe	PostScript *
Illustrator *	HPGL/7470
Epson-FX	HPGL/7475
Epson-LQ	TIFF File *
HP-LaserJet	PCX File
- \* These file formats are also compatible with Macintosh page layout software (FrameMaker, PageMaker, and QuarkXpress).

Reveal secrets in your data you could only guess at before.

## TEXTBOOK: Multivariate

### Analysis in Community Ecology

by Hugh G. Gauch.

Users of the Cornell Ecology

Programs may also want a copy of *Multivariate Analysis in Community Ecology*, by Hugh G. Gauch, Jr., from the *Cambridge University Press* (1982).

There are 298 pages and 7 chapters: Introduction, Sampling Methods, Direct Gradient Analysis, Ordination, Classification, Applications, and Conclusions.

The book emphasizes both principles (ecological and mathematical) and applications. Preferred multivariate methods are emphasized, rather than presenting a compendium of all the methods that have been suggested.

The book treats the algorithms used by each of the CEP programs, emphasizing both principles and applications.

ORDIFLEX, COMPCCLUS, DECORANA, TWINSPLAN and DATADIT—and develops an integrated research strategy that employs all these programs.

**Readership** advanced undergraduate students, graduate students, and professional researchers, primarily in ecology and related applied fields (forestry, natural resources, agronomy, and environmental management).

Some consideration is also given to other fields such as business, economics, psychology, education, social and political sciences, and medicine because of the wide applicability of multivariate methods.

☐ **HGG-P Gauch** (1982) ✎

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## Description of The Major

### Programs in the Cornell

#### Ecology Programs Series

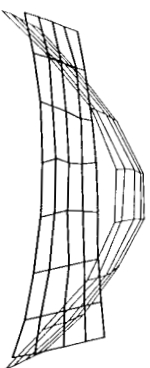
## DECORANA

by Mark O. Hill

MS-DOS™ adaptation by Charles L. Mohler

DECORANA is a FORTRAN program for detrended correspondence analysis. DECORANA improves upon reciprocal averaging (RA) and correspondence analysis are synonyms; *Journal of Ecology* 61:237-249, 65:157-174, 69:135-152, and *Vegetatio* 42:47-58)

DECORANA avoids the arch or horseshoe problem of RA (the second axis is frequently a quadratic distortion of the first axis), and it also scales the ordination axis to avoid the contrac-



tion of axis ends in RA.

Our tests indicate that in general DECORANA results are superior to RA, multidimensional scaling, and principal components analysis, making it the best general purpose ordination, particularly for very heterogeneous data sets. DECORANA can also compute RA scores.

DECORANA uses an exceptionally fast algorithm with almost linear computer requirements with respect to the amount of data; thousands of

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species and samples are practical.

The MS-DOS™ executable module is dimensioned for 500 Species, 800 Samples, 38,000 non-zero array elements.

## TWINSPLAN

by Mark O. Hill

MS-DOS™ adaptation by Charles L. Mohler

TWINSPLAN is a FORTRAN program for two-way indicator species analysis.

TWINSPLAN is an improvement upon the original indicator species analysis in that species are classified as well as samples (*Journal of Ecology* 63:597-603 and 69:537-557).

The result is similar to that obtained by Braun-Blanquet table arrangement:

The computer workload rises approximately linearly with the amount of data.

```
11 1
219807631245
```

```
9 SOL I SEM      211-3----- 0000
5 PRA COM      53415----- 0001
3 IVA FRU      452113----- 0010
11 SPAR PAT    3254-5----- 0011
8 SCR OLN      -1---53----- 01
2 DIST SP1     -5414545-424    100
1 ATRI PAT    231--3221411  101
6 SAL I EUR    --22-23411   1100
10 SPAR ALT    --142-135553  1101
7 SAL I VIF    -----34    1110
12 SVAE MAR    -----54    1110
4 JUNC GER     -----151--- 1111
```

```
00000001111111
000001001111
00011 010011
00101 0101
01
```

The MS-DOS™ executable module is dimensioned for 800 Pseudospecies, 500 Samples, 30,000 non-zero array elements.

<tech@microcomputerpower.com>

## COMPCCLUS

by Hugh G. Gauch

MS-DOS™ adaptation by Charles L. Mohler

COMPCCLUS is a program for rapid initial clustering of large data sets. It is executed interactively (see *Vegetatio* 42:103-111).

For each cluster a composite sample is produced which is simply the average of the samples contained; these composite samples are often useful for subsequent analysis by ordination or by hierarchical clustering.

Computing requirements are linear with respect to the amount of data, and thousands of species and samples are practical. The computing time for clustering is on the order of the time required merely to read the data.

The MS-DOS™ executable module is dimensioned for 3,000 Species, 5,000 Samples, 27,000 non-zero array elements.

## ORDIFLEX

by Hugh G. Gauch

MS-DOS™ adaptation by Charles L. Mohler

ORDIFLEX is a flexible program for four ordination techniques:

- weighted averages (WA)
- polar (Bray-Curtis) ordination (PO)
- principal components analysis (PCA)
- reciprocal averaging (RA)

A simple control line is used to select the computations desired for each data set. The format of the input species-by-samples data matrix is flexible and ORDIFLEX can apply elementary editing and com-

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Each of the major programs described at left is included in the **CEP-PC** MS-DOS™ Microcomputer Package.