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Two FORTRAN II Programs for the Univariate and Bivariate Analysis of Morphometric Data

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This work forms number 285 of the *Bulletin* series.

Frank A. Taylor
Director, United States National Museum

Contents

Two FORTRAN II Programs for the Univariate and Bivariate Analysis of Morphometric Data

Abstract

Two computer programs, written in FORTRAN II for the IBM 7094, perform univariate and bivariate analyses of morphometric data and plot bivariate scatter diagrams of pairs of data. Basically, the programs are designed to process arrays in which rows (up to 100) represent specimens and columns (up to 52) represent measured and computed variables. Alternatively, an input array may represent a single organism, for example a coiled snail or a segmented arthropod, with the rows representing, respectively, individual whorls or segments. A high degree of adaptability to different kinds of problems is achieved because of the numerous control cards which specify input and output format, table headings, and column numbers of variables on which operations are to be performed.

Program devices allow for the elimination of zeroes representing missing data and for the conversion of selected columns to logarithms to the base 10. The computed univariate statistics include the maximum, minimum, observed range, arithmetic mean, standard deviation, standard error of the mean, and coefficient of variation. Bivariate statistics include the correlation coefficient, slopes and intercepts of either regression lines or the reduced major axis, coefficients of relative dispersion, and factors for the computation of confidence intervals. Finally, the programs plot selected pairs of data on bivariate scatter diagrams and furnish the end points for the plotting of regression lines or reduced major axes.

Introduction

Morphometry, or the measurement of form, is becoming increasingly important in the study of fossil and living organisms. The uses and limitations of univariate and bivariate techniques in the analysis of morphometric data in paleontology have been summarized by Imbrie (1956), and the application of such analytic techniques in zoology has been described by Simpson, Roe, and Lewontin (1960).

In paleontology, it is often necessary to deal with fragmentary specimens in order to obtain samples (groups of specimens) which are large enough to be statistically treated. If the missing data are represented by zeroes, these zeroes must be eliminated from any statistical analysis. Furthermore, if the data are transformed to logarithms, a zero representing the logarithm of one to the base ten must be treated statistically and must therefore be differentiated from a zero representing missing data.

Examples of other operations which may be required in morphometric work are as follows:

1. Subtract the thickness of a measuring platform from a measurement where, in order to obtain the measurement, this thickness had to be included.
2. Convert certain measurements, which are invariably in ocular micrometer units, to millimeters.
3. Convert certain measurements, which are in ocular micrometer units only when the specimen is small, to millimeters.
4. Compute the cross-sectional area of a muscle or ligament, where such an area can be approximated by a simple formula, e.g., the area of a circle or a triangle.
5. Compute measurements which are the sums or differences of other measurements.
6. Convert any or all measurements to logarithms.
7. Compute ratios of one measurement to another.
8. Arrange data in order of decreasing size of one of the measurements and/or preserve the order of specimens in the input.

9. Construct bivariate scatter diagrams of ratios and compute regression lines or lines of best fit.

The programs described here, for use on the IBM 7094, perform all of these operations. In addition, they punch out the final measurements and ratios and print out the statistics listed in Table 1.

TABLE 1.—Symbols and Formulae for Statistics Computed by Data Assembly and Analysis (DASAN) (x or y = any variate; *see section on statistics)

Statistics	Output Symbol	FORTRAN Symbol	Math Symbol	Formula
Univariate Statistics				
Number of non-zero values or pairs of values	NUM.	NUMBER	N	-------------------
Maximum value	MAX.	AMAX	x_1	-------------------
Minimum value	MIN.	AMIN	x_2	-------------------
Observed range	RANGE	RANGE	OR_x	$OR_x=x_1-x_2$
Arithmetic mean	MEAN	AMEAN	$\bar{x}$	$\bar{x}=\frac{\Sigma x}{N}$
Standard deviation	STDDV	STDDV	s_x	$s_x=\sqrt{\frac{\Sigma(x-\bar{x})^2}{N-1}}$
Standard error of the mean	SDVMN	SDVMN	$\sigma_{\bar{x}}$	$\sigma_{\bar{x}}=\frac{s_x}{\sqrt{N}}$
Coefficient of variation	V	V	V	$V=\frac{100\ s_x}{\bar{x}}$
Bivariate Statistics (Routine #1)				
Correlation coefficient	R	R	r	$r=\frac{\Sigma(x-\bar{x})(y-\bar{y})}{\sqrt{\Sigma(x-\bar{x})^2\Sigma(y-\bar{y})^2}}$
Slope of reduced major axis	A	A	a	$a=\frac{s_y}{s_x}$
Standard error of A	SIG(A)	STERRA	σ_a	$\sigma_a=a\sqrt{\frac{1-r^2}{N}}$
y-intercept of reduced major axis	B	B	b	$b=\bar{y}-\bar{x}a$
Coefficient of relative dispersion from reduced major axis	D(RMA)	DRMA	D	$D=\sqrt{\frac{2(1-r)(s_x^2+s_y^2)}{\bar{x}^2+\bar{y}^2}}\cdot 100$
Arithmetic mean of y	MEAN Y	AMEANY	y	-------------------
Arithmetic mean of x	MEAN X	AMEANX	x	-------------------
Ordinate of point at which reduced major axis crosses maximum value of x on scale of a plot printed by VPLOT	YMAX 1	YMAX1		-------------------
Ordinate of YMAX 1 in scale-units of a plot printed by VPLOT	TOP 1	TOP1		-------------------
Ordinate of y-intercept in scale-units of a plot printed by VPLOT	BASE 1	BASE1		-------------------
Bivariate Statistics (Routine #2)				
Correlation coefficient	R	R	r	Same as above.
Slope of regression of y on x	A(YX)	BYX	b_{yx}	$b_{yx}=\frac{\Sigma(x-\bar{x})(y-\bar{y})}{\Sigma(x-\bar{x})^2}$
Y-intercept of regression of y on x	B(Y)	AY	a_y	$a_y=\bar{y}-b_{yx}\bar{x}$
Slope of regression of x on y	A(XY)	BXY	b_{xy}	$b_{xy}=\frac{\Sigma(x-\bar{x})(y-\bar{y})}{\Sigma(y-\bar{y})^2}$
X-intercept of regression of x on y	B(X)	AX	a_x	$a_x=\bar{x}-b_{xy}\bar{y}$
Standard error of estimate in y direction	S(Y.X)	STESTY	s_{yx}	$s_{yx}=s_y\sqrt{1-r^2}$
Standard error or estimate in x direction	S(X.Y)	STESTX	s_{xy}	$s_{xy}=s_x\sqrt{1-r^2}$
Coefficient of relative dispersion from regression of y on x	D(Y.X)	DYX	D_{yx}	$D_{yx}=\frac{100\ s_{yx}}{\bar{y}}$
Standard error of D(Y.X)	S(DYX)	ERRDYX	$\sigma_{D_{yx}}$	$\sigma_{D_{yx}}=\frac{D_{yx}}{\sqrt{2N}}$

TABLE 1.—Symbols and Formulae for Statistics Computed by Data Assembly and Analysis (DASAN) (*Continued*)
(x or y = any variate; *see section on statistics)

Statistics	Output Symbol	FORTRAN Symbol	Math Symbol	Formula
Coefficient of relative dispersion from regression of x on y	D(X.Y)	DXY	D_{xy}	$D_{xy}=\frac{100\, s_{xy}}{\bar{x}}$
Standard error of D(X.Y)	S(DXY)	ERRDXY	$\sigma_{D_{xy}}$	$\sigma_{D_{xy}}=\frac{D_{xy}}{2N}$
Factor for computing a confidence interval of A(YX)*	CONAYX	CONBYX	CA_{yx}	$CA_{yx}=\frac{s_{xy}}{s_y\sqrt{N-1}}$
Factor for computing a confidence interval of B(Y)*	CONBY	CONAY	CB_y	$CB_y=\frac{s_{yx}}{\sqrt{N}}$
Factor for computing a confidence interval of A(XY)*	CONAXY	CONBXY	CA_{xy}	$CA_{xy}=\frac{s_{xy}}{s_x\sqrt{N-1}}$
Factor for computing a confidence interval of B(X)*	CONBX	CONAX	CB_x	$CB_x=\frac{s_{xy}}{\sqrt{N}}$

Basically, the programs are designed to process arrays of data in which rows represent specimens and columns represent measured and computed variables. Alternatively, an input array may represent a single organism, for example, a coiled snail or a segmented anthropod, with the rows representing, respectively, individual whorls or segments. A high degree of adaptability to different kinds of problems is achieved because of the numerous control cards which specify input and output format, table headings, and column numbers of variables on which operations are to be performed.

The first program, referred to here as DASAN (Data Assembly and Analysis), computes the output arrays and all statistics; the second program, referred to as VPLOT (Variable Plotting), plots the bivariate scatter diagrams, using the punched output deck from DASAN as input.

Background and Acknowledgments.—The initial versions of the programs described here were lengthy and were designed for the author's own research concerned with the morphometric analysis and phylogenetic interpretation of a closely-knit group of species within the Pectinidae (Mollusca: Bivalvia). Interest expressed by others made clear the value of revising the programs so that they would be adaptable to a wide variety of problems.

The reprogramming was carried out at the Smithsonian Institution, Washington, D.C., as part of a continuing project concerned with the paleobiology of the Pectinidae, which is supported by a grant from the Smithsonian Research Foundation. Use of the IBM 7094 of the Columbia University Computer Center was made possible through the generosity of Dr. John Imbrie of the Department of Geology. Invaluable assistance in constructing the initial programs, particularly in incorporating the variable plotting routine (Subroutine APLOT), was received from D. M. Vincent Manson of the American Museum of Natural History. The APLOT subroutine originally appeared in a program written by Clarence Bradford and Arthur Gasche of the University of Chicago and has subsequently been adapted to a number of programs by Manson. Constructive suggestions regarding both programs and texts have been gratefully received from Alan Cheetham of the Smithsonian Institution, Stephen Jay Gould of Harvard University, and Niles Eldredge of Columbia University.

Statistics

The statistics appearing in the output of DASAN are computed by means of the formulae shown in Table 1, all of which have been taken from either Imbrie (1956) or Simpson, Roe, and Lewontin (1960). In addition to their use in summarizing data and in the drawing of regression lines or lines of best fit directly onto the output of VPLOT, the statistics are of use in the construction of modified Dice-Leraas diagrams (Simpson et al., p. 355) and in determining whether differences in the position and slope of reduced major axes are statistically significant (Imbrie, p. 237).

Using the factors marked by asterisks in Table 1, confidence intervals (CI) for the slopes and intercepts of regression lines may be calculated as follows, where t is the familiar Student's t with N−2 degrees of freedom and other symbols are the mathematical symbols of Table 1:

$$CI_{b_{yx}}=b_{yx}\pm CA_{yx}t$$
$$CI_{a_y}=a_y\pm CB_y t$$
$$CI_{b_{xy}}=b_{xy}\pm CA_{xy}t$$
$$CI_{a_x}=a_x\pm CB_x t$$

DASAN: Description of Program

Construction and Handling of Arrays.—The construction and handling of arrays by DASAN is illustrated in Figure 1. Note that the input, referred to as the *univariate input array,* contributes to and becomes part of a *univariate output array.* The latter consists of the univariate input array plus any new variables, *other than ratios,* which are computed from the input variables. All of the variables represented in the univariate output array may therefore not be univariate in a mathematical sense, but they serve here as the data for a statistical analysis which yields the univariate statistics listed in the introduction. The *bivariate array* consists only of form ratios, which are computed from pairs of variables drawn from the univariate output array.

In each of the three arrays, the first variable (first column) consists of specimen identification numbers, with the remaining variables consecutively numbered from left to right beginning with variable No. 2.

In the schematic problem illustrated in Figure 1, the univariate input array, containing a column of specimen numbers (a) and five columns of measurements (b through f), becomes a subarray (A) within the univariate output array. Two of the original variables, d and f, are modified so that

$$d' = \frac{d}{10.18}$$

and

$$f' = f - 9.45$$

where 10.18 and 9.45 are constants specified on control cards.

Four new subarrays have been generated and included in the univariate output array. The subarray B contains two variables, g and h, where

$$g = \frac{b \cdot c}{2}$$

and

$$h = d' \cdot e$$

These are special computations made possible by the insertion of special statements in DASAN, as described in a following section. Subarray C consists of variables generated by subtracting one of the variables in the preceding columns from another. Let us suppose that here

$$i = b - e$$

and

$$j = b - f$$

Subarray D consists of variables generated by adding any two of the variables in the preceding columns. For example,

$$k = e + h$$

Subarray E consists of the logarithms (base 10) of variables in the preceding columns. For example,

$$l = \log_{10} b$$

and

$$m = \log_{10} c$$

Univariate statistics for all of the variables (except for the specimen identification numbers) in the univariate output array are computed. Both univariate and bivariate statistics are computed for the variables in the bivariate array.

In addition to the bivariate statistics which are computed for each variable (ratio) in the bivariate array, an option exists whereby a bivariate analysis of x and y transformed to logarithms (base 10) may be performed for certain columns, the column numbers of which are specified on a control card. Let us suppose that in the sample problem illustrated in Figure 1 a control card specifies that the variables comprising the ratios appearing in columns 2, 3, 5, 6, and 8 in the bivariate array are to be transformed to logs for an additional bivariate analysis. These statistics appear in Array IV. The wavy lines beneath the ratios f'/c, j/d', and l/m mark those variables which were *not* designated for logarithmic transformation and for which the bivariate statistics from Array III are merely repeated (with the exception of the coordinates of the end points of the lines of best fit or regressions, which have been altered and are no longer valid).

In the bivariate array for this same sample problem, the ratio l/m is the ratio of one log (log b) to another (log c). Such ratios which are constructed from variables previously transformed to logarithms in the univariate output array cannot be processed to yield correct univariate and bivariate statistics. These invalid statistics are indicated by a wavy line in Arrays II and III. Note that correct bivariate statistics for this same ratio (log b/log c) appear under b/c in Array IV.

If the horizontal dimension of an output array exceeds the width of standard output paper, the array must be broken into segments, each of which can be printed on the computer paper. This has been done in the sample output (see listing of sample output).

Flow of Control.—The flow of control through DASAN is schematically represented in Figure 2, and the main steps followed by the program during an execution involving all subroutines are listed below:

DASAN (main)

1. Control cards, variable formats, and data are read in.
2. Subroutine RAWTAB is called if so indicated by option.

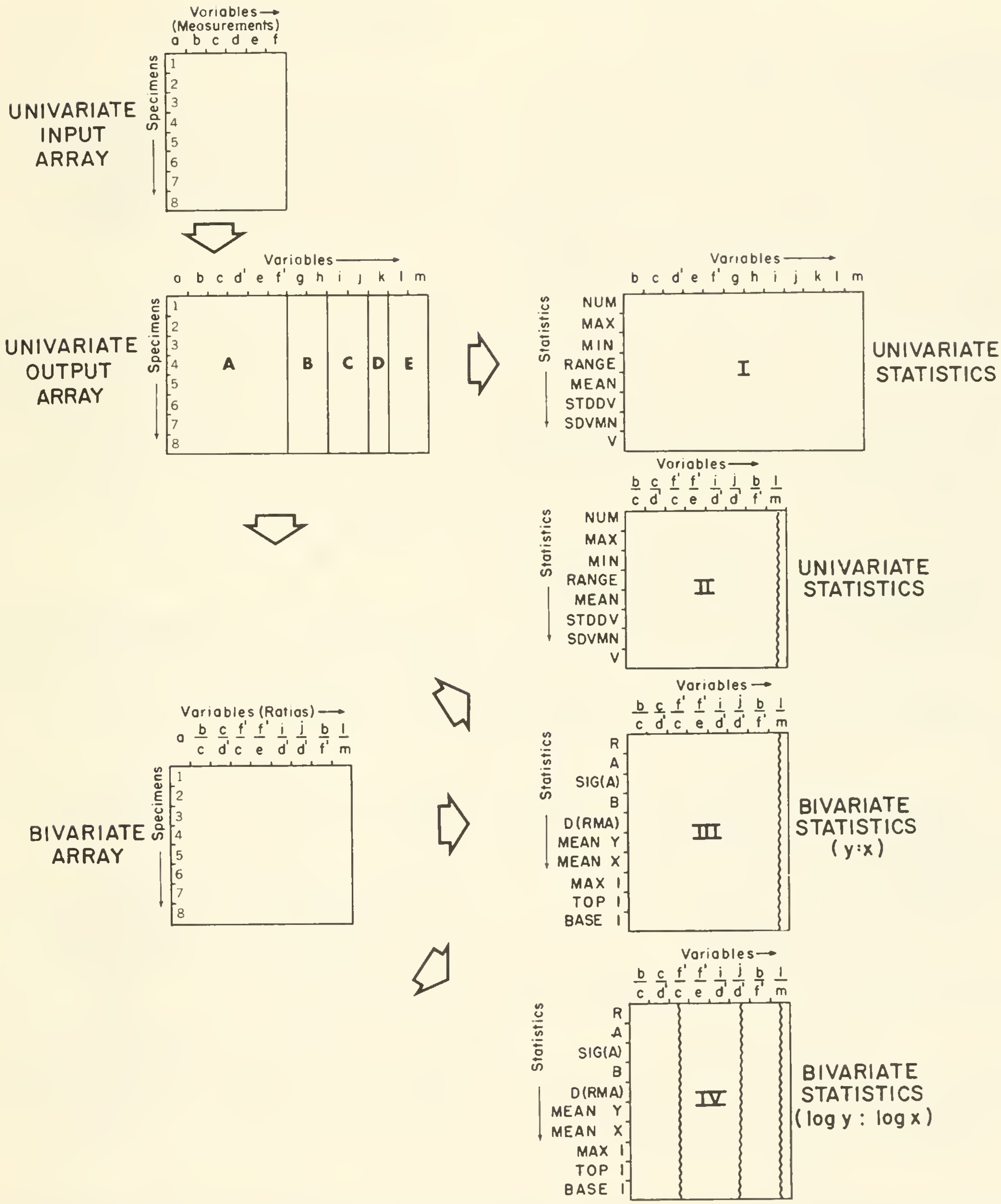

FIGURE 1.—Construction of arrays by DASAN for a sample problem. (Abbreviations and construction procedures are explained in the description of the program. The bivariate statistics shown here are for the reduced major axis.)

Subroutine RAWTAB

Each of the following steps in RAWTAB is optional, depending upon values on control cards.

3. A read-in constant is subtracted from certain columns of variables, the column numbers of which are specified on control cards. The results replace the original values.

4. Certain variables, the column numbers of which are specified on control cards, are divided by a read-in constant. The results replace the original values.

5. If so indicated by signals on each data card, certain data cells, the column numbers of which are specified on control cards, are divided by a read-in constant. The results replace the original values.

6. Special variables are computed (e.g., the areas of muscle attachments). The results are new columns of variables which are added to the original data array.

7. Certain variables, specified on control cards, are subtracted from certain other variables, also specified on control cards. The results are new columns of variables added to the univariate input array.

8. Same as Step 7, but involving the addition of variables.

9. Certain variables, specified on control cards, are converted to logarithms to the base 10. The logs are added to the univariate input array as columns of new variables.

10. Control is returned to the main program.

DASAN (main)

11. Subroutine XRATIO is called, if so indicated by option.

Subroutine XRATIO

12. Ratios are computed and entered in a new array. The column numbers of variables comprising the ratios are specified on control cards.

13. Control is returned to the main program.

DASAN (main)

14. If so indicated by option, subroutine XPUNCH is called.

Subroutine XPUNCH

15. The univariate output array is punched onto cards according to format specified on control cards.

16. Control is returned to the main program.

DASAN (main)

17. If so indicated by option, the first page of the univariate output array is printed with no change in the order of specimens in the input deck.

18. Subroutine UNIVAR is called.

Subroutine UNIVAR

19. Univariate statistics are computed from the variables which are to appear on one page of output.

20. The univariate statistics are printed out below the page of the univariate output array.

21. Control is returned to the main program.

DASAN (main)

22. If no more univariate output pages remain to be printed, the option to proceed to the first page of bivariate output is interrogated. If more pages of the univariate output array remain to be printed, the next page is printed out, followed by a call to UNIVAR and printing out of the univariate statistics as in Steps 17 through 21.

23. If so indicated by option, the first page of the bivariate array is printed out, with no change in the order of specimens in the input deck.

24. Subroutine UNIVAR is called.

Subroutine UNIVAR

25. Univariate statistics are computed from the bivariate variables on a page of output.

26. The univariate statistics are printed out below the page of the bivariate array.

27. Control is returned to the main program.

DASAN (main)

28. Subroutine BIVAR is called.

Subroutine BIVAR

29. Bivariate statistics are computed for the ratios appearing on one page of the bivariate array.

30. The bivariate statistics are printed out below the univariate statistics.

31. Bivariate statistics for $\log_{10}y$ and $\log_{10}x$ are computed for any or all of the ratios, as instructed by control cards.

32. The bivariate statistics of the log data are printed out below the bivariate statistics of the non-log data.

33. Control is returned to the main program.

DASAN (main)

34. The number of bivariate output pages is checked. If more remain to be printed, Steps 23 through 33 are repeated.

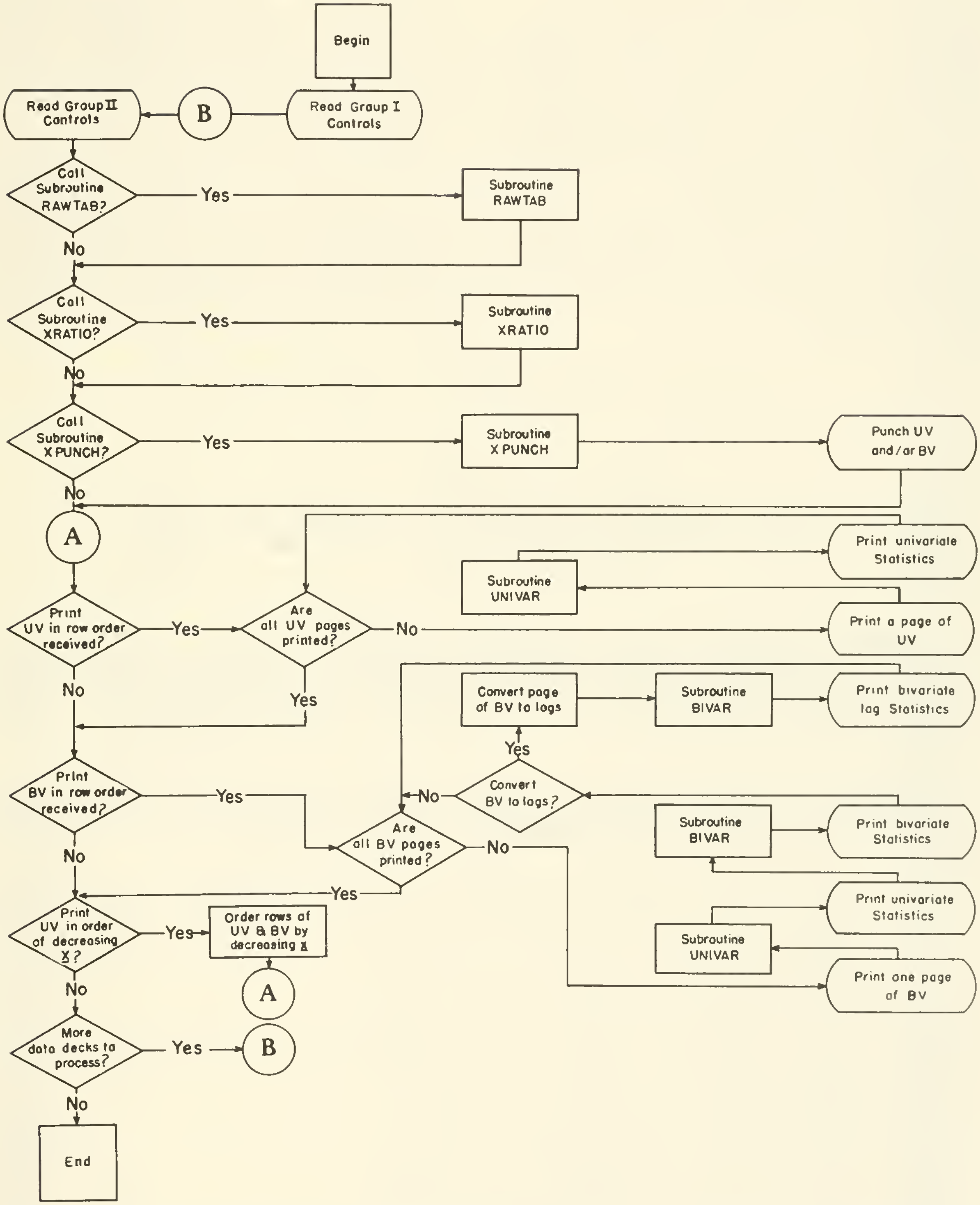

FIGURE 2.—Simplified block diagram showing the flow of control through DASAN and the major output options. The abbreviations *UV* and *BV* refer, respectively, to the univariate output array and the bivariate array. *A* and *B* indicate points between which flow lines cannot be conveniently drawn.

35. If no more bivariate output pages remain, the option to print all data in order of decreasing values of one of the variables, the column number of which is indicated on a control card, is interrogated. If so indicated, Steps 17 through 34 are repeated (flow returns to connecting point A in Figure 2) with an option to print the bivariate array in order of decreasing values of a specified variable replacing the option referred to in Step 23.

36. If more data decks remain to be processed, control is passed back to Step 1 (connecting point B in Figure 2) with the reading in of new Group-II control cards (see section on input data preparation) and data. Otherwise the execution is completed.

Computation Time.—The test run of DASAN (binary) on the IBM 7094, which used the input and furnished the output listed and described in following sections, analyzed 12 specimens, with 28 variables in the input array, 36 variables in the univariate output array, and 42 variables in the bivariate array, in 52 seconds.

Core Space.—DASAN in its present form approaches the maximum storage allowed in the IBM 7094. Increasing the dimensions so that up to 150 rather than only 100 specimens can be included in a sample resulted in an overlap of COMMON and PROGRAM storage areas. The maximum capacity of the program (in terms of numbers of specimens) which can be reached through redimensioning is therefore between 100 and 150.

Listing of FORTRAN II Statements in DASAN

```
C - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - -
C                       DASAN (MAIN ROUTINE)
C     PROGRAM FOR THE ASSEMBLY AND ANALYSIS OF MORPHOMETRIC DATA
C   THOMAS R. WALLER, DEPT. OF PALEOBIOLOGY, SMITHSONIAN INSTITUTION
C                         FEBRUARY 6, 1967
C - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - -
C
      DIMENSION ANAME(21),FMT1(60),FMT2(60),FMT3(60),FMT4(60),FMT5(60).  DMAIN   1
     1FMT6(60),FMT7(60),FMT8(96),IDADD1(30),IDADD2(30),IDGLAS(30),IDLOG(DMAIN   2
     230),IDMIN(30),IDMTR1(30),IIMTR2(5),IDSUBT(30),INDXBV(80,4),MMTRNS(DMAIN   3
     3100,5),RATIO(100,56),RAW(100.53),SPMAX(53),TEMP1(53),TEMP2(56),    DMAIN   4
     4VNAME(10,24),SLGMIN(53)                                            DMAIN   5
C
      COMMON K,RAW,NLOG,NTRNS,GLASS,OCULAR,NGLASS,IDGLAS,NMMTRN,IDMTR1,  DMAIN   6
     1IDMTR2,NSUB,IDMIN,IDSUBT,NADD,IDADD1,IDADD2,IDLOG,NBIVAR,FMT8,FMT2DMAIN   7
     2,FMT3,FMT6,FMT7,SPMAX,RATIO,INDXBV,MMTRNS.SLGMIN,NBVT              DMAIN   8
C
      READ INPUT TAPE 5,34,NDATA,L,NUVTOT,NBVTOT,NRTAB,NRAT              DMAIN   9
      READ INPUT TAPE 5,36,NGLASS,NMMTRN,NTRNS,NSUB,NADD,NLOG            DMAIN  10
      IF (NGLASS)30.56,55                                                DMAIN  11
   55 READ INPUT TAPE 5,36,(IDGLAS(J),J=1,NGLASS)                        DMAIN  12
   56 IF (NMMTRN)30,58,57                                                DMAIN  13
   57 READ INPUT TAPE 5,36,(IDMTR1(J),J=1,NMMTRN)                        DMAIN  14
   58 IF (NTRNS)30,60,59                                                 DMAIN  15
   59 READ INPUT TAPE 5,36,(IDMTR2(J),J=1,NTRNS)                         DMAIN  16
   60 IF (NSUB)30,62,61                                                  DMAIN  17
   61 READ INPUT TAPE 5,36,(IDMIN(J).J=1,NSUB)                           DMAIN  18
      READ INPUT TAPE 5,36,(IDSUBT(J),J=1,NSUB)                          DMAIN  19
   62 IF (NADD)30,64,63                                                  DMAIN  20
   63 READ INPUT TAPE 5.36,(IDADD1(J),J=1,NADD)                          DMAIN  21
      READ INPUT TAPE 5,36,(IDADD2(J),J=1,NADD)                          DMAIN  22
   64 IF (NLOG)30,66,65                                                  DMAIN  23
   65 READ INPUT TAPE 5,36,(IDLOG(J),J=1,NLOG)                           DMAIN  24
   66 READ INPUT TAPE 5,36,NUVAR,NPAGE1                                  DMAIN  25
```

```
      READ INPUT TAPE 5,36,NBIVAR,NPAGE2
      IF (NBVTOT)30,68,67
   67 NBVT = NBVTOT - 1
      READ INPUT TAPE 5,36,((INDXBV(I,J),J=1,4),I=1,NBVT)
   68 NPTOT = NPAGE1 + NPAGE2
      READ INPUT TAPE 5,37,((VNAME(I,J),J=1,24),I=1,NPTOT)
C
      READ INPUT TAPE 5,36,NFMT1,NFMT2,NFMT3,NFMT4,NFMT5,NFMT6,NFMT7,
     1NFMT8
      KK = 12 * NFMT1
      READ INPUT TAPE 5,37,(FMT1(I),I=1,KK)
      KK = 12 * NFMT2
      READ INPUT TAPE 5,37,(FMT2(I),I=1,KK)
      KK = 12 * NFMT3
      READ INPUT TAPE 5,37,(FMT3(I),I=1,KK)
      KK = 12 * NFMT4
      READ INPUT TAPE 5,37,(FMT 4(I),I=1,KK)
      KK = 12 * NFMT5
      READ INPUT TAPE 5,37,(FMT5(I),I=1,KK)
      KK = 12 * NFMT6
      READ INPUT TAPE 5,37 FMT6(I),I - 1,KK)
      KK = 12 * NFMT7
      READ INPUT TAPE 5,37,(FMT7(I), I - 1,KK)
      KK = 12 * NFMT8
      READ INPUT TAPE 5,37,FMT8(I),I=1,KK)
C
      READ INPUT TAPE 5,FMT2,(SPMAX(J),J=1,NUVTOT)
      READ INPUT TAPE 5,FMT2,(SLGMIN(J),J-1,NUVTOT)
    1 READ INPUT TAPE 5,38,PUNCH,WRITE1,WRITE2,RITHT1,RITHT2,NORDER
      READ INPUT TAPE 5,37,ANAME
      READ INPUT TAPE 5,39,GLASS,OCULAR,ISIDE,K
      IF (NTRNS)30,46,47
   46 READ INPUT TAPE 5,FMT1,((RAW(I,J),J=1,L),I=1,K
      GO TO 51
   47 READ INPUT TAPE 5,FMT1,((MMTRNS(I,J),J=1,NTRNS),(RAW(I,J),J=1,L),
     1I=1,K)
   51 IF (NRTAB)30,49,48
   48 CALL RAWTAB (L,NSPCMP)
C
   49 IF (NRAT)30,50,52
   52 CALL XRATIO (NBVT)
C
   50 IF (PUNCH)30,3,2
    2 CALL XPUNCH (NUVTOT,NBVTOT,PUNCH)
C
    3 IF (WRITE1)30,11,4
    4 NPTEMP = 1
      NPTOT = 0
      NV1 = 2
      NV2 = NUVAR
      WRITE1 = 0.
    5 IF (NPAGE1 - NPTEMP)12,6,6
```

```
    6 NPTOT - NPTOT + 1                                              DMAIN 73
C
      WRITE OUTPUT TAPE 6,40,ANAME                                   DMAIN 74
C
      IF (ISIDE)7,9,8                                                DMAIN 75
    7 WRITE OUTPUT TAPE 6,41,K                                       DMAIN 76
      GO TO 10                                                       DMAIN 77
    8 WRITE OUTPUT TAPE 6,42,K                                       DMAIN 78
      GO TO 10                                                       DMAIN 79
    9 WRITE OUTPUT TAPE 6,43,K                                       DMAIN 80
C
   10 WRITE OUTPUT TAPE 6,45,(VNAME(NPTOT,J),J=1,20)                 DMAIN 81
      WRITE OUTPUT TAPE 6,FMT4,(RAW(I,1),(RAW(I,J),J=NV1,NV2),I=1,K) DMAIN 82
C
      CALL UNIVAR (RAW,NV1,NV2,NPTEMP,NUVAR,1,L,NSPCMP,NSUB,NADD)    DMAIN 83
      GO TO 5                                                        DMAIN 84
C
   11 NPTOT = NPAGE1                                                 DMAIN 85
   12 IF (WRITE2)30,20,13                                            DMAIN 86
   13 NPTEMP = 1                                                     DMAIN 87
      NV1 = 2                                                        DMAIN 88
      NV2 = NBIVAR                                                   DMAIN 89
      NPTMP2 = 1                                                     DMAIN 90
      NROW1 = 1                                                      DMAIN 91
      NROW2 = NBIVAR - 1                                             DMAIN 92
      WRITE2 = 0.                                                    DMAIN 93
   14 IF (NPAGE2 - NPTEMP)20,15,15                                   DMAIN 94
   15 NPTOT = NPTOT + 1                                              DMAIN 95
C
      WRITE OUTPUT TAPE 6,40,ANAME                                   DMAIN 96
C
      IF (ISIDE)16,18,17                                             DMAIN 97
   16 WRITE OUTPUT TAPE 6,41,K                                       DMAIN 98
      GO TO 19                                                       DMAIN 99
   17 WRITE OUTPUT TAPE 6,42,K                                       DMAIN100
      GO TO 19                                                       DMAIN101
   18 WRITE OUTPUT TAPE 6,43,K                                       DMAIN102
C
   19 WRITE OUTPUT TAPE 6,45,(VNAME(NPTOT,J),J=1,20)                 DMAIN103
      WRITE OUTPUT TAPE 6,FMT5,(RATIO(I,1),(RATIO(I,J),J=NV1,NV2),I=1,K) DMAIN104
C
      CALL UNIVAR (RATIO,NV1,NV2,NPTEMP,NBIVAR,2,L,NSPCMP,NSUB,NADD) DMAIN105
      CALL BIVAR (NROW1,NROW2,NPTMP2)                                DMAIN106
      GO TO 14                                                       DMAIN107
C
   20 IF (RITHT1)30,22,21                                            DMAIN108
   21 WRITE1 = 1.                                                    DMAIN109
   22 IF (RITHT2)30,24,23                                            DMAIN110
   23 WRITE2 = 1.                                                    DMAIN111
   24 IF (RITHT1 + RITHT2) 30,32,25                                  DMAIN112
C
   25 K2 = K - 1                                                     DMAIN113
```

```
      DO 29 I=1,K2                                                      DMAIN114
      IP1 = I + 1                                                       DMAIN115
      DO 29 I2=IP1,K                                                    DMAIN116
      IF (RAW(I,NORDER) - RAW(I2,NORDER))26,26,29                       DMAIN117
   26 DO 27 J=1,NUVTOT                                                  DMAIN118
      TEMP1(J) = RAW(I,J)                                               DMAIN119
      RAW(I,J) = RAW(I2,J)                                              DMAIN120
   27 RAW(I2,J) = TEMP1(J)                                              DMAIN121
      DO 28 J=1,NBVTOT                                                  DMAIN122
      TEMP2(J) = RATIO(I,J)                                             DMAIN123
      RATIO(I,J) = RATIO(I2,J)                                          DMAIN124
   28 RATIO(I2,J) = TEMP2(J)                                            DMAIN125
   29 CONTINUE                                                          DMAIN126
C
      RITHT1 = 0.                                                       DMAIN127
      RITHT2 = 0.                                                       DMAIN128
      GO TO 3                                                           DMAIN129
C
   30 WRITE OUTPUT TAPE 6,44                                            DMAIN130
      GO TO 33                                                          DMAIN131
C
   32 NDATA = NDATA - 1                                                 DMAIN132
      IF (NDATA)33,33,70                                                DMAIN133
   70 WRITE OUTPUT TAPE 6,71                                            DMAIN134
      GO TO 1                                                           DMAIN135
   33 CALL EXIT                                                         DMAIN136
C
   34 FORMAT (I3)                                                       DMAIN137
   36 FORMAT (24I3)                                                     DMAIN138
   37 FORMAT (12A6)                                                     DMAIN139
   38 FORMAT (F2.0,4F3.0,I3)                                            DMAIN140
   39 FORMAT (F6.2/F6.2/I2/I3)                                          DMAIN141
   40 FORMAT (1H1,21A6)                                                 DMAIN142
   41 FORMAT (1H0,I3,12H LEFT VALVES)                                   DMAIN143
   42 FORMAT (1H0,I3,13H RIGHT VALVES)                                  DMAIN144
   43 FORMAT (1H0,I3,10H SPECIMENS)                                     DMAIN145
   44 FORMAT (1H1,23HANOMALOUS VALVE IN DATA)                           DMAIN146
   45 FORMAT (1H0,20A6)                                                 DMAIN147
   71 FORMAT (1H1/1H1)                                                  DMAIN148
C
C
      END
C - - - - - - - - - - -  DASAN (SUBROUTINE RAWTAB) - - - - - - - - - - - - -
C
      SUBROUTINE RAWTAB (L,NSPCMP)                                      RAWTB   1
C
      DIMENSION DUMMY1(390),DUMMY2(100,56),IDADD1(30),IDADD2(30),IDGLAS(RAWTB   2
     130),IDLOG(30),IDMIN(30),IDMTR1(30),IDMTR2(5),IDSUBT(30),MMTRNS(100RAWTB   3
     2,5),RAW(100,53),DUMMY3(80,4)                                      RAWTB   4
C
      COMMON K,RAW,NLOG,NTRNS,GLASS,OCULAR,NGLASS,IDGLAS,NMMTRN,IDMTR1, RAWTB   5
     1IDMTR2,NSUB,IDMIN,IDSUBT,NADD,IDADD1,IDADD2,IDLOG,DUMMY1,DUMMY2,  RAWTB   6
```

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```
     2DUMMY3,MMTRNS                                                     RAWTB  7
C
      DO 28 I=1,K                                                       RAWTB  8
C
      IF (NGLASS)30,4,1                                                 RAWTB  9
    1 DO 3 J=1,NGLASS                                                   RAWTB 10
      J2 = IDGLAS(J)                                                    RAWTB 11
      IF (RAW(I,J2))30,3,2                                              RAWTB 12
    2 RAW(I,J2) = RAW(I,J2) - GLASS                                     RAWTB 13
    3 CONTINUE                                                          RAWTB 14
C
    4 IF (NMMTRN)30,7,5                                                 RAWTB 15
    5 DO 6 J=1,NMMTRN                                                   RAWTB 16
      J2 = IDMTR1(J)                                                    RAWTB 17
    6 RAW(I,J2) = RAW(I,J2) / OCULAR                                    RAWTB 18
    7 IF (NTRNS)30,11,8                                                 RAWTB 19
    8 DO 10 J=1,NTRNS                                                   RAWTB 20
      J3 = IDMTR2(J)                                                    RAWTB 21
      IF (MMTRNS(I,J))9,30,10                                           RAWTB 22
    9 RAW(I,J3) = RAW(I,J3) / OCULAR                                    RAWTB 23
   10 CONTINUE                                                          RAWTB 24
C
   11 J4 = L                                                            RAWTB 25
      NSPCMP = 0                                                        RAWTB 26
C
C     J4 = J4 + 1                                                       RAWTB 27
C     NSPCMP = NSPCMP + 1                                               RAWTB 28
C
C  12 RAW(I,J4) = .5 * RAW(I,21) * RAW(I,20)                            RAWTB 29
C
C         ADD ADDITIONAL COMPUTATIONS LIKE STATEMENT NO. 12 IN PLACE OF
C  THESE COMMENTS.  EACH COMPUTATION MUST BE PRECEDED BY J4=J4 + 1 AND
C  NSPCMP = NSPCMP + 1, AND EACH COMPUTATION STATEMENT BEGINS LIKE
C  STATEMENT NO. 12. WITH RAW(I,J4) ON LEFT SIDE OF = SIGN.  NO STATE-
C  MENT NUMBERS ARE REQUIRED.
C
      IF (NSUB)30,18,13                                                 RAWTB 30
   13 DO 17 J=1,NSUB                                                    RAWTB 31
      J2 = IDMIN(J)                                                     RAWTB 32
      J3 = IDSUBT(J)                                                    RAWTB 33
      J4 = J4 + 1                                                       RAWTB 34
      IF (RAW(I,J2))15,14,15                                            RAWTB 35
   14 RAW(I,J4) = 0.                                                    RAWTB 36
      GO TO 17                                                          RAWTB 37
   15 IF (RAW(I,J3))16,14,16                                            RAWTB 38
   16 RAW(I,J4) = RAW(I,J2) - RAW(I,J3)                                 RAWTB 39
   17 CONTINUE                                                          RAWTB 40
C
   18 IF (NADD)30,24,19                                                 RAWTB 41
   19 DO 23 J=1,NADD                                                    RAWTB 42
      J2 = IDADD1(J)                                                    RAWTB 43
      J3 = IDADD2(J)                                                    RAWTB 44
      J4 = J4 + 1                                                       RAWTB 45
```

```
      IF (RAW(I,J2))21,20,21
   20 RAW(I,J4) = 0.
      GO TO 23
   21 IF (RAW(I,J3))22,20,22
   22 RAW(I,J4) = RAW(I,J2) + RAW(I,J3)
   23 CONTINUE
C
   24 IF (NLOG)30,36,25
   25 DO 28 J = 1,NLOG
      J2 = IDLOG(J)
      J4 = J4 + 1
      IF (RAW(I,J2))30,28,26
   26 RAW(I,J4) = LOG10F(RAW(I,J2))
   28 CONTINUE
      GO TO 36
C
   30 WRITE OUTPUT TAPE 6,31
   31 FORMAT (1H1,23HANOMALOUS VALUE IN DATA)
      CALL EXIT
C
   36 RETURN
      END
C - - - - - - - - - - DASAN (SUBROUTINE XRATIO) - - - - - - - - - - - -
C
      SUBROUTINE XRATIO (NBVT)
C
      DIMENSION DUMMY1(613),INDXBV(80,4),RATIO(100,56),RAW(100,53)
C
      COMMON K,RAW,DUMMY1,RATIO,INDXBV
C
      DO 1 I=1,K
      RATIO(I,1) = RAW(I,1)
      J2 = 1
      DO 1 II=1,NBVT
      JY = INDXBV(II,1)
      JX = INDXBV(II,2)
      J2 = J2 + 1
    1 RATIO(I,J2) = RAW(I,JY) / RAW(I,JX)
C
      RETURN
      END
C - - - - - - - - - - DASAN (SUBROUTINE XPUNCH) - - - - - - - - - - - -
C
      SUBROUTINE XPUNCH (NUVTOT,NBVTOT,PUNCH)
C
      DIMENSION DUMMY1(320),DUMMY2(173),FMT2(60),FMT3(60),RATIO(100,56),
     1RAW(100,53)
C
      COMMON K,RAW,DUMMY1,FMT2,FMT3,DUMMY2,RATIO
C
      IF (PUNCH - 2.)1,2,1
    1 PUNCH = PUNCH - 1.
```

```
C
      WRITE OUTPUT TAPE 7,FMT2,((RAW(I,J),J=1,NUVTOT),I=1,K)
C
      IF (PUNCH - 1.)3,3,2
    2 WRITE OUTPUT TAPE 7,FMT3,((RATIO(I,J),J=1 NBVTOT),I=1,K)
C
    3 RETURN
      END

C - - - - - - - - - - -  DASAN (SUBROUTINE UNIVAR) - - - - - - - - - - - - - -
C
      SUBROUTINE UNIVAR (XX,N1,N2,NPTEMP,NVAR,M,L,NSPCMP,NSUB,NADD)
C
      DIMENSION AMAX(20),AMEAN(20),AMIN(20),ANUM(20),BNUM(20),DIFFER(100
     1,20),DIFSQR(100,20),DUMMY1(100,53),DUMMY2(192),FMT6(60),FMT7(60),
     2IDLOG2(100,20),NUMBER(20),RANGE(20),SDVMN(20),STDDV(20),SUM(20),
     3SUMSQR(20),V(20),X(100,20),XX(100,56),IDLOG(30),DUMMY3(217)
C
      COMMON K,DUMMY1,NLOG,DUMMY2,IDLOG,DUMMY3,FMT6,FMT7
C
      DO 43 I = 1,K
      DO 43 J = 1,NVAR
   43 IDLOG2(I,J) = 0
      IF (M - 1)28,44,29
   44 IF (NLOG)34,29,38
   38 DO 33 J1=1,NLOG
      J2 = L + NSPCMP + NSUB + NADD + J1
      IF (J2-N1)33,30,30
   30 IF (J2-N2)31,31,29
   31 J3 = IDLOG(J1)
      J4 = J2-N1 + 1
      DO 32 I=1,K
      IF (XX(I,J3))34,32,35
   35 IDLOG2(I,J4) = 1
   32 CONTINUE
   33 CONTINUE
C
   29 DO 1 J=N1,N2
      JJ = J - N1 + 1
      DO 1 I=1,K
    1 X(I,JJ) = XX(I,J)
      NN1 = 1
      NN2 = N2 - N1 + 1
C
      DO 3 J=NN1,NN2
      AMAX(J) = X(1,J)
      DO 3 I = 2,K
      IF (AMAX(J) - X(I,J))2,3,3
    2 AMAX(J) = X(I,J)
    3 CONTINUE
C
      DO 14 J=NN1,NN2
      I = 1
```

```
      ANUM(J) = 0.                                                      UV      37
      SUM(J) = 0.                                                       UV      38
   39 IF (IDLOG2(I,J))28,4,7                                            UV      39
    4 IF (X(I,J))7,5,7                                                  UV      40
    5 IF (I-K)6,7,28                                                    UV      41
    6 I = I + 1                                                         UV      42
      GO TO 39                                                          UV      43
    7 AMIN(J) = X(I,J)                                                  UV      44
      SUM(J) = X(I,J)                                                   UV      45
      ANUM(J) = 1.                                                      UV      46
    8 I = I + 1                                                         UV      47
      IF (I - K)40,40,13                                                UV      48
   40 IF (IDLOG2(I,J))28,9,10                                           UV      49
    9 IF (X(I,J))10,8,10                                                UV      50
   10 ANUM(J) = ANUM(J) + 1.                                            UV      51
      SUM(J) = SUM(J) + X(I,J)                                          UV      52
      IF (AMIN(J) - X(I,J))8,8,11                                       UV      53
   11 AMIN(J) = X(I,J)                                                  UV      54
   12 GO TO 8                                                           UV      55
   13 RANGE(J) = AMAX(J) - AMIN(J)                                      UV      56
   14 AMEAN(J) = SUM(J) / ANUM(J)                                       UV      57
C
      DO 19 J=NN1,NN2                                                   UV      58
      I = 1                                                             UV      59
      SUMSQR(J) = 0.                                                    UV      60
      IF (IDLOG2(I,J))28,15,17                                          UV      61
   15 IF (X(I,J))17,16,17                                               UV      62
   16 I = I + 1                                                         UV      63
      IF (I - K)15,15,19                                                UV      64
   17 IF (I - K)18,18,19                                                UV      65
   18 DIFFER(I,J) = X(I,J) - AMEAN(J)                                   UV      66
      DIFSQR(I,J) = DIFFER(I,J) ** 2.                                   UV      67
      SUMSQR(J) = SUMSQR(J) + DIFSQR(I,J)                               UV      68
      GO TO 16                                                          UV      69
   19 CONTINUE                                                          UV      70
C
      DO 20 J=NN1,NN2                                                   UV      71
      STDDV(J) = (SUMSQR(J) / (ANUM(J) - 1.)) ** .5                     UV      72
   20 V(J) = 100. * STDDV(J) / AMEAN(J)                                 UV      73
C
      DO 23 J=NN1,NN2                                                   UV      74
      NUMBER(J) = 0                                                     UV      75
      DO 22 I = 1,K                                                     UV      76
      IF (IDLOG2(I,J))28,42,21                                          UV      77
   42 IF (X(I,J))21,22,21                                               UV      78
   21 NUMBER(J) = NUMBER(J) + 1                                         UV      79
   22 CONTINUE                                                          UV      80
      BNUM(J) = NUMBER(J)                                               UV      81
   23 SDVMN(J) = STDDV(J) / BNUM(J) ** .5                               UV      82
C
   24 GO TO (25,26),M                                                   UV      83
   25 WRITE OUTPUT TAPE 6,FMT6,(NUMBER(J),J=NN1,NN2),(AMAX(J),J=NN1,NN2)UV      84
```

```
     1,(AMIN(J),J=NN1,NN2),(RANGE(J),J=NN1,NN2),(AMEAN(J),J=NN1,NN2),(STUV      85
     2DDV(J),J=NN1,NN2),(SDVMN(J),J=NN1,NN2),(V(J),J=NN1,NN2)              UV      86
      GO TO 27                                                             UV      87
C
   26 WRITE OUTPUT TAPE 6,FMT7,(NUMBER(J),J=NN1,NN2),(AMAX(J),J=NN1,NN2)UV      88
     1,(AMIN(J),J=NN1,NN2),(RANGE(J),J=NN1,NN2),(AMEAN(J),J=NN1,NN2),(STUV      89
     2DDV(J),J=NN1,NN2),(SDVMN(J),J=NN1,NN2),(V(J),J=NN1,NN2)              UV      90
      GO TO 27                                                             UV      91
C
   34 WRITE OUTPUT TAPE 6,36                                               UV      92
      CALL EXIT                                                            UV      93
C
   27 NPTEMP = NPTEMP + 1                                                  UV      94
      N1 = N2 + 1                                                          UV      95
      N2 = N2 + NVAR - 1                                                   UV      96
C
   36 FORMAT (1H1,23HANOMALOUS VALUE IN DATA                               UV      97
C
   28 RETURN                                                               UV      98
      END                                                                  UV      99
C - - - - - - - - - - DASAN (SUBROUTINE BIVAR) - - - - - - - - - - - - -
C
      SUBROUTINE BIVAR (NROW1,NROW2,NPTMP2)                                BVRMA  1
C
      DIMENSION A(20),AMEANX(20),AMEANY(20),B(20),BASE1(20),DIFFER(100,2BVRMA  2
     1),DIFSQR(100,2),DRMA(20),DUMMY1(222),DUMMY2(240),DUMMY3(100,56),FMBVRMA  3
     2T8(96),INDXBV(80,4),PAIRS(20),R(20),RSQ(20),SPMAX(53),STDDVX(20), BVRMA  4
     3STDDVY(20),STERRA(20),SUM2(2),SUMMUL(20),SUMSQ2(2),TOP1(20),TX(100BVRMA  5
     4,2),X(100,53),YMAX1(20),LGCOL(20),DUMMY4(100,5),SLGMIN(53)          BVRMA  6
C
      COMMON K,X,NLOG,DUMMY1,NBIVAR,FMT8,DUMMY2,SPMAX,DUMMY3,INDXBV,DUMMBVRMA  7
     1Y4,SLGMIN,NBVT                                                       BVRMA  8
C
      M = 0                                                                BVRMA  9
      MM = 0                                                               BVRMA 10
      IM = 0                                                               BVRMA 11
   32 DO 16 II = NROW1,NROW2                                               BVRMA 12
      IF (II - NBVT)55,55,54                                               BVRMA 13
   55 J1 = INDXBV(II,1)                                                    BVRMA 14
      J2 = INDXBV(II,2)                                                    BVRMA 15
      LL = INDXBV(II,3)                                                    BVRMA 16
      LGT = INDXBV(II,4)                                                   BVRMA 17
      IF (M)22,33,35                                                       BVRMA 18
   35 IF (INDXBV(II,4))34,33,34                                            BVRMA 19
   34 IM = IM + 1                                                          BVRMA 20
      LGCOL(IM) = LL                                                       BVRMA 21
   33 PAIRS(LL) = 0.                                                       BVRMA 22
      SUMSQ2( 1) = 0.                                                      BVRMA 23
      SUMSQ2( 2) = 0.                                                      BVRMA 24
      SUM2( 1) = 0.                                                        BVRMA 25
      SUM2( 2) = 0.                                                        BVRMA 26
      SUMMUL(LL) = 0.                                                      BVRMA 27
```

```
C
      IF (M)30,41,30                                    BVRMA 28
   41 IF (LGT)29,30,29                                  BVRMA 29
   29 LGT = 0                                           BVRMA 30
      MM = 1                                            BVRMA 31
C
   30 Z = 0.                                            BVRMA 32
      DO 5 I=1,K                                        BVRMA 33
      IF (LGT)1,2,1                                     BVRMA 34
    1 TX(I,1) = X(I,J1)                                 BVRMA 35
      TX(I,2) = X(I,J2)                                 BVRMA 36
      IF (X(I,J1))20,5,24                               BVRMA 37
   24 IF (X(I,J2))20,5,23                               BVRMA 38
   23 X(I,J1) = LOG10F(X(I,J1))                         BVRMA 39
      X(I,J2) = LOG10F (X(I,J2))                        BVRMA 40
      IF (Z) 4,60,4                                     BVRMA 41
   60 IF (SPMAX(J1))20,20,51                            BVRMA 42
   51 TSPMAX = SPMAX(J1)                                BVRMA 43
      SPMAX(J1) = LOG10F(SPMAX(J1))                     BVRMA 44
      IF (SPMAX(J2))20,20,61                            BVRMA 45
   61 TSPMXX = SPMAX(J2)                                BVRMA 46
      SPMAX(J2) = LOG10F(SPMAX(J2))                     BVRMA 47
      Z = 1.                                            BVRMA 48
      GO TO 4                                           BVRMA 49
    2 IF (X(I,J1))3,5,3                                 BVRMA 50
    3 IF (X(I.J2))4,5.4                                 BVRMA 51
    4 PAIRS(LL) = PAIRS(LL) + 1.                        BVRMA 52
      SUM2( 1) = SUM2( 1) + X(I,J1)                     BVRMA 53
      SUM2( 2) = SUM2( 2) + X(I,J2)                     BVRMA 54
    5 CONTINUE                                          BVRMA 55
C
      AMEANY(LL) = SUM2( 1) / PAIRS(LL)                 BVRMA 56
      AMEANX(LL) = SUM2( 2) / PAIRS(LL)                 BVRMA 57
C
      DO 6 J=1,2                                        BVRMA 58
      DO 6 I=1,K                                        BVRMA 59
      DIFSQR(I,J) = 0.                                  BVRMA 60
    6 DIFFER(I,J) = 0.                                  BVRMA 61
C
      DO 9 I = 1.K                                      BVRMA 62
      IF (LGT)47,7,47                                   BVRMA 63
   47 IF (TX(I,1))20,9,25                               BVRMA 64
   25 IF (TX(I,2))20,9,10                               BVRMA 65
    7 IF (X(I,J1))8,9,8                                 BVRMA 66
    8 IF (X(I,J2))10,9,10                               BVRMA 67
   10 DIFFER(I,1) = X(I,J1) - AMEANY(LL)                BVRMA 68
      DIFFER(I,2) = X(I,J2) - AMEANX(LL)                BVRMA 69
      DIFSQR(I,1) = DIFFER(I,1) ** 2.                   BVRMA 70
      DIFSQR(I,2) = DIFFER(I,2) ** 2.                   BVRMA 71
    9 CONTINUE                                          BVRMA 72
C
   11 DO 14 I=1,K                                       BVRMA 73
      DIFMUL = DIFFER(I,1) * DIFFER(I,2)                BVRMA 74
```

```
      SUMMUL(LL) = SUMMUL(LL) + DIFMUL                                  BVRMA 75
      IF (LGT)26,27,26                                                  BVRMA 76
   26 IF (TX(I,1))20,14,28                                              BVRMA 77
   28 IF (TX(I,2))20,14,13                                              BVRMA 78
   27 IF (X(I,J1))12,14,12                                              BVRMA 79
   12 IF (X(I,J2))13,14,13                                              BVRMA 80
   13 SUMSQ2(1) = SUMSQ2(1) + DIFSQR(I,1)                               BVRMA 81
      SUMSQ2( 2) = SUMSQ2( 2) + DIFSQR(I, 2)                            BVRMA 82
   14 CONTINUE                                                          BVRMA 83
C
      STDDVY(LL) = (SUMSQ2(1) / (PAIRS(LL) - 1.)) ** .5                 BVRMA 84
      STDDVX(LL) = (SUMSQ2(2) / (PAIRS(LL) - 1.)) ** .5                 BVRMA 85
      SY2 = STDDVY(LL) ** 2.                                            BVRMA 86
      SX2 = STDDVX(LL) ** 2.                                            BVRMA 87
      R(LL) = SUMMUL(LL) / (SUMSQ2( 1) * SUMSQ2( 2)) ** .5              BVRMA 88
      A(LL) = STDDVY(LL) / STDDVX(LL)                                   BVRMA 89
      RSQ(LL) = R(LL) ** 2.                                             BVRMA 90
      STERRA(LL) = A(LL) * ((1. - RSQ(LL)) / PAIRS(LL)) ** .5           BVRMA 91
      B(LL) = AMEANY(LL) - AMEANX(LL) * A(LL)                           BVRMA 92
      DRMA(LL) = 100. * (2. * (1.-R(LL)) * (SX2+SY2) / ((AMEANX(LL)**2.)BVRMA 93
     1 + (AMEANY(LL)**2.))) ** .5                                       BVRMA 94
      YMAX1(LL) = SPMAX(J2) * A(LL) + B(LL)                             BVRMA 95
      IF (LGT)49,48,49                                                  BVRMA 96
   48 VDY = SPMAX(J1) / 49.                                             BVRMA 97
      GO TO 50                                                          BVRMA 98
   49 VDY = (SPMAX(J1) - SLGMIN(J1)) / 49.                              BVRMA 99
   50 TOP1(LL) = (YMAX1(LL) - SPMAX(J1)) / VDY                          BVRMA100
      BASE1(LL) = B(LL) / VDY                                           BVRMA101
C
      DO 17 I=1,K                                                       BVRMA102
      IF (LGT)15,16,15                                                  BVRMA103
   15 X(I,J1) = TX(I,1)                                                 BVRMA104
   17 X(I,J2) = TX(I 2)                                                 BVRMA105
      SPMAX(J1) = TSPMAX                                                BVRMA106
      SPMAX(J2) = TSPMXX                                                BVRMA107
   16 CONTINUE                                                          BVRMA108
   54 NN = NBIVAR                                                       BVRMA109
C
      IF (M+MM)36,31,36                                                 BVRMA110
   31 IF (89-K)45,46,46                                                 BVRMA111
   45 WRITE OUTPUT TAPE 6,19                                            BVRMA112
   46 WRITE OUTPUT TAPE 6,18                                            BVRMA113
      GO TO 39                                                          BVRMA114
   36 IF (M)43,42,43                                                    BVRMA115
   42 IF (70-K)44,46,46                                                 BVRMA116
   44 WRITE OUTPUT TAPE 6,19                                            BVRMA117
   43 WRITE OUTPUT TAPE 6,40,(LGCOL(J),J=1,IM)                          BVRMA118
   39 WRITE OUTPUT TAPE 6,FMT8,(R(J),J=2,NN),(A(J),J=2,NN),(STERRA(J),J=BVRMA119
     12,NN),(B(J),J=2,NN),(DRMA(J),J=2,NN),(AMEANY(J),J=2,NN),(AMEANX(J)BVRMA120
     2,J=2,NN),(YMAX1(J),J=2,NN),(TOP1(J),J=2,NN),(BASE1(J),J=2,NN)     BVRMA121
C
      DO 53 J=2,NN                                                      BVRMA122
```

```
      R(J) = 0.                                                         BVRMA123
      A(J) = 0.                                                         BVRMA124
      STERRA(J) = 0.                                                    BVRMA125
      B(J) = 0.                                                         BVRMA126
      DRMA(J) = 0.                                                      BVRMA127
      AMEANY(J) = 0.                                                    BVRMA128
      AMEANX(J) = 0.                                                    BVRMA129
      YMAX1(J) = 0.                                                     BVRMA130
      TOP1(J) = 0.                                                      BVRMA131
   53 BASE1(J) = 0.                                                     BVRMA132
C
      IF (MM)37,38,37                                                   BVRMA133
   37 M = 1                                                             BVRMA134
      MM = 0                                                            BVRMA135
      GO TO 32                                                          BVRMA136
   38 NPTMP2 = NPTMP2 + 1                                               BVRMA137
      NROW1 = NROW2 + 1                                                 BVRMA138
      NROW2 = NROW2 + NBIVAR - 1                                        BVRMA139
      GO TO 22                                                          BVRMA140
C
   20 WRITE OUTPUT TAPE 6,21                                            BVRMA141
      CALL EXIT                                                         BVRMA142
C
   21 FORMAT(1H1,23HANOMALOUS VALUE IN DATA)                            BVRMA143
   18 FORMAT (1H-,93HBIVARIATE ANALYSIS (REDUCED MAJOR AXIS) OF Y/X.  REBVRMA144
     1SULTS NOT VALID FOR COLUMNS OF LOG Y/LOGX.)                       BVRMA145
   19 FORMAT (1H1)                                                      BVRMA146
   40 FORMAT (1H-,80HBIVARIATE ANALYSIS (REDUCED MAJOR AXIS) OF LOG Y/LOBVRMA147
     1G X  VALID ONLY FOR COLUMN(S),10I4/1H,10I4)                       BVRMA148
C
   22 RETURN                                                            BVRMA149
      END

C - - - - - - - - - - DASAN (SUBROUTINE BIVAR) - - - - - - - - - - - -
C                ALTERNATE SUBROUTINE BIVAR WHICH COMPUTES
C               THE REGRESSIONS OF Y ON X AND X ON Y.
C - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - -
C
      SUBROUTINE BIVAR (NROW1,NROW2,NPTMP2)                             BVYXY  1
C
      DIMENSION AMEANX(20),AMEANY(20),AX(20),AY(20),BASE2(20),BASE3(20),BVYXY  2
     1BXY(20),BYX(20),CONAX(20),CONAY(20),CONBXY(20),CONBYX(20),DIFFER(1BVYXY  3
     200,2),DIFSQR(100,2),DUMMY1(222),DUMMY2(240),DUMMY3(100,56),DUMMY4(BVYXY  4
     3100,5),DXY(20),DYX(20),ERRDXY(20),ERRDYX(20),FMT8(96),INDXBV( 80,4BVYXY  5
     4),LGCOL(20),PAIRS(20),R(20),RSQ(20),SLGMIN(53),SPMAX(53),STDDVX(20BVYXY  6
     5),STDDVY(20),STESTX(20),STESTY(20),SUM2(2),SUMMUL(20),SUMSQ2(2),SXBVYXY  7
     6Y(20),SYX(20),TOP2(20),TOP3(20),TX(100,2),X(100,53),XMAX(20),YMAX2BVYXY  8
     7(20)                                                              BVYXY  9
C
      COMMON K,X,NLOG,DUMMY1,NBIVAR,FMT8,DUMMY2,SPMAX,DUMMY3,INDXBV,DUMMBVYXY 10
     1Y4,SLGMIN,NBVT                                                    BVYXY 11
C
      M = 0                                                             BVYXY 12
```

```
      MM = 0                                                            BVYXY 13
      IM = 0                                                            BVYXY 14
   32 DO 16 II = NROW1,NROW2                                            BVYXY 15
      IF (II - NBVT)55,55,54                                            BVYXY 16
   55 J1 = INDXBV(II,1)                                                 BVYXY 17
      J2 = INDXBV(II,2)                                                 BVYXY 18
      LL = INDXBV(II,3)                                                 BVYXY 19
      LGT = INDXBV(II,4)                                                BVYXY 20
      IF (M)22,33,35                                                    BVYXY 21
   35 IF (INDXBV(II,4))34,33,34                                         BVYXY 22
   34 IM = IM + 1                                                       BVYXY 23
      LGCOL(IM) = LL                                                    BVYXY 24
   33 PAIRS(LL) = 0.                                                    BVYXY 25
      SUMSQ2( 1) = 0.                                                   BVYXY 26
      SUMSQ2( 2) = 0.                                                   BVYXY 27
      SUM2( 1) = 0.                                                     BVYXY 28
      SUM2( 2) = 0.                                                     BVYXY 29
      SUMMUL(LL) = 0.                                                   BVYXY 30
C
      IF (M)30,41,30                                                    BVYXY 31
   41 IF (LGT)29,30,29                                                  BVYXY 32
   29 LGT = 0                                                           BVYXY 33
      MM = 1                                                            BVYXY 34
C
   30 Z = 0.                                                            BVYXY 35
      DO 5 I=1,K                                                        BVYXY 36
      IF (LGT)1,2,1                                                     BVYXY 37
    1 TX(I,1) = X(I,J1)                                                 BVYXY 38
      TX(I,2) = X(I,J2)                                                 BVYXY 39
      IF (X(I,J1))20,5,24                                               BVYXY 40
   24 IF (X(I,J2))20,5,23                                               BVYXY 41
   23 X(I,J1) = LOG10F (X(I,J1))                                        BVYXY 42
      X(I,J2) = LOG10F (X(I,J2))                                        BVYXY 43
      IF (Z) 4,60,4                                                     BVYXY 44
   60 IF (SPMAX(J1))20,20,51                                            BVYXY 45
   51 TSPMAX = SPMAX(J1)                                                BVYXY 46
      SPMAX(J1) = LOG10F(SPMAX(J1))                                     BVYXY 47
      IF (SPMAX(J2))20,20,52                                            BVYXY 48
   52 TSPMXX = SPMAX(J2)                                                BVYXY 49
      SPMAX(J2) = LOG10F(SPMAX(J2))                                     BVYXY 50
      Z = 1.                                                            BVYXY 51
      GO TO 4                                                           BVYXY 52
    2 IF (X(I,J1))3,5,3                                                 BVYXY 53
    3 IF (X(I,J2))4,5,4                                                 BVYXY 54
    4 PAIRS(LL) = PAIRS(LL) + 1.                                        BVYXY 55
      SUM2( 1) = SUM2( 1) + X(I,J1)                                     BVYXY 56
      SUM2( 2) = SUM2( 2) + X(I,J2)                                     BVYXY 57
    5 CONTINUE                                                          BVYXY 58
C
      AMEANY(LL) = SUM2( 1) / PAIRS(LL)                                 BVYXY 59
      AMEANX(LL) = SUM2( 2) / PAIRS(LL)                                 BVYXY 60
C
      DO 6 J=1,2                                                        BVYXY 61
```

```
      DO 6 I=1,K
      DIFSQR(I,J) = 0.
    6 DIFFER(I,J) = 0.
C
      DO 9 I = 1,K
      IF (LGT)47,7,47
   47 IF (TX(I,1))20,9,25
   25 IF (TX(I,2))20,9,10
    7 IF (X(I,J1))8,9,8
    8 IF (X(I,J2))10,9,10
   10 DIFFER(I,1) = X(I,J1) - AMEANY(LL)
      DIFFER(I,2) = X(I,J2) - AMEANX(LL)
      DIFSQR(I,1) = DIFFER(I,1) ** 2.
      DIFSQR(I,2) = DIFFER(I,2) ** 2.
    9 CONTINUE
C
   11 DO 14 I=1,K
      DIFMUL = DIFFER(I,1) * DIFFER(I,2)
      SUMMUL(LL) = SUMMUL(LL) + DIFMUL
      IF (LGT)26,27,26
   26 IF (TX(I,1))20,14,28
   28 IF (TX(I,2))20,14,13
   27 IF (X(I,J1))12,14,12
   12 IF (X(I,J2))13,14,13
   13 SUMSQ2(1) = SUMSQ2(1) + DIFSQR(I,1)
      SUMSQ2(2) = SUMSQ2(2) + DIFSQR(I,2)
   14 CONTINUE
C
      STDDVY(LL) = (SUMSQ2(1) / (PAIRS(LL) - 1.)) ** .5
      STDDVX(LL) = (SUMSQ2(2) / (PAIRS(LL) - 1.)) ** .5
      BYX(LL) = SUMMUL(LL) / SUMSQ2(2)
      BXY(LL) = SUMMUL(LL) / SUMSQ2(1)
      AY(LL) = AMEANY(LL) - BYX(LL) * AMEANX(LL)
      AX(LL) = AMEANX(LL) - BXY(LL) * AMEANY(LL)
      SY2 = STDDVY(LL) ** 2.
      SX2 = STDDVX(LL) ** 2.
      YY = BYX(LL) ** 2. * SX2
      XX = BXY(LL) ** 2. * SY2
      SYX(LL) = (PAIRS(LL) - 1.) / (PAIRS(LL) - 2.) * (SY2 - YY)
      SXY(LL) = (PAIRS(LL) - 1.) / (PAIRS(LL) - 2.) * (SX2 - XX)
      R(LL) = SUMMUL(LL) / (SUMSQ2( 1) * SUMSQ2( 2)) ** .5
      RSQ(LL) = R(LL) ** 2.
      STESTY(LL) = STDDVX(LL) * (1. - RSQ(LL)) ** .5
      STESTX(LL) = STDDVY(LL) * (1. - RSQ(LL)) ** .5
      DXY(LL) = 100. * STESTY(LL) / AMEANX(LL)
      ERRDXY(LL) = DXY(LL) / (2. * PAIRS(LL)) ** .5
      DYX(LL) = 100. * STESTX(LL) / AMEANY(LL)
      ERRDYX(LL) = DYX(LL) / (2. * PAIRS(LL)) ** .5
      CONBYX(LL) = SYX(LL) ** .5 / (STDDVX(LL) * ((PAIRS(LL) - 1.)**.5))
      CONBXY(LL) = SXY(LL) ** .5 / (STDDVY(LL) * ((PAIRS(LL) - 1.)**.5))
      CONAY(LL) = SYX(LL) ** .5 / (PAIRS(LL) ** .5)
      CONAX(LL) = SXY(LL) ** .5 / (PAIRS(LL) ** .5)
      XMAX(LL) = SPMAX(J1) * BXY(LL) + AX(LL)
```

```
      YMAX2(LL) = SPMAX(J2) * BYX(LL) + AY(LL)                          BVYXY112
C
      IF (LGT)49,48,49                                                  BVYXY113
   48 VDY = SPMAX(J1) / 49.                                             BVYXY114
      VDX = SPMAX(J2) / 35.                                             BVYXY115
      GO TO 50                                                          BVYXY116
   49 VDY = (SPMAX(J1) - SLGMIN(J1)) / 49.                              BVYXY117
      VDX = (SPMAX(J2) - SLGMIN(J2)) / 35.                              BVYXY118
   50 TOP2(LL) = (YMAX2(LL) - SPMAX(J1)) / VDY                          BVYXY119
      BASE2(LL) = AY(LL) / VDY                                          BVYXY120
      TOP3(LL) = (XMAX(LL) - SPMAX(J2)) / VDX                           BVYXY121
      BASE3(LL) = AX(LL) / VDX                                          BVYXY122
C
      IF (LGT)15,16,15                                                  BVYXY123
   15 DO 17 I=1,K                                                       BVYXY124
      X(I,J1) = TX(I,1)                                                 BVYXY125
   17 X(I,J2) = TX(I,2)                                                 BVYXY126
      SPMAX(J1) = TSPMAX                                                BVYXY127
      SPMAX(J2) = TSPMXX                                                BVYXY128
   16 CONTINUE                                                          BVYXY129
   54 NN = NBIVAR                                                       BVYXY130
C
      IF (M+MM)36,31,36                                                 BVYXY131
   31 IF (81-K)45,46,46                                                 BVYXY132
   45 WRITE OUTPUT TAPE 6,19                                            BVYXY133
   46 WRITE OUTPUT TAPE 6,18                                            BVYXY134
      GO TO 39                                                          BVYXY135
   36 IF (M)43,42,43                                                    BVYXY136
   42 IF (50-K)44,46,46                                                 BVYXY137
   44 WRITE OUTPUT TAPE 6,19                                            BVYXY138
   43 WRITE OUTPUT TAPE 6,40,(LGCOL(J),J=1,IM)                          BVYXY139
   39 WRITE OUTPUT TAPE 6,FMT8,(R(J),J=2,NN),(BYX(J),J=2,NN),(AY(J),J=2,BVYXY140
     1NN),(BXY(J),J=2,NN),(AX(J),J=2,NN),(STESTY(J),J=2,NN),(STESTX(J),JBVYXY141
     2=2,NN),(DYX(J),J=2,NN),(ERRDYX(J),J=2,NN),(DXY(J),J=2,NN),(ERRDXY(BVYXY142
     3J),J=2,NN),(CONBYX(J),J=2,NN),(CONAY(J),J=2,NN),(CONBXY(J),J=2,NN)BVYXY143
     4,(CONAX(J),J=2,NN),(YMAX2(J),J=2,NN),(XMAX(J),J=2,NN),(TOP2(J),J=2BVYXY144
     5,NN),(BASE2(J),J=2,NN),(TOP3(J),J=2,NN),(BASE3(J),J=2,NN)         BVYXY145
C
C
      DO 53 J=2,NN                                                      BVYXY146
      R(J) = 0.                                                         BVYXY147
      BYX(J) = 0.                                                       BVYXY148
      AY(J) = 0.                                                        BVYXY149
      BXY(J) = 0.                                                       BVYXY150
      AX(J) = 0.                                                        BVYXY151
      STESTY(J) = 0.                                                    BVYXY152
      STESTX(J) = 0.                                                    BVYXY153
      DYX(J) = 0.                                                       BVYXY154
      ERRDYX(J) = 0.                                                    BVYXY155
      DXY(J) = 0.                                                       BVYXY156
      ERRDXY(J) = 0.                                                    BVYXY157
      CONBYX(J) = 0.                                                    BVYXY158
      CONAY(J) = 0.                                                     BVYXY159
```

```
      CONBXY(J) = 0.                                                    BVYXY160
      CONAX(J) = 0.                                                     BVYXY161
      YMAX2(J) = 0.                                                     BVYXY162
      YMAX(J) = 0.                                                      BVYXY163
      TOP2(J) = 0.                                                      BVYXY164
      BASE2(J) = 0.                                                     BVYXY165
      TOP3(J) = 0.                                                      BVYXY166
   53 BASE3(J) = 0.                                                     BVYXY167
C
      IF (MM)37,38,37                                                   BVYSY168
   37 M = 1                                                             BVYXY169
      MM = 0                                                            BVYXY170
      GO TO 32                                                          BVYXY171
   38 NPTMP2 = NPTMP2 + 1                                               BVYXY172
      NROW1 = NROW2 + 1                                                 BVYXY173
      NROW2 = NROW2 + NBIVAR - 1                                        BVYXY174
      GO TO 22                                                          BVYXY175
C
   20 WRITE OUTPUT TAPE 6,21                                            BVYXY176
      CALL EXIT                                                         BVYXY177
C
   21 FORMAT(1H1,23HANOMALOUS VALUE IN DATA)                            BVYXY178
   18 FORMAT (1H-,107HBIVARIATE ANALYSIS (REGRESSION OF Y ON X AND X ON BVYXY179
     1Y) OF Y/X.  RESULTS NOT VALID FOR COLUMNS OF LOG Y/LOG X.)        BVYXY180
   19 FORMAT (1H1)                                                      BVYXY181
   40 FORMAT (1H-,93HBIVARIATE ANALYSIS (REGRESSION OF Y ON X AND X ON YBVYXY182
     1) OF LOG Y/LOG X, VALID ONLY FOR COLUMN(S),7I4/1H ,13I4)          BVYXY183
C
   22 RETURN                                                            BVYXY184
      END
```

Input Data Preparation for DASAN

The following section describes the preparation of control and data cards and the order in which they are to be placed behind the program source deck. The control cards are described in two groups. Group I is placed directly behind the program source deck and is not repeated for each data deck included in the computer run. Group II follows Group I and must be repeated before each data deck in the run. This means that operations controlled by Group I apply to all data decks in a run, but that operations controlled by each Group II apply only to the data deck immediately following that appearance of Group II.

In the description below, instructions are numbered consecutively. Numbers in parentheses indicate the minimum and maximum numbers of control cards which are permitted for each instruction.

All numbers punched on control cards are without decimal points, unless otherwise indicated, and are right justified within their fields.

The schematic problem illustrated in Figure 1 is used as an example for some of the controls. All instructions are further demonstrated by the listing of controls in the input for a real problem.

Group I Control Cards

1. (1): The number of data decks (from 1 to 999) which are to be processed in a single run. Punch in card columns 1-3.
2. (1): The number of variables in the univariate input array (from 2 to 53), including the column of specimen identification numbers. Punch in columns 2-3.

   The number is *6* for the problem in Figure 1.
3. (1): The number of variables in the univariate output array (from 2–53), including the column

of specimen identification numbers. (Note that if the number for Instruction 2 is maximal, i.e., *53,* there is no room remaining for additional univariate variables, and the univariate output array will consist only of the array *A* shown in Figure 1.) Punch in columns 2–3.

The number is *13* for the problem in Figure 1.

4. (1): The number of variables in the bivariate array (from 0 to 56), including the column of specimen identification numbers. Punch in columns 2–3.

The number is *9* for the problem in Figure 1.

5. (1): Signal for the calling of Subroutine RAWTAB (one) or the bypassing of RAWTAB (zero), punched in column 3. RAWTAB may be bypassed if no new univariate variables are to be added to the input array.

6. (1): Signal for the calling (one) or bypassing (zero) of Subroutine XRATIO, punched in column 3. XRATIO may be bypassed if no ratios are to be computed and if no bivariate analyses are to be run.

7. (1): (a) *Columns 2–3:* The number of univariate input variables (from 0 to 30) from which a constant, the value of which is specified in Instruction 33, is to be subtracted.

(b) *Columns 5–6:* The number of univariate input variables (from 0 to 30) which are always to be divided by a constant, the value of which is specified in Instruction 34. (See also Instruction 9.)

(c) *Column 9:* The number of univariate input variables (from 0 to 5) which may or may not be divided by the constant referred to above (7b) depending on the value of a signal included with the data for each specimen. (See discussion of data deck in Instructions 21 and 37.)

(d) *Columns 11–12:* The number of univariate variables (from 0 to 30) to be generated by subtracting one input variable from another.

(e) *Columns 14–15:* The number of univariate variables (from 0 to 30) to be generated by adding two input variables.

(f) *Columns 17–18:* The number of univariate variables (from 0 to 30) to be transformed to logarithms to the base 10 and to be added as new columns to the original array.

For the problem in Figure 1, the control card for Instruction 7 is punched 01 01 0 02 01 02.

8. (0–2): The column numbers of variables in the univariate output array from which a constant, specified in Instruction 33, is to be subtracted. (See also Instruction 7a.) Punch numbers in fields of 3 in columns 1–72.

The card is punched 006 for the problem in Figure 1.

9. (0–2): The column numbers of variables in the univariate output array which are always to be divided by a constant, specified in Instruction 34. (See also Instruction 7b.) Punch numbers in fields of 3 in columns 1–72.

The card is punched 004 for the problem in Figure 1.

10. (0–1): The column numbers of variables in the univariate output array which may or may not be divided by a constant, specified in Instruction 34, depending on a signal read in with the data for each specimen (see Instruction 21). The maximum number of column numbers which can be listed here is 5. Punch numbers in fields of 3 in columns 1–15.

No card is required here for the problem in Figure 1.

11. (0–2): Column numbers of variables in the univariate output array which are to serve as minuends (see Instructions 7d and 12). Punch in fields of 3 in columns 1–72.

The card is punched 002002 for the problem in Figure 1.

12. (0–2): Column numbers of variables in the univariate output array which are to serve as subtrahends, so that the first subtrahend specified here is subtracted from the first minuend specified in Instruction 11, the second subtrahend from the second minuend, etc. Punch numbers in fields of 3 in columns 1–72.

The card is punched 002002 for the problem in Figure 1.

13. (0–2): Column numbers of variables in the univariate output array to which other variables, specified in Instruction 14, are to be added. (See also Instruction 7e.) Punch in fields of 3 in columns 1–72.

The card is punched 005 for the problem in Figure 1.

14. (0–2): Column numbers of variables in the univariate output array which are to be added to variables specified in Instruction 13, such that the first variable specified here is added to the

first variable specified in Instruction 13, the second variable to the second variable, etc. Punch in fields of 3 in columns 1–72.

The card is punched 008 for the problem in Figure 1.

15. (0–2): Column numbers of variables in the univariate output array which are to be transformed to logarithms to the base 10 and which are to be entered as new columns in the univariate output array. (See Instruction 7f.) Punch in fields of 3 in columns 1–72.

The card is punched 002003 for the problem in Figure 1.

16. (1): (a) *Columns 2–3:* The number of univariate variables which are to be fitted on an output page. (This includes a column of specimen identification numbers on each page.)

(b) *Columns 5–6:* The number of segments into which the univariate output array must be broken in order to fit on standard output paper. Each output segment of the array begins with a column occupied by the specimen identification numbers, so that rows in the segment may be readily identified. Calculate the number of segments by means of the following formula:

$$N=\frac{T-C}{C-1}+1$$

where N, the number of univariate output segments, is rounded to the next highest whole number; T is the number of variables in the univariate output array (Instruction 3); and C is the number of columns which can be fitted on an output page (Instruction 16a).

For the sample output (see listing), T is *6*, and C is *14*, so that N is *3*, after rounding *2.7* to the next highest whole number.

17. (1): (a) *Columns 2–3:* The number of bivariate variables which are to be fitted on an output page. (This includes a column of specimen identification numbers.)

(b) *Columns 5–6:* The number of segments into which the bivariate array must be broken in order to fit on standard output paper. Calculate by means of the formula in Instruction 16b, where T is the total number of variables in the bivariate array (Instruction 4) and C is the number of bivariate columns which are to be fitted on an output page (Instruction 17a).

For the sample output (see listing), T is *42* and C is *12*, so that N is *4* after rounding *3.8* to the next highest whole number.

18. (0–10): Indexing of column numbers of variables to be used in computation of ratios, y/x, beginning with the first ratio to appear on the first bivariate output page and proceeding from left to right through consecutive pages. Each ratio is represented by a group of 12 card columns, punched as follows:

(a) *Columns 2–3:* Column number of y in the univariate output array.

(b) *Columns 5–6:* Column number of x in the univariate output array.

(c) *Columns 8–9:* Column number which the ratio will have on its respective output page. (The column of specimen identification numbers is column 1 on each page.)

(d) *Column 12:* Signal for the log (base 10) transformation of both y and x in order to produce bivariate statistics of the ratio both before and after log transformation. Punch zero if no transformation; punch one for transformation.

Indexing for the next ratio begins in the next field of 3 columns, and so on, through the first 72 columns of the card (6 ratios indexed per card). Indexing then begins again on a second card. Because the maximum number of ratios permissible is 55, the maximum number of cards allowed here is 10.

If no ratios are to be computed (i.e., if the control number described in Instruction 4 is zero), no cards should be present for this instruction.

For the schematic problem in Figure 1, two cards would be required which would be punched as follows: first card: 02 03 02 01 03 04 03 01 06 03 04 00 06 05 05 01 09 04 06 01 10 04 07 00; second card: 02 06 08 01 12 13 09 00.

19. (2n): Names of variables to be placed as column headings on each output page. The column headings of each page occupy two cards (columns 1–72 of the first card and columns 1–48 of the second card), with the spacing beginning with card column 1, corresponding to print positions on the output page (120 print positions per line). The names of variables on consecutive pages occupy consecutive pairs of cards. The number of cards required here is

twice the number of output pages. These cards must be present even if they are blank.

20. (1): Numbers of cards to be read in for each of 8 variable formats (Instructions 21–28). Punch in fields of 3 in card columns 1–24. The number of cards for each format must be at least one and cannot exceed 5, with the exception of the eighth format, for which up to 8 cards may be present.

21. (1–5): The format, in FORTRAN II, for the reading in of data cards. The format must begin with a left-parenthesis and end with a right-parenthesis.

If the control described in Instruction 7c is greater than zero, the following applies:

Make provision at the beginning of each data card (or each group of cards if a specimen is represented by more than one card) for reading in the signals which will determine whether certain variables (the column numbers of which were specified in Instruction 10) are to be divided (−1) or not divided (+1) by a constant, the value of which is specified in Instruction 34.

There can be no more than 5 signals, and the signals are to be read in as fixed-point (integer) variables by means of an "I" specification as shown in the format listed with the controls for the sample output. All other variables on the data card must be read in as floating-point variables by means of an "F" or "E" specification.

In addition to the example given by the listing of control cards for the sample input, the following is given:

A data card which is punched, beginning in the first card column, +1–1–1001760321947, and which is read in by the format (3I2, F3.0, 2F3.1, F3.3), will be read in as the following values: +1, –1, –1, 1., 76.0, 32.1, and .947.

For further instruction on format specification in FORTRAN II, particularly with regard to Hollerith "H" specifications and carriage control, the reader is referred to the *FORTRAN General Information Manual* (IBM, 1961) or to McCracken (1961).

22. (1–5): The format, in FORTRAN II, for the punching out of the univariate output array. The order in which the variables are punched out is the same as the order of the subarrays shown in Figure 1.

This is also the format for the reading in of maxima for the variables in the univariate output array (Instruction 29) and for the reading in of log minima for the variables which will be transformed to logs by Instruction 18d.

23. (1–5): The format, in FORTRAN II, for punching out the bivariate array.

24. (1–5): The format, in FORTRAN II, for printing the univariate output array. The format is repeatedly used for each row of the array throughout all segments, so that the maximum number of decimal places which will be required by any one variable should be used for all variables. The same applies to Instruction 25.

25. (1–5): The format, in FORTRAN II, for the printing of the bivariate array. (See Instruction 24.)

26. (1–5): The format, in FORTRAN II, for printing the univariate statistics beneath each table of the univariate array. Column alignment is achieved by matching the field specifications to those of Instruction 24. Note in the listing of the sample input that an "I" (integer) specification must be used for the row of numbers of non-zero values.

27. (1–5): The format, in FORTRAN II, for printing the univariate statistics beneath each table of the bivariate array, again with "I" specifications for the row of numbers of non-zero values.

28. (1–5): The format, in FORTRAN II, for printing the bivariate statistics beneath each segment of the bivariate array.

29. (1–): Card(s) containing the anticipated maximum values of all the variables in the univariate output array of this run or any future run analyzing the same variables. The maxima are hypothetical and are specified in order to determine the calibration of the axes of the machine-plotted bivariate scatter diagrams, which in turn allows the computation of slopes and intercepts in terms of the scale-units of the diagrams. (See Instructions 11 and 12 in the description of input data for VPLOT.) In this manner, the calibration is kept uniform throughout all runs so that the

scatter diagrams for any given ratio can be superimposed for comparison.

The axes of plots of non-log data are assumed to cross at (0,0). For log data, however, the axes may cross at (a,b), where *a* and *b* are minima specified for *x* and *y* on control cards (Instruction 30).

The punching format, and hence the number of cards occupied by the maxima, is determined by Instruction 22. There must be at least one card present, even if no maxima are specified.

30. (1–): Card(s) containing the anticipated minimum log values of those variables which will be transformed to logarithms (base 10) by Instruction 18d. These minima are specified in order to determine the coordinates of the end points of regression lines in terms of scale units of a scatter diagram plotted by VPLOT. Generally the specified log minima are –1. or –2.

The punching format is the same as in Instruction 29, with no data required in the fields of those variables which will not be transformed to logs.

Group II Control Cards

31. (1): (a) *Columns 1–2:* Signal for the punching out of the univariate and bivariate arrays, as follows:

00=no punch-out
+1=punch univariate array only
+2=punch bivariate array only
+3=punch both univariate and bivariate arrays.

(b) *Columns 4–5:* Signal for the printing out of the univariate array and accompanying univariate statistics with the order of the specimens in the data deck preserved:

00=no print-out
+1=print.

(c) *Columns 7–8:* Signal for the printing out of the bivariate array with its accompanying univariate and bivariate statistics, with the order of specimens in the data deck preserved:

00=no print-out
+1=print

(d) *Columns 10–11:* Signal for the printing out of the univariate array and accompanying univariate statistics, with the specimens sorted according to decreasing values of a univariate variable specified in Instruction 31f:

00=no print-out
+1=print.

(e) *Columns 13–14:* Signal for the printing out of the bivariate array and accompanying univariate and bivariate statistics, with the specimens sorted according to decreasing values of a univariate variable specified in Instruction 31f.

00=no print-out
+1=print

(f) *Columns 16–17:* Column number of a variable in the univariate output array, the decreasing values of which will control the ordering of specimens (rows) in the output, if such output is indicated by the options described in Instructions 31d and 31e.

32. (2): Any name or sample-identification information to be printed at the top of each output page. Punch in columns 1–72 of the first card and columns 1–48 of the second card.

33. (1): A constant which is to be subtracted from certain univariate variables specified in Instruction 8. Punch in columns 1–6 without decimal point. The decimal will be placed by the computer before the last two digits; for example, 017291 will be read in as 172.91.

34. (1): A constant by which certain univariate variables, specified in Instructions 7b and 9, are to be divided. Punch in columns 1–6 in the same manner as the constant described in Instruction 33.

35. (1): A signal allowing for the following choices of lines to be printed at the top of the first output page, below the sample-identification information:

−1: *x* LEFT VALVES
00: *x* SPECIMENS
+1: *x* RIGHT VALVES

where *x* is the number of specimens in the data deck. Punch signal in columns 1–2.

36. (1): The number of specimens (from 1–100) in the data deck. Punch in columns 1–3.

Data Deck

37. The data cards must be punched according to the format specified in Instruction 20. There can be any number of continuation cards for each specimen provided that these are specified by the format.

298-840 O—69——3

Alternative Statements and Subroutines for DASAN

Comments following statement No. 28 in Subroutine RAWTAB mark the position in which may be inserted FORTRAN II statements for the computation of special variables. As shown in Figure 1, these variables form a subarray *B* within the univariate output array. One special-computation statement and the two statements that must accompany it are included in RAWTAB for the purpose of illustration. (The "C" in column 1 makes each of these statements inoperative in the program.) In this case a variable named "P.AR" in the sample output is computed, where P.AR is the area of a triangle, the base and height of which appear in the univariate output array in columns 21 and 20 respectively. No special control cards are required, but the number of variables in the univariate output array must be increased by *1* for each special computation carried out and adjustments must be made in the output formats.

Sample Input Data for DASAN

Listed below is the entire assembly of data for a test run of DASAN. The problem involves the analysis of 12 specimens, with 28 variables in the univariate input array, 36 variables in the univariate output array, and 42 variables in the bivariate array. The numbers on the far right side of each card refer to instruction numbers in the discussion of input preparation. Included within the listing (Instruction 28) is the format for the print-out of bivariate statistics involving regressions. The alternative format, to be used with the bivariate subroutine involving the reduced major axis, is shown below the input list.

```
*       DATA
001                                                                                   1
028                                                                                   2
036                                                                                   3
042                                                                                   4
001                                                                                   5
  1                                                                                   6
 01 00  5 02 02 03                                                                    7
012                                                                                   8
013018019020021                                                                      10
006007                                                                               11
005011                                                                               12
004008                                                                               13
002007                                                                               14
029012006                                                                            15
014003                                                                               16
012004                                                                               17
 06 32 02 00 06 28 03 00 04 02 04 00 05 30 05 00 07 02 06 00 07 32 07 00            18
 08 04 08 00 08 32 09 00 07 08 10 00 33 32 11 00 09 06 12 0C 10 06 02 00
 31 07 03 00 14 32 04 00 12 06 05 01 12 32 06 00 13 32 07 00 13 06 08 00
 18 19 09 00 18 06 10 00 20 06 11 00 21 32 12 0C 20 21 02 00 22 32 03 00
 23 06 04 00 22 23 05 00 24 06 06 00 25 32 07 00 24 25 08 00 26 06 09 00
 27 32 10 00 05 03 11 00 05 04 12 00 31 02 02 00 34 36 03 00 29 06 04 00
 07 06 05 00 12 28 06 00 02 03 07 00 29 12 08 00 07 28 09 00
SPEC      DG        GP        AD        AK        AM        DF        CD                 19
EI        BJ        DE        LO        RIB HT    HI
SPEC    PLICAE    ANTCOS    POSCOS    INTRIB  INTGRV    (AD)      (CE)      (
IK)      (PQ)      (BJ)      (AB)      (MN)    (FG)
SPEC     ALM     P. AREA     KM        EF        AG        CF       LOG P.AR LO
G LO    LOG AM
SPEC     AM/AG      AM/ALM    AD/DG      AK/KM    DF/DG      DF/AG      CD/A
```

```
D     CD/AG     DF/CD     CF/AG      EI/AM
SPEC    BJ/AM     EF/DF     HI/AG      LO/AM    LO/AG    RIBHT/AG  RIBHT/
AM   RIB/GRV   RIB/AM    (AD)/AM    (CE)/AG
SPEC (AD)/(CE)   (IK)/AG   (PQ)/AM  (IK)/(PQ)  (BJ)/AM   (AB)/AG  (BJ)/(
AB)  (MN)/AM   (FG)/AG    AK/GP      AK/AD
SPEC    EF/DG  LOG PA/AM    PA/AM     DF/AM    LO/ALM    DG/GP    P.AR/L
O     DF/ALM
001001001001001003003008                                                    20
(5I2,F3.0,4F3.1,F4.1,8F3.1,3F2.0,4F3.1/6F3.1,F4.1)                          21
(F4.0,F6.1,12F5.1,9X,1HA/14F5.1,9X,1HB/5F5.1,3F7.4,33X,1HC)                 22
(F4.0,11F6.3,9X,1HA/a2F6.3,7X,1HB/12F6.3,7X,1HC/6F6.3,43X,1HD)              23
(1HO/(1H ,F4.0,F8.1,12F9.1))                                                24
(1HO/(1H ,F4.0,F9.3,10F10.3))                                               25
(1H-,4HNUM.,I6,12I9/1H ,4HMAX.,F8.1,12F9.1/1H ,4HMIN.,F8.1,12F9.1/1H , 5    26
HRANGE,F7.1,12F9.1/1H ,4HMEAN,F8.1,12F9.1/1H 5HSTDDV,F7.1,12F9.1/1H ,5HS
DVMN,F7.1,12F9.1/1H ,3HV  ,13F9.1)
(1H-,4HNUM.,I8,10I10/1H ,4HMAX.,F9.3,10F10.3/1H ,4HMIN.,F9.3,10F10.3/1H     27
,5HRANGE,F8.3,10F10.3/1H ,4HMEAN,F9.3,10F10.3/1H ,5HSTDDV,F8.3,10F10.3/
1H ,5HSDVMN,F8.3,10F10.3/1H ,3HV  ,11F10.3)
(1H-,3HR  ,11F10.3/1HO,5HA(YX),F8.3,10F10.3/1H ,4HB(Y),F9.3,10F10.3/1HO,    28
5HA(XY),F8.3,10F10.3/1H ,4HB(X),F9.3,10F10.3/1HO,6HS(Y.X),F7.3,10F10.3/1
H ,6HS(X.Y),F7.3,10F10.3/1HO,6HD(Y.X),F7.3,1CF10.3/1H , 6HS(DYX),F7.3,10
F10.3/1H ,6HD(X.Y),F7.3,10F10.3/1H ,6HS(DXY),F7.3,10F10.3/1HO,6HCONAYX,F
7.3,10F10.3/1H ,5HCONBY,F8.3,10F10.3/1H ,6HCONAXY,F7.3,10F10.3/1H ,5HCON
BX,F8.3,10F10.3/1HO,6HYMAX 2,F7.3,10F10.3/1H ,4HXMAX,F9.3,1CF10.3/1HO,6H
TOP YX,F7.3,10F10.3/1H ,6HBASEYX, F7.3,1CF10.3/1H ,6HTOP XY,F7.3,10F10.3
/1H ,6HBASEXY, F7.3,10F10.3)
 99.  40.0 40.0 45.0 40.0 75.0 25.0 27.0 14.0 19.5 25.0 26.0  3.5 50.0      29
 30.0 10.0 12.0  5.5  5.0  5.5  6.5 27.0 21.0 31.0 15.0 20.0  9.0100.0
 20.0 35.0  6.3 85.0  6.3 1.3010 1.4150 1.8751
 98.                       -1.0                          -1.0               30
                                                                            30
                                                                            30
+3 00 00 +1 +1 06                                                           31
AEQUIPECTEN NUCLEUS -- MIAMI AND LAKE WORTH, FLA., MCZ 197942,232557,232    32
553 -- LIVING
000945                                                                      33
002675                                                                      34
+1                                                                          35
012                                                                         36
+1-1-1-1-1  1145130148150 280    80 43 61 66186 1615519 3 4560370410460     37
                  340
+1-1-1-1-1  2119110125128 240 72 71 35 61 50174 1313419 3 5390300340390
                  290
+1-1-1-1-1  3110109117121 219 70 64 30 51 43160 1111521 3 6350240280320
               19 260
+1-1-1-1-1  4139141142151 274 89 89 42 69 59184 1515518 3 6410270400410
                  335
+1-1-1-1-1  5116116121120 239 80 78 38 63 50166 1313421 4 6300250330380
                  285
+1-1-1-1-1  6127127135141 260 82 79 42 67 56180 1414619 3 6430280380440
                  315
```

```
+1-1-1-1-1  7123117133129 243 74 72 35 55 50171 1413219 3 6420300350410
                24 290
+1-1-1-1-1  8111105124115 222 70 65 34 59 51162 1312521 3 6350210260320
                     270
+1-1-1-1-1  9 99 98100105 193 66 64 31 50 41151 1211120 2 6290180270280
             46 21 220
+1-1-1-1-1 10110111115123 226 68 66 34 50 49161 1212120 3 6350200290310
 66 54 80 49 49 17 270
+1-1-1-1-1 11127121126125 239 86 82 37 68 57185 1414420 3 6450190370520
 85 66 95 49 66    320
+1-1-1-1-1 12126111122130 236 81 76 35 62 60188 1614120 3 6400210410460
             66 27 320
```

```
(1H-,3HR  ,11F10.3/1H0,3HA  ,11F10.3/1H ,6HSIG(A),F7.3,10F10.3/1H0,3HB        28
,11F10.3/1H0,6HD(RMA),F7.3,10F10.3/1H0,6HMEAN Y,F7.3,10F10.3/1H ,6HMEAN
X,F7.3,10F10.3/1H0,6HYMAX 1,F7.3,10F10.3/1H0,5HTOP 1,F8.3,10F10.3/1H ,6H
BASE 1,F7.3,10F10.3)
```

Sample Output from DASAN

Listed below are the punch-outs of the univariate output array and bivariate array and the printed output for the sample problem. In the printed output, variable names consist of at least two letters, with parentheses enclosing letters which represent lower-case letters. The abbreviations for statistics have already been explained in Table 1 and the use of the output in the plotting of reduced major axes and regression lines will be explained at the end of the description of VPLOT.

The specimens, which were ordered from 1 through 12 in the input array, have been rearranged in order of decreasing values of the variable *AM*. As in the simplified sample problem illustrated in Figure 1, certain columns of statistics are not valid. In arrays of bivariate statistics these columns are indicated in output messages. In the arrays of univariate statistics for bivariate data, the statistics for variable No. 36 (Log *P.A.*/*Log AM*) are or may be incorrect.

The bivariate analyses from an additional run using the alternate bivariate subroutine are shown for the second to the last page of the output.

PUNCH-OUT OF UNIVARIATE OUTPUT ARRAY

```
  1.  14.5 13.0 14.8 15.0 28.0 -0.   8.0  4.3  6.1  6.6  9.1  1.6 15.5
 19.0  3.0  4.0  2.1  1.4  1.5  1.7 -0.  -0.  -0.  -0.  -0.  -0.  34.0
  1.3 13.0  0.  29.3  0.  0.1199 0.9614 1.4472
  2.  11.9 11.0 12.5 12.8 24.0  7.2  7.1  3.5  6.1  5.0  7.9  1.3 13.4
 19.0  3.0  5.0  1.5  1.1  1.3  1.5 -0.  -0.  -0.  -0.  -0.  -0.  29.0
  0.9 11.2  2.2 24.4 14.3-0.0331 0.9004 1.3802
  3.  11.0 10.9 11.7 12.1 21.9  7.0  6.4  3.0  5.1  4.3  6.6  1.1 11.5
 21.0  3.0  6.0  1.3  0.9  1.0  1.2 -0.  -0.  -0.  -0.  -0.   1.9 26.0
  0.6  9.8  2.7 22.7 13.4-0.2034 0.8162 1.3404
  4.  13.9 14.1 14.2 15.1 27.4  8.9  8.9  4.2  6.9  5.9  8.9  1.5 15.5
 18.0  3.0  6.0  1.5  1.0  1.5  1.5 -0.  -0.  -0.  -0.  -0.  -0.  33.5
  1.1 12.3  3.0 28.1 17.8 0.0592 0.9518 1.4378
```

```
 5.  11.6 11.6 12.1 12.0 23.9  8.0  7.8  3.8  6.3  5.0  7.1  1.3 13.4
21.0  4.0  6.0  1.1  0.9  1.2  1.4 -0.  -0.  -0.  -0.  -0.  -0.  28.5
 0.9 11.9  3.0 23.7 15.8-0.0574 0.8543 1.3784
 6.  12.7 12.7 13.5 14.1 26.0  8.2  7.9  4.2  6.7  5.6  8.6  1.4 14.6
19.0  3.0  6.0  1.6  1.0  1.4  1.6 -0.  -0.  -0.  -0.  -0.  -0.  31.5
 1.2 11.9  2.6 26.2 16.1 0.0676 0.9320 1.4150
 7.  12.3 11.7 13.3 12.9 24.3  7.4  7.2  3.5  5.5  5.0  7.6  1.4 13.2
19.0  3.0  6.0  1.6  1.1  1.3  1.5 -0.  -0.  -0.  -0.  -0.   2.4 29.0
 1.0 11.4  2.4 25.6 14.6 0.0012 0.8837 1.3856
 8.  11.1 10.5 12.4 11.5 22.2  7.0  6.5  3.4  5.9  5.1  6.7  1.3 12.5
21.0  3.0  6.0  1.3  0.8  1.0  1.2 -0.  -0.  -0.  -0.  -0.  -0.  27.0
 0.6 10.7  1.9 23.5 13.5-0.2356 0.8293 1.3464
 9.   9.9  9.8 10.0 10.5 19.3  6.6  6.4  3.1  5.0  4.1  5.6  1.2 11.1
20.0  2.0  6.0  1.1  0.7  1.0  1.0 -0.  -0.  -0.  -0.   4.6  2.1 22.0
 0.5  8.8  2.5 19.9 13.0-0.2772 0.7520 1.2856
10.  11.0 11.1 11.5 12.3 22.6  6.8  6.6  3.4  5.0  4.9  6.6  1.2 12.1
20.0  3.0  6.0  1.3  0.7  1.1  1.2  6.6  5.4  8.0  4.9  4.9  1.7 27.0
 0.6 10.3  1.9 22.5 13.4-0.2019 0.8228 1.3541
11.  12.7 12.1 12.6 12.5 23.9  8.6  8.2  3.7  6.8  5.7  9.1  1.4 14.4
20.0  3.0  6.0  1.7  0.7  1.4  1.9  8.5  6.6  9.5  4.9  6.6 -0.  32.0
 1.3 11.4  2.9 25.3 16.8 0.1285 0.9566 1.3784
12.  12.6 11.1 12.2 13.0 23.6  8.1  7.6  3.5  6.2  6.0  9.4  1.6 14.1
20.0  3.0  6.0  1.5  0.8  1.5  1.7 -0.  -0.  -0.  -0.   6.6  2.7 32.0
 1.3 10.6  2.1 24.8 15.7 0.1199 0.9708 1.3729
```

PUNCH-OUT OF BIVARIATE ARRAY

```
  1. 0.956 0.824 1.021 1.154-0.   -0.    0.541 0.273-0.    0.    0.154      A
 0.218-0.    0.529 0.327 0.312 0.055 0.057 1.514 0.075 0.055 0.059 0.891    B
-0.   -0.    0.   -0.   -0.    0.   -0.   -0.    1.154 1.014 0.    0.083    C
 0.047-0.    0.269 1.115 0.144-0.                                           D
  2. 0.984 0.828 1.050 1.143 0.605 0.295 0.568 0.291 1.014 0.586 0.146      A
 0.254 0.306 0.549 0.331 0.326 0.053 0.054 1.300 0.061 0.053 0.060 0.872    B
-0.   -0.    0.   -0.   -0.    0.   -0.   -0.    1.164 1.024 0.185-0.024    C
 0.039 0.300 0.274 1.082 0.117 0.248                                        D
  3. 0.965 0.842 1.064 1.235 0.636 0.308 0.547 0.282 1.094 0.590 0.137      A
 0.233 0.386 0.507 0.299 0.289 0.048 0.050 1.458 0.060 0.048 0.053 0.875    B
-0.   -0.    0.   -0.   -0.    0.   -0.    0.084 1.110 1.034 0.245-0.152    C
 0.029 0.320 0.252 1.009 0.096 0.269                                        D
  4. 0.975 0.818 1.022 1.228 0.640 0.317 0.627 0.317 1.000 0.633 0.153      A
 0.252 0.337 0.552 0.327 0.319 0.053 0.055 1.519 0.056 0.055 0.055 0.976    B
-0.   -0.    0.   -0.   -0.    0.   -0.   -0.    1.071 1.063 0.216 0.041    C
 0.042 0.325 0.267 0.986 0.128 0.266                                        D
  5. 1.008 0.839 1.043 1.008 0.690 0.338 0.645 0.329 1.026 0.667 0.159      A
 0.264 0.375 0.565 0.299 0.302 0.055 0.054 1.200 0.047 0.052 0.060 0.868    B
-0.   -0.    0.   -0.   -0.    0.   -0.   -0.    1.034 0.992 0.259-0.042    C
 0.037 0.335 0.251 1.000 0.123 0.281                                        D
  6. 0.992 0.825 1.063 1.185 0.646 0.313 0.585 0.302 1.038 0.615 0.162      A
 0.258 0.317 0.557 0.329 0.326 0.053 0.054 1.536 0.062 0.055 0.063 0.864    B
-0.   -0.    0.   -0.   -0.    0.   -0.   -0.    1.110 1.044 0.205 0.048    C
 0.045 0.315 0.271 1.000 0.137 0.260                                        D
  7. 0.949 0.838 1.081 1.132 0.602 0.289 0.541 0.281 1.028 0.570 0.144      A
```

```
 0.226 0.324 0.516 0.315 0.299 0.055 0.058 1.400 0.065 0.054 0.060 0.854   B
-0.   -0.    0.   -0.   -0.    0.   -0.    0.094 1.103 0.970 0.195 0.001   C
 0.041 0.305 0.264 1.051 0.131 0.255                                       D
  8. 0.945 0.822 1.117 1.075 0.631 0.298 0.524 0.277 1.077 0.574 0.153     A
 0.266 0.271 0.532 0.304 0.287 0.055 0.059 1.667 0.059 0.044 0.051 0.812   B
-0.   -0.    0.   -0.   -0.    0.   -0.   -0.    1.095 0.927 0.171-0.175   C
 0.026 0.315 0.250 1.057 0.086 0.259                                       D
  9. 0.970 0.877 1.010 1.193 0.667 0.332 0.640 0.322 1.031 0.653 0.161     A
 0.259 0.379 0.558 0.293 0.284 0.060 0.062 1.611 0.056 0.052 0.053 0.964   B
-0.   -0.    0.   -0.   -0.    0.    0.238 0.106 1.071 1.050 0.253-0.216   C
 0.027 0.342 0.257 1.010 0.093 0.300                                       D
 10. 1.004 0.837 1.045 1.194 0.618 0.302 0.574 0.293 1.030 0.596 0.150     A
 0.221 0.279 0.538 0.294 0.296 0.053 0.053 1.750 0.058 0.048 0.052 0.935   B
 0.293 0.239 1.222 0.354 0.218 1.633 0.217 0.076 1.108 1.070 0.173-0.149   C
 0.028 0.301 0.246 0.991 0.094 0.252                                       D
 11. 0.945 0.747 0.992 1.096 0.677 0.340 0.651 0.324 1.049 0.664 0.155     A
 0.285 0.337 0.569 0.379 0.358 0.055 0.059 2.368 0.070 0.058 0.077 0.712   B
 0.336 0.276 1.288 0.397 0.194 1.939 0.276-0.    1.033 0.992 0.228 0.093   C
 0.056 0.360 0.283 1.050 0.149 0.269                                       D
 12. 0.952 0.737 0.968 1.226 0.643 0.327 0.623 0.306 1.066 0.633 0.148     A
 0.263 0.259 0.569 0.396 0.377 0.065 0.068 1.905 0.063 0.065 0.069 0.891   B
-0.   -0.    0.   -0.   -0.    0.    0.280 0.109 1.171 1.066 0.167 0.087   C
 0.056 0.343 0.292 1.135 0.141 0.253                                       D
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AEQUIPECTEN NUCLEUS -- MIAMI AND LAKE WORTH, FLA., MCZ 197942,232557,232553 -- LIVING

12 RIGHT VALVES

SPEC	DG	GP	AO	AK	AM	DF	CD	EI	BJ	OE	LO	RIB HT	HI
1.	14.5	13.0	14.8	15.0	28.0	-0.	8.0	4.3	6.1	6.6	9.1	1.6	15.5
4.	13.9	14.1	14.2	15.1	27.4	8.9	8.9	4.2	6.9	5.9	8.9	1.5	15.5
6.	12.7	12.7	13.5	14.1	26.0	8.2	7.9	4.2	6.7	5.6	8.6	1.4	14.6
7.	12.3	11.7	13.3	12.9	24.3	7.4	7.2	3.5	5.5	5.0	7.6	1.4	13.2
2.	11.9	11.0	12.5	12.8	24.0	7.2	7.1	3.5	6.1	5.0	7.9	1.3	13.4
11.	12.7	12.1	12.6	12.5	23.9	8.6	8.2	3.7	6.8	5.7	9.1	1.4	14.4
5.	11.6	11.6	12.1	12.0	23.9	8.0	7.8	3.8	6.3	5.0	7.1	1.3	13.4
12.	12.6	11.1	12.2	13.0	23.6	8.1	7.6	3.5	6.2	6.0	9.4	1.6	14.1
10.	11.0	11.1	11.5	12.3	22.6	6.8	6.6	3.4	5.0	4.9	6.6	1.2	12.1
8.	11.1	10.5	12.4	11.5	22.2	7.0	6.5	3.4	5.9	5.1	6.7	1.3	12.5
3.	11.0	10.9	11.7	12.1	21.9	7.0	6.4	3.0	5.1	4.3	6.6	1.1	11.5
9.	9.9	9.8	10.0	10.5	19.3	6.6	6.4	3.1	5.0	4.1	5.6	1.2	11.1
NUM.	12	12	12	12	12	11	12	12	12	12	12	12	12
MAX.	14.5	14.1	14.8	15.1	28.0	8.9	8.9	4.3	6.9	6.6	9.4	1.6	15.5
MIN.	9.9	9.8	10.0	10.5	19.3	6.6	6.4	3.0	5.0	4.1	5.6	1.1	11.1
RANGE	4.6	4.3	4.8	4.6	8.7	2.3	2.5	1.3	1.9	2.5	3.7	0.5	4.4
MEAN	12.1	11.6	12.6	12.8	23.9	7.6	7.4	3.6	6.0	5.3	7.8	1.4	13.4
STDDV	1.3	1.2	1.3	1.4	2.4	0.8	0.8	0.4	0.7	0.7	1.2	0.2	1.5
SDVMN	0.4	0.3	0.4	0.4	0.7	0.2	0.2	0.1	0.2	0.2	0.4	0.0	0.4
V	10.7	10.2	10.2	10.6	10.0	10.2	11.0	11.6	11.5	13.7	15.9	11.5	10.8

AEQUIPECTEN NUCLEUS -- MIAMI AND LAKE WORTH, FLA., MCZ 197942,232557,232553 -- LIVING

12 RIGHT VALVES

SPEC	PLICAE	ANTCOS	POSCOS	INTRIB	INTGRV	(AO)	(CE)	(IK)	(PQ)	(BJ)	(AB)	(MN)	(FG)
1.	19.0	3.0	4.0	2.1	1.4	1.5	1.7	-0.	-0.	-0.	-0.	-0.	-0.
4.	18.0	3.0	6.0	1.5	1.0	1.5	1.5	-0.	-0.	-0.	-0.	-0.	-0.
6.	19.0	3.0	6.0	1.6	1.0	1.4	1.6	-0.	-0.	-0.	-0.	-0.	-0.
7.	19.0	3.0	6.0	1.6	1.1	1.3	1.5	-0.	-0.	-0.	-0.	-0.	2.4
2.	19.0	3.0	5.0	1.5	1.1	1.3	1.5	-0.	-0.	-0.	-0.	-0.	-0.
11.	20.0	3.0	6.0	1.7	0.7	1.4	1.9	8.5	6.6	9.5	4.9	6.6	-0.
5.	21.0	4.0	6.0	1.1	0.9	1.2	1.4	-0.	-0.	-0.	-0.	-0.	-0.
12.	20.0	3.0	6.0	1.5	0.8	1.5	1.7	-0.	-0.	-0.	-0.	6.6	2.7
10.	20.0	3.0	6.0	1.3	0.7	1.1	1.2	6.6	5.4	8.0	4.9	4.9	1.7
8.	21.0	3.0	6.0	1.3	0.8	1.0	1.2	-0.	-0.	-0.	-0.	-0.	-0.
3.	21.0	3.0	6.0	1.3	0.9	1.0	1.2	-0.	-0.	-0.	-0.	-0.	1.9
9.	20.0	2.0	6.0	1.1	0.7	1.0	1.0	-0.	-0.	-0.	-0.	4.6	2.1
NUM.	12	12	12	12	12	12	12	2	2	2	2	4	5
MAX.	21.0	4.0	6.0	2.1	1.4	1.5	1.9	8.5	6.6	9.5	4.9	6.6	2.7
MIN.	18.0	2.0	4.0	1.1	0.7	1.0	1.0	6.6	5.4	8.0	4.9	4.6	1.7
RANGE	3.0	2.0	2.0	1.0	0.7	0.6	0.9	1.9	1.2	1.5	0.	2.0	1.0
MEAN	19.7	3.0	5.7	1.5	0.9	1.3	1.5	7.5	6.0	8.7	4.9	5.7	2.2
STDDV	1.0	0.4	0.6	0.3	0.2	0.2	0.3	1.3	0.8	1.1	0.	1.1	0.4
SDVMN	0.3	0.1	0.2	0.1	0.1	0.1	0.1	1.0	0.6	0.7	0.	0.5	0.2
V	4.9	14.2	10.8	18.6	22.6	16.2	18.6	17.8	14.1	12.1	0.	18.9	18.4

AEQUIPECTEN NUCLEUS -- MIAMI AND LAKE WORTH, FLA., MCZ 197942,232557,232553 -- LIVING

12 RIGHT VALVES

SPEC	ALM	P. AREA	KM	EF	AG	CF	LOG P.AR	LOG LO	LOG AM				
1.	34.0	1.3	13.0	0.	29.3	0.	0.1	1.0	1.4	0.	0.	0.	0.
4.	33.5	1.1	12.3	3.0	28.1	17.8	0.1	1.0	1.4	0.	0.	0.	0.
6.	31.5	1.2	11.9	2.6	26.2	16.1	0.1	0.9	1.4	0.	0.	0.	0.
7.	29.0	1.0	11.4	2.4	25.6	14.6	0.0	0.9	1.4	0.	0.	0.	0.
2.	29.0	0.9	11.2	2.2	24.4	14.3	-0.0	0.9	1.4	0.	0.	0.	0.
11.	32.0	1.3	11.4	2.9	25.3	16.8	0.1	1.0	1.4	0.	0.	0.	0.
5.	28.5	0.9	11.9	3.0	23.7	15.8	-0.1	0.9	1.4	0.	0.	0.	0.
12.	32.0	1.3	10.6	2.1	24.8	15.7	0.1	1.0	1.4	0.	0.	0.	0.
10.	27.0	0.6	10.3	1.9	22.5	13.4	-0.2	0.8	1.4	0.	0.	0.	0.
8.	27.0	0.6	10.7	1.9	23.5	13.5	-0.2	0.8	1.3	0.	0.	0.	0.
3.	26.0	0.6	9.8	2.7	22.7	13.4	-0.2	0.8	1.3	0.	0.	0.	0.
9.	22.0	0.5	8.8	2.5	19.9	13.0	-0.3	0.8	1.3	0.	0.	0.	0.
NUM.	12	12	12	11	12	11	12	12	12	0	0	0	0
MAX.	34.0	1.3	13.0	3.0	29.3	17.8	0.1	1.0	1.4	0.	0.	0.	0.
MIN.	22.0	0.5	8.8	1.9	19.9	13.0	-0.3	0.8	1.3	0.	0.	0.	0.
RANGE	12.0	0.8	4.2	1.1	9.4	4.8	0.4	0.2	0.2	0.	0.	0.	0.
MEAN	29.3	1.0	11.1	2.5	24.7	14.9	-0.0	0.9	1.4	0.	0.	0.	0.
STDDV	3.5	0.3	1.2	0.4	2.5	1.6	0.2	0.1	0.0	0.	0.	0.	0.
SDVMN	1.0	0.1	0.3	0.1	0.7	0.5	0.0	0.0	0.0	0.	0.	0.	0.
V	11.9	32.2	10.4	16.6	10.3	10.7	-353.3	8.0	3.2	0.	0.	0.	0.

AEQUIPECTEN NUCLEUS -- MIAMI AND LAKE WORTH, FLA., MCZ 197942,232557,232553 -- LIVING

12 RIGHT VALVES

SPEC	AM/AG	AM/ALM	AO/OG	AK/KM	DF/DG	DF/AG	CD/AD	CD/AG	DF/CD	CF/AG	EI/AM
1.	0.956	0.824	1.021	1.154	-0.	-0.	0.541	0.273	-0.	0.	0.154
4.	0.975	0.818	1.022	1.228	0.640	0.317	0.627	0.317	1.000	0.633	0.153
6.	0.992	0.825	1.063	1.185	0.646	0.313	0.585	0.302	1.038	0.615	0.162
7.	0.949	0.838	1.081	1.132	0.602	0.289	0.541	0.281	1.028	0.570	0.144
2.	0.984	0.828	1.050	1.143	0.605	0.295	0.568	0.291	1.014	0.586	0.146
11.	0.945	0.747	0.992	1.096	0.677	0.340	0.651	0.324	1.049	0.664	0.155
5.	1.008	0.839	1.043	1.008	0.690	0.338	0.645	0.329	1.026	0.667	0.159
12.	0.952	0.737	0.968	1.226	0.643	0.327	0.623	0.306	1.066	0.633	0.148
10.	1.004	0.837	1.045	1.194	0.618	0.302	0.574	0.293	1.030	0.596	0.15[illegible]
8.	0.945	0.822	1.117	1.075	0.631	0.298	0.524	0.277	1.077	0.574	0.153
3.	0.965	0.842	1.064	1.235	0.636	0.308	0.547	0.282	1.094	0.590	0.137
9.	0.970	0.877	1.010	1.193	0.667	0.332	0.640	0.322	1.031	0.653	0.161
NUM.	12	12	12	12	11	11	12	12	11	11	12
MAX.	1.008	0.877	1.117	1.235	0.690	0.340	0.651	0.329	1.094	0.667	0.162
MIN.	0.945	0.737	0.968	1.008	0.602	0.289	0.524	0.273	1.000	0.570	0.137
RANGE	0.064	0.140	0.149	0.226	0.088	0.051	0.127	0.056	0.094	0.096	0.025
MEAN	0.970	0.820	1.040	1.156	0.641	0.314	0.589	0.300	1.041	0.617	0.152
STDDV	0.023	0.039	0.040	0.069	0.028	0.018	0.046	0.020	0.028	0.036	0.007
SDVMN	0.007	0.011	0.012	0.020	0.008	0.005	0.013	0.006	0.008	0.011	0.002
V	2.338	4.796	3.883	5.986	4.370	5.614	7.826	6.594	2.680	5.768	4.743

BIVARIATE ANALYSIS (REDUCED MAJOR AXIS) OF Y/X. RESULTS NOT VALID FOR COLUMNS OF LOG Y/LOGX.

R	0.974	0.916	0.934	0.832	0.905	0.836	0.730	0.806	0.975	0.844	0.922
A	0.948	0.686	0.983	1.182	0.700	0.357	0.637	0.321	0.936	0.734	0.176
SIG(A)	0.062	0.079	0.102	0.189	0.090	0.059	0.126	0.055	0.063	0.119	0.02[illegible]
B	0.530	3.821	0.675	-0.310	-0.700	-1.045	-0.623	-0.539	0.757	-2.857	-0.578
D(RMA)	2.297	4.597	3.804	6.091	4.187	5.191	7.637	6.441	2.401	5.276	3.982
MEAN Y	23.925	23.925	12.567	12.817	7.618	7.618	7.383	7.383	7.618	14.945	3.633
MEAN X	24.667	29.292	12.100	11.108	11.882	24.245	12.567	24.667	7.327	24.245	23.925
YMAX 1	81.149	72.454	39.987	41.049	27.302	29.326	28.047	26.760	26.039	59.554	12.624
TOP 1	4.017	-1.664	-5.459	1.286	4.513	8.478	1.900	-0.435	2.037	414.201	-4.814
BASE 1	0.346	2.497	0.735	-0.380	-1.371	-2.048	-1.131	-0.978	1.484	-22.219	-2.024

AEQUIPECTEN NUCLEUS -- MIAMI AND LAKE WORTH, FLA., MCZ 197942,232557,232553 -- LIVING

12 RIGHT VALVES

SPEC	BJ/AM	EF/OF	HI/AG	LO/AM	LO/AG	RIBHT/AG	RIBHT/AM	RIB/GRV	RIB/AM	(AO)/AM	(CE)/AG
1.	0.218	0.	0.529	0.327	0.312	0.055	0.057	1.514	0.075	0.055	0.059
4.	0.252	0.337	0.552	0.327	0.319	0.053	0.055	1.519	0.056	0.055	0.055
6.	0.258	0.317	0.557	0.329	0.326	0.053	0.054	1.536	0.062	0.055	0.063
7.	0.226	0.324	0.516	0.315	0.299	0.055	0.058	1.400	0.065	0.054	0.060
2.	0.254	0.306	0.549	0.331	0.326	0.053	0.054	1.300	0.061	0.053	0.060
11.	0.285	0.337	0.569	0.379	0.358	0.055	0.059	2.368	0.070	0.058	0.077
5.	0.264	0.375	0.565	0.299	0.302	0.055	0.054	1.200	0.047	0.052	0.060
12.	0.263	0.259	0.569	0.396	0.377	0.065	0.068	1.905	0.063	0.065	0.069
10.	0.221	0.279	0.538	0.294	0.296	0.053	0.053	1.750	0.058	0.048	0.052
8.	0.266	0.271	0.532	0.304	0.287	0.055	0.059	1.667	0.059	0.044	0.051
3.	0.233	0.386	0.507	0.299	0.289	0.048	0.050	1.458	0.060	0.048	0.053
9.	0.259	0.379	0.558	0.293	0.284	0.060	0.062	1.611	0.056	0.052	0.053
NUM.	12	11	12	12	12	12	12	12	12	12	12
MAX.	0.285	0.386	0.569	0.396	0.377	0.065	0.068	2.368	0.075	0.065	0.077
MIN.	0.218	0.259	0.507	0.293	0.284	0.048	0.050	1.200	0.047	0.044	0.051
RANGE	0.067	0.126	0.063	0.103	0.093	0.016	0.018	1.168	0.028	0.021	0.026
MEAN	0.250	0.325	0.545	0.324	0.314	0.055	0.057	1.602	0.061	0.053	0.059
STDDV	0.021	0.044	0.021	0.033	0.029	0.004	0.005	0.307	0.007	0.005	0.008
SDVMN	0.006	0.013	0.006	0.009	0.008	0.001	0.001	0.089	0.002	0.002	0.002
V	8.241	13.457	3.811	10.127	9.189	7.185	8.204	19.178	11.702	10.081	13.138

BIVARIATE ANALYSIS (REDUCED MAJOR AXIS) OF Y/X. RESULTS NOT VALID FOR COLUMNS OF LOG Y/LOGX.

R	0.701	0.621	0.937	0.807	0.850	0.806	0.741	0.675	0.790	0.828	0.743
A	0.285	0.529	0.573	0.514	0.487	0.062	0.065	1.291	0.113	0.086	0.108
SIG(A)	0.059	0.125	0.058	0.088	0.074	0.011	0.013	0.275	0.020	0.014	0.021
B	-0.847	-1.555	-0.694	-4.507	-4.235	-0.165	-0.200	0.257	-1.248	-0.781	-1.188
D(RMA)	7.839	9.537	3.685	6.673	5.961	6.393	7.230	15.990	6.543	5.906	7.397
MEAN Y	5.967	2.473	13.442	7.783	7.783	1.358	1.358	1.464	1.464	1.274	1.464
MEAN X	23.925	7.618	24.667	23.925	24.667	24.667	23.925	0.935	23.925	23.925	24.667
YMAX 1	20.512	11.663	48.018	34.020	37.179	5.085	4.685	6.714	7.255	5.660	7.952
TOP 1	2.542	41.710	-1.943	15.115	21.068	22.191	16.585	10.817	15.632	1.429	10.943
BASE 1	-2.127	-12.095	-0.680	-8.494	-7.981	-2.314	-2.797	2.292	-11.120	-6.954	-8.957

BIVARIATE ANALYSES (REDUCED MAJOR AXIS) OF LOG Y/LOG X, VALID ONLY FOR COLUMNS 5

R	0.701	0.621	0.937	0.835	0.850	0.806	0.741	0.675	0.790	0.828	0.743
A	0.285	0.529	0.573	1.614	0.487	0.062	0.065	1.291	0.113	0.086	0.108
SIG(A)	0.059	0.125	0.058	0.256	0.074	0.011	0.013	0.275	0.020	0.014	0.021
B	-0.847	-1.555	-0.694	-1.336	-4.235	-0.165	-0.200	0.257	-1.248	-0.781	-1.188
D(RMA)	7.839	9.537	3.685	2.929	5.961	6.393	7.230	15.990	6.543	5.906	7.397
MEAN Y	5.967	2.473	13.442	0.886	7.783	1.358	1.358	1.464	1.464	1.274	1.464
MEAN X	23.925	7.618	24.667	1.377	24.667	24.667	23.925	0.935	23.925	23.925	24.667
YMAX 1	20.512	11.663	48.018	1.690	37.179	5.085	4.685	6.714	7.255	5.660	7.952
TOP 1	2.542	41.710	-1.943	5.584	21.068	22.191	16.585	10.817	15.632	1.429	10.943
BASE 1	-2.127	-12.095	-0.680	-27.116	-7.981	-2.314	-2.797	2.292	-11.120	-6.954	-8.957

AEQUIPECTEN NUCLEUS -- MIAMI AND LAKE WORTH, FLA., MCZ 197942,232557,232553 -- LIVING

12 RIGHT VALVES

SPEC	(AD)/(CE)	(IK)/AG	(PQ)/AM	(IK)/(PQ)	(BJ)/AM	(AB)/AG	(BJ)/(AB)	(MN)/AM	(FG)/AG	AK/GP	AK/AD
1.	0.891	-0.	-0.	0.	-0.	-0.	0.	-0.	-0.	1.154	1.014
4.	0.976	-0.	-0.	0.	-0.	-0.	0.	-0.	-0.	1.071	1.063
6.	0.864	-0.	-0.	0.	-0.	-0.	0.	-0.	-0.	1.110	1.044
7.	0.854	-0.	-0.	0.	-0.	-0.	0.	-0.	0.094	1.103	0.970
2.	0.872	-0.	-0.	0.	-0.	-0.	0.	-0.	-0.	1.164	1.024
11.	0.712	0.336	0.276	1.288	0.397	0.194	1.939	0.276	-0.	1.033	0.992
5.	0.868	-0.	-0.	0.	-0.	-0.	0.	-0.	-0.	1.034	0.997
12.	0.891	-0.	-0.	0.	-0.	-0.	0.	0.280	0.109	1.171	1.066
10.	0.935	0.293	0.239	1.222	0.354	0.218	1.633	0.217	0.076	1.108	1.070
8.	0.812	-0.	-0.	0.	-0.	-0.	0.	-0.	-0.	1.095	0.927
3.	0.875	-0.	-0.	0.	-0.	-0.	0.	-0.	0.084	1.110	1.034
9.	0.964	-0.	-0.	0.	-0.	-0.	0.	0.238	0.106	1.071	1.050
NUM.	12	2	2	2	2	2	2	4	5	12	12
MAX.	0.976	0.336	0.276	1.288	0.397	0.218	1.939	0.280	0.109	1.171	1.070
MIN.	0.712	0.293	0.239	1.222	0.354	0.194	1.633	0.217	0.076	1.033	0.927
RANGE	0.264	0.043	0.037	0.066	0.044	0.024	0.306	0.063	0.033	0.138	0.142
MEAN	0.876	0.315	0.258	1.255	0.376	0.206	1.786	0.253	0.093	1.102	1.023
STDDV	0.070	0.030	0.026	0.046	0.031	0.017	0.216	0.030	0.014	0.045	0.044
SDVMN	0.020	0.021	0.019	0.033	0.022	0.012	0.153	0.015	0.006	0.013	0.013
V	7.962	9.581	10.217	3.699	8.188	8.284	12.122	12.024	15.119	4.127	4.264

BIVARIATE ANALYSIS (REDUCED MAJOR AXIS) OF Y/X. RESULTS NOT VALID FOR COLUMNS OF LOG Y/LOGX.

R	0.875	1.000	1.000	1.000	1.000	0.	0.	0.835	0.589	0.921	0.917
A	0.758	0.679	0.923	1.583	1.154	0.	0.	0.510	0.178	1.146	1.065
SIG(A)	0.106	0.000	0.000	0.000	0.000	0.	0.	0.140	0.064	0.129	0.127
B	0.165	-8.668	-15.462	-1.950	-18.077	4.900	8.750	-5.724	-1.957	-0.516	-0.561
D(RMA)	8.803	0.002	0.001	0.003	0.001	11.477	14.957	5.900	8.850	4.146	4.224
MEAN Y	1.274	7.550	6.000	7.550	8.750	4.900	8.750	5.675	2.160	12.817	12.817
MEAN X	1.464	23.900	23.250	6.000	23.250	23.900	4.900	22.350	23.100	11.633	12.567
YMAX 1	5.089	49.011	53.769	31.300	68.462	4.900	8.750	32.528	13.191	45.328	47.344
TOP 1	-3.663	39.945	76.462	7.804	59.213	-32.993	-35.169	30.693	22.819	6.527	8.997
BASE 1	1.470	-15.731	-36.077	-3.539	-28.573	16.007	13.831	-14.024	-10.653	-0.633	-0.688

AEQUIPECTEN NUCLEUS -- MIAMI AND LAKE WORTH, FLA., MCZ 197942,232557,232553 -- LIVING

12 RIGHT VALVES

SPEC	EF/DG	LOG PA/AM	PA/AM	OF/AM	LO/ALM	DG/GP	P.AR/LO	OF/ALM			
1.	0.	0.083	0.047	-0.	0.269	1.115	0.144	-0.	0.	0.	0.
4.	0.216	0.041	0.042	0.325	0.267	0.986	0.128	0.266	0.	0.	0.
6.	0.205	0.048	0.045	0.315	0.271	1.000	0.137	0.260	0.	0.	0.
7.	0.195	0.001	0.041	0.305	0.264	1.051	0.131	0.255	0.	0.	0.
2.	0.185	-0.024	0.039	0.300	0.274	1.082	0.117	0.248	0.	0.	0.
11.	0.228	0.093	0.056	0.360	0.283	1.050	0.149	0.269	0.	0.	0.
5.	0.259	-0.042	0.037	0.335	0.251	1.000	0.123	0.281	0.	0.	0.
12.	0.167	0.087	0.056	0.343	0.292	1.135	0.141	0.253	0.	0.	0.
10.	0.173	-0.149	0.028	0.301	0.246	0.991	0.094	0.252	0.	0.	0.
8.	0.171	-0.175	0.026	0.315	0.250	1.057	0.086	0.259	0.	0.	0.
3.	0.245	-0.152	0.029	0.320	0.252	1.009	0.096	0.269	0.	0.	0.
9.	0.253	-0.216	0.027	0.342	0.257	1.010	0.093	0.300	0.	0.	0.
NUM.	11	12	12	11	12	12	12	11	0	0	0
MAX.	0.259	0.093	0.056	0.360	0.292	1.135	0.149	0.300	0.	0.	0.
MIN.	0.167	-0.216	0.026	0.300	0.246	0.986	0.086	0.248	0.	0.	0.
RANGE	0.092	0.309	0.030	0.060	0.046	0.149	0.062	0.052	0.	0.	0.
MEAN	0.209	-0.034	0.039	0.324	0.265	1.041	0.120	0.265	0.	0.	0.
STDDV	0.034	0.112	0.011	0.019	0.014	0.050	0.022	0.015	0.	0.	0.
SDVMN	0.010	0.032	0.003	0.006	0.004	0.014	0.006	0.005	0.	0.	0.
V	16.202	-333.033	26.883	5.982	5.361	4.794	18.509	5.663	0.	0.	0.

BIVARIATE ANALYSIS (REDUCED MAJOR AXIS) OF Y/X. RESULTS NOT VALID FOR COLUMNS OF LOG Y/LOGX.

R	0.388	0.802	0.761	0.815	0.964	0.891	0.970	0.903	0.	0.	0.
A	0.370	3.426	0.128	0.364	0.353	1.095	0.250	0.233	0.	0.	0.
SIG(A)	0.103	0.590	0.024	0.064	0.027	0.144	0.017	0.030	0.	0.	0.
B	-1.925	-4.760	-2.112	-0.961	-2.544	-0.644	-0.987	0.885	0.	0.	0.
D(RMA)	10.767	7.171	6.990	5.562	3.292	4.900	3.949	5.048	0.	0.	0.
MEAN Y	2.473	-0.043	0.955	7.618	7.783	12.100	0.955	7.618	0.	0.	0.
MEAN X	11.882	1.377	23.925	23.555	29.292	11.633	7.783	28.864	0.	0.	0.
YMAX 1	12.880	1.664	7.503	26.357	32.712	43.174	5.501	24.214	0.	0.	0.
TOP 1	51.179	13.689	-30.618	2.659	12.650	3.888	-35.522	-1.541	0.	0.	0.
BASE 1	-14.973	-179.271	-5.174	-1.884	-4.794	-0.789	-2.418	1.734	0.	0.	0.

BIVARIATE ANALYSIS (REGRESSION OF Y ON X AND X ON Y) OF Y/X. RESULTS NOT VALID FOR COLUMNS OF LOG Y/LOG X.

R	0.388	0.802	0.761	0.815	0.964	0.891	0.970	0.903	0.	0.	0.
A(YX)	0.144	2.749	0.098	0.297	0.340	0.976	0.242	0.211	0.	0.	0.
B(Y)	0.765	-3.828	-1.379	0.622	-2.170	0.750	-0.929	1.540	0.	0.	0.
A(XY)	1.049	0.234	5.937	2.239	2.734	0.813	3.888	3.869	0.	0.	0.
B(X)	9.287	1.387	18.253	6.499	8.013	1.796	4.069	-0.611	0.	0.	0.
S(Y.X)	1.021	0.026	1.558	1.233	0.932	0.539	0.298	1.431	0.	0.	0.
S(X.Y)	0.378	0.090	0.200	0.449	0.329	0.591	0.074	0.334	0.	0.	0.
D(Y.X)	15.283	-210.843	20.905	5.893	4.223	4.881	7.791	4.383	0.	0.	0.
S(DYX)	3.258	-43.038	4.267	1.256	0.862	0.996	1.590	0.934	0.	0.	0.
D(X.Y)	8.593	1.908	6.512	5.233	3.183	4.635	3.832	4.959	0.	0.	0.
S(DXY)	1.832	0.390	1.329	1.116	0.650	0.946	0.782	1.057	0.	0.	0.
CONAYX	0.114	0.647	0.026	0.070	0.030	0.158	0.019	0.033	0.	0.	0.
CONBY	0.120	0.027	0.060	0.143	0.100	0.179	0.023	0.106	0.	0.	0.
CONAXY	0.830	0.055	1.600	0.530	0.239	0.131	0.306	0.615	0.	0.	0.
CONBX	0.325	0.008	0.472	0.392	0.282	0.163	0.090	0.455	0.	0.	0.
YMAX 2	6.514	1.327	5.939	22.899	31.811	39.776	5.366	22.597	0.	0.	0.
XMAX	15.897	1.692	137.000	62.468	79.094	34.317	81.836	96.114	0.	0.	0.
TOP YX	1.667	0.982	-34.450	-4.119	10.952	-0.275	-35.852	-4.710	0.	0.	0.
BASEYX	5.949	-144.160	-3.379	1.219	-4.091	0.919	-2.277	3.019	0.	0.	0.
TOP XY	-21.090	-3.427	28.933	-5.848	-7.317	-4.973	75.164	-1.360	0.	0.	0.
BASEXY	8.127	25.886	8.518	3.033	2.805	1.571	5.477	-0.214	0.	0.	0.

Error Messages in DASAN

Only one error message has been written into DASAN, which reads, ANOMALOUS VALUE IN DATA. This statement will appear and the job will be terminated for any of the following reasons:

1. Control cards contain negative values where these are not allowed.

2. A zero on a card in the data deck has been used as a signal for division by a constant, whereas only a +1 or a −1 is permitted.

3. A variable which is to be converted to a logarithm is negative.

VPLOT: Description of Program

The variable plotting program (VPLOT) provides for very rapid plotting of bivariate scatter diagrams and the construction of reduced major axes or regression lines. The univariate output array of DASAN (Figure 1), or any array in which columns represent variables (measurements) and rows represent specimens, may serve as the input data array. Within VPLOT, this input array is altered and/or expanded to form an *internal data array*. Alterations consist of logarithmic (base 10) transformations of any of the input variables, with the logs replacing the original values. Alternatively, the logs may be entered in new columns of variables, thereby preserving the original values. An alteration of the input array is desirable if only the logs are to be plotted and not the original values. On the other hand, expanding the input array by entering the logs in new columns allows both the original data and the logs to be plotted.

The main routine of VPLOT is concerned with input, with the alteration and expansion of the input array, and with output. The actual plotting of each bivariate scatter diagram is carried out by the subroutine, APLOT, which employs both Boolean algebra and FAP. This subroutine accepts and plots the values in two columns of the internal data array at a time according to column indentification numbers specified on control cards.

Listed below are the main steps followed by the program:

VPLOT (main)

1. Control cards, variable format, and data are read in.

2. The value of each input variable (except for the first, which should be a specimen indentification number) is compared to a specified minimum value. If below this value, the variable is replaced by the specified minimum.

3. The value of each input variable is compared to a specified maximum value. If greater than this value, the variable is replaced by the specified maximum.

4. Columns of variables, specified on control cards, are replaced by their logarithms (base 10).

5. The logarithms of specified columns of variables are computed and entered as new columns of data.

6. Two variables, designated as x and y on control cards, are entered as arguments in a call to Subroutine APLOT.

Subroutine APLOT

7. One bivariate scatter diagrams is computed, and control is returned to the main program.

VPLOT (main)

8. The scatter diagram computed by APLOT is printed.

9. If more diagrams remain to be plotted, Steps 6 through 8 are repeated for each plot.

10. If more data decks remain in the run, control returns to Step 1 with the reading in of new control cards and data. Otherwise, the job is completed.

Computation Time.—The sample problem described below (12 specimens, 36 input variables, and 43 plots) required only 50 seconds on the IBM 7094. Increasing the number of specimens does not add greatly to the computation time.

Core Space.—The space occupied by VPLOT is not large, but because there are difficulties in plotting points consisting of three digits rather than two, 99 must remain the upper limit of the number of specimens which can be run at a time.

Listing of FORTRAN II Statements in VPLOT

```
C                         VARIABLE PLOTTING PROGRAM
C    THOMAS R. WALLER, DEPT. OF PALEOBIOLOGY, SMITHSONIAN INSTITUTION
C                            FEBRUARY 6, 1967
C
C  - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - -
C                         VPLOT (MAIN ROUTINE)
C  - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - -
C
      DIMENSION X(99,100),A(99),B(99),TAG(100),IDYVAR(20) , IDXVAR(10),XA(VMAIN  1
     15),YA(5),FMT(60),ANAME(15),LALCOL(60),LENCOL(60)
C
      READ INPUT TAPE 5,37,NVAR,NTAG
      READ INPUT TAPE 5,32,(TAG(J),J=1,NTAG)
C
    1 READ INPUT TAPE 5,32,ANAME
      IF (ANAME(1)-(+6HFINISH))2,40,2
    2 II = 0
      READ INPUT TAPE 5,37,NS
      MIN = NS + 1
      NS2 = NS + 2
      NS3 = NS + 3
      K = 0
      READ INPUT TAPE 5,37,NGROUP
    3 READ INPUT TAPE 5,31,IDYVAR,IDXVAR,NY,NX,NODATA
      IF (NODATA)30,4,24
    4 READ INPUT TAPE 5,37,NFMT
      KK = 12 * NFMT
      READ INPUT TAPE 5,32,(FMT(I),I=1,KK)
      READ INPUT TAPE 5,FMT,((X(I,J),J=1,NVAR), I=1,NS2)
      READ INPUT TAPE 5,37,LALTER,LENTER
      IF (LALTER)30,6,5
    5 READ INPUT TAPE 5,39,(LALCOL(J),J=1,LALTER)
    6 IF (LENTER)30,41,7
    7 READ INPUT TAPE 5,39,(LENCOL(J),J=1,LENTER)
      NVAR1 = NVAR + 1
      NVAR2 = NVAR + LENTER
   41 IF (LALTER + LENTER)30,8,45
   45 READ INPUT TAPE 5,42,(X(NS3,J),J=1,NVAR)
C
      IF (LALTER)30,18,13
   13 DO 43 JL=1,LALTER
      J = LALCOL(JL)
      DO 16 I=1,NS2
      IF (X(I,J))30,15,14
   14 X(I,J) = LOG10F(X(I,J))
      GO TO 16
   15 X(I,J) = X(NS3,J)
   16 CONTINUE
   43 CONTINUE
```

```
C
   18 IF (LENTER)30, 8,19
   19 J2 = NVAR
      DO 23 JL=1,LENTER
      J = LENCOL(JL)
      J2 = J2 + 1
      DO 22 I=1,NS2
      IF (X(I,J))30,21,20
   20 X(I,J2) = LOG1OF(X(I,J))
      GO TO 22
   21 X(I,J2) = X(NS3,J)
   22 CONTINUE
   23 CONTINUE
C
    8 DO 46 I=1,NS
      DO 10 J=2,NVAR
      IF (X(I,J)-X(MIN,J))9,10,10
    9 X(I,J) = X(MIN,J)
   10 CONTINUE
   46 CONTINUE
C
      DO 47 I=1,MIN
      DO 12 J=2,NVAR
      IF (X(I,J) - X(NS2,J))12,12,11
   11 X(I,J) = X(NS2,J)
   12 CONTINUE
   47 CONTINUE
C
   24 XA(1) = 0.0
      YA91) = 0.0
      II = II + 1
C
      DO 28 M=1,NX
      L = IDXVAR(M)
      DO 27 J=1,NY
      JJ = IDYVAR(J)
      IF (JJ - L)25,27,25
   25 K = K + 1
      DO 26 I=1,NS2
      B(I) = X(I,JJ)
   26 A(I) = X(I,L)
C
      WRITE OUTPUT TAPE 6,34,NS,ANAME
      WRITE OUTPUT TAPE 6,35,K,TAG(JJ)
      WRITE OUTPUT TAPE 6,36,TAG(JJ),TAG(L),TAG(L)
      CALL APLOT (1,NS2,1,1,XA,YA,A,B)
   27 CONTINUE
   28 CONTINUE
C
      IF (NGROUP - II)29,29,3
   29 WRITE OUTPUT TAPE 6,33
      GO TO 1
   30 WRITE OUTPUT TAPE 6,38
```

```
C
   31 FORMAT (20I2,2X,10I2,4X,3I2)
   32 FORMAT (12A6)
   33 FORMAT (1H1/1H1)
   34 FORMAT (1H1,10H PLOT FOR ,I4,16H SPECIMENS      , 15A6)
   35 FORMAT (1H0,5X,9HPLOT NO. , I3,40X,11HORDINATE - ,A6)
   36 FORMAT (1H0,5X,A6,8H VERSUS ,A6,32X,11HABSCISSA --,A6)
   37 FORMAT (I3)
   38 FORMAT (1H1,24HNEGATIVE VALUE IN INPUT.)
   39 FORMAT (36I2)
   42 FORMAT (F4.0,9F7.4/(10F7.4))
C
   40 CALL EXIT
      END

      SUBROUTINE APLOT(L,N,NXAXIS,NYAXIS,XA,YA,X,Y)
C
      DIMENSION X(140),Y(140),PLOT(50,12),XA(5),YA(5),OUT(8),B(140),ALPH
     1A(275)
C
    1 FORMAT(1H ,84X5HALPHA,10X14HIDENTIFICATION)
    2 FORMAT(1H ,6X1H.,12A6,1H.,11(2XA2))
    3 FORMAT(1H ,7X,7(10H+.........),1H+,1H.,1H+)
    4 FORMAT(1H ,4XF6.2,4XF6.2,4XF6.2,4XF6.2,4X6.2,4XF6.2,4XF6.2,4XF6.2)
    5 FORMAT(1H ,F6.2,1H+,12A6,1H+,11(2XA2))
    6 FORMAT(   1H0,2HDX,2XF8.4,2X2HDY,2XF8.4)
C
      LSAV = L
      NSAV = N
      XL = X(L)
      XS = X(L)
      YL = Y(L)
      YS = Y(L)
      N = N+L-1
C
      DO 14I=L,N
      IF(XL-X(I))7,8,8
    7 XL = X(I)
    8 IF(XS-X(I))10,10,9
    9 XS = X(I)
   10 IF(YL-Y(I))11,12,12
   11 YL = Y(I)
   12 IF(YS-Y(I))14,14,13
   13 YS = Y(I)
   14 CONTINUE
C
      IF(XL-XS)102,102,15
   15 IF(YL-YS)102,102,16
   16 DX = (XL-XS)/35.0
      DY = (YL-YS)/49.0
C
      DO 300 K = 1,50
      DO 300 J = 1,12
```

```
  300 PLOT(K,J) = (+6H      )
      DO 200 I = 1,275
  200 ALPHA(I) = (+6H      )
      ALPHA(1)   =  (+6HAAAAAA)
      ALPHA(12)  =  (+6HBBBBBB)
      ALPHA(23)  =  (+6HCCCCCC)
      ALPHA(34)  =  (+6HDDDDDD)
      ALPHA(45)  =  (+6HEEEEEE)
      ALPHA(56)  =  (+6HFFFFFF)
      ALPHA(67)  =  (+6HGGGGGG)
      ALPHA(78)  =  (+6HHHHHHH)
      ALPHA(89)  =  (+6HJJJJJJ)
      ALPHA(100) = (+6HKKKKKK)
      ALPHA(111) = (+6HLLLLLL)
      ALPHA(122) = (+6HMMMMMM)
      ALPHA(133) = (+6HNNNNNN)
      ALPHA(144) = (+6HOOOOOO)
      ALPHA(155) = (+6HPPPPPP)
      ALPHA(166) = (+6HQQQQQQ)
      ALPHA(177) = (+6HRRRRRR)
      ALPHA(188) = (+6HSSSSSS)
      ALPHA(199) = (+6HTTTTTT)
      ALPHA(210) = (+6HUUUUUU)
      ALPHA(221) = (+6HVVVVVV)
      ALPHA(232) = (+6HWWWWWW)
      ALPHA(243) = (+6HXXXXXX)
      ALPHA(254) = (+6HYYYYYY)
      ALPHA(265) = (+6HZZZZZZ)
B     B(1)  = 000100010001
B     B(2)  = 000200020002
B     B(3)  = 000300030003
B     B(4)  = 000400040004
B     B(5)  = 000500050005
B     B(6)  = 000600060006
B     B(7)  = 000700070007
B     B(8)  = 001000100010
B     B(9)  = 001100110011
B     B(10) =010001000100
B     B(11) =010101010101
B     B(12) =010201020102
B     B(13) =010301030103
B     B(14) =010401040104
B     B(15) =010501050105
B     B(16) =010601060106
B     B(17) =010701070107
B     B(18) =011001100110
B     B(19) =011101110111
B     B(20) =020002000200
B     B(21) =020102010201
B     B(22) =020202020202
B     B(23) =020302030203
B     B(24) =020402040204
```

```
B       B(25) =020502050205
B       B(26) =020602060206
B       B(27) = 020702070207
B       B(28) =021002100210
B       B(29) =021102110211
B       B(30) = 030003000300
B       B(31) = 030103010301
B       B(32) = 030203020302
B       B(33) = 030303030303
B       B(34) = 030403040304
B       B(35) = 030503050305
B       B(36) = 030603060306
B       B(37) = 030703070307
B       B(38) = 031003100310
B       B(39) = 031103110311
B       B(40) = 040004000400
B       B(41) = 040104010401
B       B(42) = 040204020402
B       B(43) = 040304030403
B       B(44) = 040404040404
B       B(45) = 040504050405
B       B(46) = 040604060406
B       B(47) = 040704070407
B       B(48) = 041004100410
B       B(49) = 041104110411
B       B(50) = 050005000500
B       B(51) = 050105010501
B       B(52) = 050205020502
B       B(53) = 050305030503
B       B(54) = 050405040504
B       B(55) = 050505050505
B       B(56) = 050605060506
B       B(57) = 050705070507
B       B(58) = 051005100510
B       B(59) = 051105110511
B       B(60) = 060006000600
B       B(61) = 060106010601
B       B(62) = 060206020602
B       B(63) = 060306030603
B       B(64) = 060406040604
B       B(65) = 060506050605
B       B(66) = 060606060606
B       B(67) = 060706070607
B       B(68) = 061006100610
B       B(69) = 061106110611
B       B(70) = 070007000700
B       B(71) = 070107010701
B       B(72) = 070207020702
B       B(73) = 070307030703
B       B(74) = 070407040704
B       B(75) = 070507050705
B       B(76) = 070607060706
B       B(77) = 070707070707
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B      B(78) = 071007100710
B      B(79) = 071107110711
B      B(80) = 100010001000
B      B(81) = 100110011001
B      B(82) = 100210021002
B      B(83) = 100310031003
B      B(84) = 100410041004
B      B(85) = 100510051005
B      B(86) = 100610061006
B      B(87) = 100710071007
B      B(88) = 101010101010
B      B(89) = 101110111011
B      B(90) =110011001100
B      B(91) = 110111011101
B      B(92) = 110211021102
B      B(93) = 110311031103
B      B(94) = 110411041104
B      B(95) = 110511051105
B      B(96) = 110611061106
B      B(97) =110711071107
B      B(98) = 111011101110
B      B(99) = 111111111111

       IF(NXAXIS)32,32,17
C
    17 DO 31 I = 1,NXAXIS
       IF(XA(I)-XS)31,18,18
    18 IF(XA(I)-XL)19,19,31
    19 DIFX = XA(I)-XS
       DELX = DX
       J = 1
    20 IPOS = 1
    21 IF(DIFX-DELX)24,22,22
    22 DELX = DELX+DX
       IPOS = IPOS+2
       IF(IPOS-5)21,21,23
    23 J = J+1
       GO TO 20
    24 GO TO (25,25,27,27,29,29),IPOS
    25 DO 26 K = 1,50
    26 PLOT(K,J) = (+6H I    )
       GO TO 31
    27 DO 28 K = 1,50
    28 PLOT(K,J) = (+6H   I  )
       GO TO 31
    29 DO 30 K = 1,50
    30 PLOT(K,J) = (+6H     I)
    31 CONTINUE
C
    32 IF(NYAXIS)41,41,33
    33 DO 40 I = 1,NYAXIS
       IF(YA(I)-YS)40,34,34
    34 IF(YA(I)-YL)35,35,40
```

```
   35 DIFY = YA(I)-YS
      DELY = DY
      K = 1
   36 IF(DIFY-DELY)38,37,37
   37 DELY = DELY+DY
      K = K+1
      GO TO 36
   38 DO 39 J =1,12
   39 PLOT(K,J) = (+6H------)
   40 CONTINUE
C
   41 DO 88 I = L,N
      DELX = DX
      DELY = DY
      DIFX = X(I)-XS
      DIFY = Y(I)-YS
      J = 1
      K = 1
   42 IF(DIFY-DELY)44,43,43
   43 DELY = DELY+DY
      K = K+1
      GO TO 42
   44 IPOS = 1
   45 IF(DIFX-DELX)48,46,46
   46 DELX = DELX+DX
      IPOS = IPOS+2
      IF(IPOS-5)45,45,47
   47 J = J+1
      GO TO 44
   48 GO TO (49,49,62,62,75,75),IPOS
B  49 D = (606000000000+(777700000000*PLOT(K,J)))*(-(606000000000*PLOT(K
     1,J)))
B     E = (404000000000+(777700000000*PLOT(K,J)))*(-(404000000000*PLOT(K
     1,J)))
B     F = (003100000000+(007700000000*PLOT(K,J)))*(-(003100000000*PLOT(K
     1,J)))
B     G = 6000000000*PLOT(K,J)
B     IF(D)50,53,50
B  50 IF(E)51,53,51
B  51 IF(F)52,53,52
B  52 IF(G)57,54,57
B  53 PLOT(K,J) = (000077777777*PLOT(K,J))+(777700000000*B(I))
      GO TO 88
B  54 DO 55 M = 2,266,11
      IF(ALPHA(M)-(+6H      ))55,56,55
   55 CONTINUE
      GO TO 88
   56 ALPHA(M) = PLOT(K,J)
      ALPHA(M+1) = B(I)
B     PLOT(K,J) =(000077777777*PLOT(K,J))+(777700000000*ALPHA(M-1))
      GO TO 88
   57 DO 58 M = 1,265,11
B     IF((777700000000*PLOT(K,J))*(777700000000*(-(ALPHA(M)))))58,59,58
```

```
    58 CONTINUE
       GO TO 88
    59 JJ = M+2
       KK = M+10
       DO 60 MM = JJ,KK
       IF(ALPHA(MM)-(+6H       ))60,61,60
    60 CONTINUE
       GO TO 88
    61 ALPHA(MM) = B(I)
       GO TO 88
B   62 D = (000060600000+(000077770000*PLOT(K,J)))*(-(000060600000*PLOT(K
      1,J)))
B      E = (000040400000+(000077770000*PLOT(K,J)))*(-(000040400000*PLOT(K
      1,J)))
B      F = (000000310000+(000000770000*PLOT(K,J)))*(-(000000310000*PLOT(K
      1,J)))
B      G = 000060000000*PLOT(K,J)
B      IF(D)63,66,63
B   63 IF(E)64,66,64
B   64 IF(F)65,66,65
B   65 IF(G)70,67,70
B   66 PLOT(K,J) = (777700007777*PLOT(K,J))+(000077770000*B(I))
       GO TO 88
    67 DO 68 M = 2,266,11
       IF(ALPHA(M)-(+6H       ))68,69,68
    68 CONTINUE
       GO TO 88
    69 A = PLOT(K,J)
       E = 1
       CALL MOVE(A,E,12,1)
       ALPHA(M) = E
       ALPHA(M+1)= B(I)
B      PLOT(K,J) = (777700007777*PLOT(K,J))+(000077770000*ALPHA(M-1))
       GO TO 88
    70 DO 71 M = 1,265,11
B      IF((000077770000*PLOT(K,J))*(000077770000*(-(ALPHA(M)))))71,72,71
    71 CONTINUE
       GO TO 88
    72 JJ = M+2
       KK = M+10
       DO 73 MM = JJ,KK
       IF(ALPHA(MM)-(+6H       ))73,74,73
    73 CONTINUE
       GO TO 88
    74 ALPHA(MM) = B(I)
       GO TO 88
B   75 D = (000000006060+(000000007777*PLOT(K,J)))*(-(000000006060*PLOT(K
      1,J)))
B      E = (000000004040+(000000007777*PLOT(K,J)))*(-(000000004040*PLOT(K
      1,J)))
B      F = (000000000031+(000000000077*PLOT(K,J)))*(-(000000000031*PLOT(K
      1,J)))
B      G = 000000006000*PLOT(K,J)
```

```
B      IF(D)76,79,76
    76 IF(E)77,79,77
    77 IF(F)78,79,78
    78 IF(G)83,80,83
B   79 PLOT(K,J) = (777777770000*PLOT(K,J))+(000000007777*B(I))
       GO TO 88
    80 DO 81 M = 2,266,11
       IF(ALPHA(M)-(+6H      ))81,82,81
    81 CONTINUE
       GO TO 88
    82 A = PLOT(K,J)
       E = 1
       CALL MOVE(A,E,24,1)
       ALPHA(M) = E
       ALPHA(M+1) = B(I)
B      PLOT(K,J) = (777777770000*PLOT(K,J))+(000000007777*ALPHA(M-1))
       GO TO 88
    83 DO 84 M = 1,265,11
B      IF((000000007777*PLOT(K,J))*(000000007777*(-(ALPHA(M)))))84,85,84
    84 CONTINUE
       GO TO 88
    85 JJ = M+2
       KK = M+10
       DO 86 MM = JJ,KK
       IF(ALPHA(MM)-(+6H      ))86,87,86
    86 CONTINUE
       GO TO 88
    87 ALPHA(MM) = B(I)
    88 CONTINUE
C
       WRITE OUTPUT TAPE 6,1
       K = 50
       P = YL
       L = 41
       B = 40.0
       M=2
    89 IF(M-266)90,90,92
    90 IF(ALPHA(M)-(+6H      ))91,92,91
    91 MM =M-1
       NN = M+9
       WRITE OUTPUT TAPE 6,5,P,(PLOT(K,J),J=1,12),(ALPHA(I),I=MM,NN)
       GO TO 93
    92 WRITE OUTPUT TAPE 6,5,P,(PLOT(K,J),J=1,12)
    93 M = M+11
       K = K-1
       IF(K)100,100,94
    94 IF(K-L)96,95,96
    95 P = YS+(B*DY)
       L = L-10
       B = B-10.0
       GO TO 89
    96 IF(M-266)97,97,99
    97 IF(ALPHA(M)-(+6H      ))98,99,98
```

```
   98 MM = M-1
      NN = M+9
      WRITE OUTPUT TAPE 6,2,(PLOT(K,J),J=1,12),(ALPHA(I),I=MM,NN)
      GO TO 93
   99 WRITE OUTPUT TAPE 6,2,(PLOT(K,J),J=1,12)
      GO TO 93
  100 WRITE OUTPUT TAPE 6,3
      A = 0.0
      DO 101 M = 1,8
      OUT(M) = XS+(A*DX)
  101 A = A+5.0
      WRITE OUTPUT TAPE 6,4,(OUT(M),M=1,8)
      WRITE OUTPUT TAPE 6,6,DX,DY
      L = LSAV
      N = NSAV
  102 RETURN
      END
*       FAP
        COUNT 30
        ENTRY    MOVE
  MOVE  CLA      2,4
        STA      BB
        CLA      4,4
        STA      HERE
  HERE  CLA
        TZE      RITE
        CLA      1,4
        STA      AA
        CLA      3,4
        STA      NEXT
  NEXT  CLA
        ARS      18
        STA      NPL
    AA  CAL
   NPL  ALS
        TOV      BB
        TRA      BB
  RITE  CLA      1,4
        STA      AR
        CLA      3,4
        STA      TEMP
  TEMP  CLA
        ARS      18
        STA      NPRT
    AR  CAL
  NPRT  ARS
    BB  SLW
        TRA      5,4
        END
```

Input Data Preparation for VPLOT

The following section describes the preparation of control and data cards for VPLOT, using the same conventions as in the previous section describing the input for DASAN. Unlike the previous section, however, a third group of control cards is used. These Group III controls follow each data deck in the run and, like the Group II controls, contain infromation which affects only the data deck which they accompany. The major groups of cards appearing in a VPLOT run which contains two data decks are ordered as follows:

Program Source Deck
Group-I Control Cards
Group-II Control Cards
Data Deck
Group-III Control Cards
Group-II Control Cards (for following data)
Data Deck
Group-III Control Cards
FINISH Card

Group I Control Cards

1. (1): The number of variables in the input data array (from 3 to 100), including the column of specimen identification numbers. Punch in columns 1–3.

2. (1): The number of variables in the internal data array (from 3 to 100), including the column of specimen identification numbers. Punch in columns 1–3.

3. (1–9): Names of variables in the internal data array, with each name not to exceed six characters. Punch in columns 1–72 on each card, 12 names per card, with each name centered in a field of 6 columns, such that the name in the *n*th field is for the *n*th column in the array.

Group II Control Cards

4. (2): Any name or sample-identification information to be printed at the top of each output page. Punch in columns 1–72 of first card and columns 1–18 of second card. Both cards must be present even if blank.

5. (1): The number of specimens (from 3 to 97) in the input data array, punched in columns 1–3. The maximum number is 97 rather than the dimensioned 99, because the cards containing the minima (Instruction 11) and maxima (Instruction 12) are read in as data for two additional specimens.

6. (1): The number of plotting groups (from 1 to 999). A plotting group is a series of *x* and *y* variables such that each *x* is plotted against every *y*, as explained in Instruction 7. Punch in columns 1–3.

7. (1): Information for setting up a plotting group (Instruction 6), to be punched as follows:
(a) *Columns 1–40:* The column-identification numbers of the y-variables (from 1 to 20 numbers), with each number in a field of 2 card columns.
(b) *Columns 43–62:* The column-identification numbers of the x-variables (from 1 to 10 numbers), with each number in a field of 2 card columns.
(c) *Columns 67–68:* The number of y-variables in the plotting group (the number of values punched for Instruction 7a).
(d) *Columns 69–70:* The number of x-variables in the plotting group (the number of values punched for Instruction 7b).
(e) *Column 72:* Punch a zero if this is the first plotting group preceding the data deck; punch *1* if this is not the first plotting group and it follows the data deck. (See Instruction 18.)

8. (1): The number of cards (from 1 to 5) which are required to specify the format for reading in the data deck. Punch in column 3.

9. (1–5): The format, in FORTRAN II, for the reading in of data cards. (See Instruction 21 in the description of DASAN.) Punch in columns 1–72 of each of the cards needed.

Data Deck

10. See Instructions 21 and 37 in the description of DASAN. The specimen numbers, which form the first column of the data array and which must be read in, are not used by VPLOT. Rather, the specimens are assigned consecutive numbers in their read-in order, beginning with No. 1, and it is these consecutive read-in numbers which appear as the points in the output scatter diagrams.

Group III Control Cards

11. (1–): Cards containing a minimum value for each variable in the input array (see also Instruction 17). The coordinates of the origin of each bivariate scatter diagram are determined by

the minima specified for the x and y variables in each plot. The difference between the minimum and maximum (Instruction 12) specified for each variable determines the scale of calibration of each scatter diagram in which these variables are plotted. (See explanation of sample output from VPLOT.) The cards are read in according to the same format as that used for the reading in of the data deck and must therefore be punched in the same way as the data cards, with a specimen number being entered as the first variable.

12. (1-): Cards containing the anticipated maximum values for each of the variables in the input array, as explained in Instruction 29 in the description of DASAN. These values, together with the minimum values specified for each variable (Instruction 11), determine the scale to which the axes of each of the scatter diagrams are calibrated. These cards are read in according to the same format as that used for the reading in of the data deck and must therefore be punched in the same format as the data cards. with a specimen number being entered as the first variable.

13. (1): The number of columns of variables (from 0 to 60) which are to be replaced by their logarithms (base 10). Punch in columns 2–3.

14. (1): The number of columns of variables (from 0 to 60) which are to be transformed to logarithms, with the logs being entered as new columns of data and the original values being preserved. Punch in columns 2–3.

15. (0–2): Column identification numbers of the variables which are to be replaced by their logarithms. Punch in fields of 2 columns in columns 1–72 of the first card and in columns 1–48 of the second card.

16. (0–2): Column identification numbers of the variables which are to be transformed into logarithms and entered as new columns of data in the internal array. Punch in fields of 2 columns in columns 1–72 of the first card and in columns 1–48 of the second card.

17. (0–7): Cards containing a minimum log value for each variable in the input array which will be transformed to a logarithm and for which a zero minimum was specified in Instruction 11. This log minimum will be inserted by the program into any blank data cells and, like the minima for non-log data described in Instruction 11, will determine the coordinates of the origin and the calibration of the axes of each diagram.

If the minimum specified for a variable in Instruction 11 is greater than zero, the log of this value will become the log minimum, and it is not necessary to specify any new log minimum here. The maximum value for each log variable is the log of its maximum previously specified in Instruction 12.

Punch an imaginary specimen number in columns 1–4 and the log minima in fields of 7 columns in columns 5–67 of the first card and in columns 1–70 of each succeeding card. Consecutive fields represent consecutive columns in the input array, so that a minimum for the 7th variable, for example, must be punched in the field which is in columns 40–46.

The decimal point will be placed by the program in front of the last four digits of each log minimum.

18. If more plotting groups remain, enter one information card (Instruction 7) for each group. Punch as described in Instruction 7, placing a *1* in column 72.

19. If more data decks remain to be processed having the same numbers of variables in the input and internal data arrays and the same names for the variables, begin again with Instruction 4.

20. (1): If no more data decks remain, the last card consists of the word FINISH punched in columns 1–6.

Sample Input Data for VPLOT

Listed below are the control and data cards for a test run of VPLOT, the output from which is discussed in the following section. The input data is the univariate output array punched by the preceding test run of DASAN. On the far right side of each control card are numbers which refer to instructions in the section on input preparation.

```
*    DATA
036                                                                          1
041                                                                          2
 SPEC   DG    GP    AD    AK    AM    DF    CD    EI    BJ    DE    LO       3
 RIBHT  HI  PLICAEANTCOSPOSCOSINTRIBINTGRV (AD)  (CE)  (IK)  (PQ)  (BJ)
 (AB)  (MN)  (FG)   ALM P.AREA  KM    EF    AG    CF  LOGPARLOG LOLOG AM
LOG AMLOG DFLOGPARLOG LOLOGALM
AEQUIPECTEN NUCLEUS -- MIAMI AND LAKE WORTH, FLA., MCZ 197942, 232557,       4
232553 -- LIVING
012                                                                          5
016                                                                          6
06070833141213212222527                  32                  1101 0          7
  1                                                                          8
(F4.0,F6.1,12F5.1,9X,1HA/14F5.1,9X,1HB/5F5.1,3F7.4,33X,1HC)                  9
  - - - - - - - - - - - - INSERT DATA DECK HERE - - - - - - - - - - - - - - - - -   10
 98.                                                                        11
                                                                            11
                                                                            11
 99.  40.0 40.0 45.0 40.0 75.0 25.0 27.0 14.0 19.5 25.0 26.0  3.5 50.0      12
 30.0 10.0 12.0  5.5  5.5  5.5  6.5 27.0 21.0 31.0 15.0 20.0  9.0100.0
 20.0 35.0  6.3 85.0 35.0 1.3010 1.4150 1.8751
 00                                                                         13
 05                                                                         14
0607291228                                                                  16
  98                           -10000 -10000                                17
      -10000                                                                17
                                            -10000 -10000                   17
                                                                            17
0910121318202324262907                   06                  1101 1         18
040731                                   02                  0301 1
060712                                   28                  0301 1
05                                       30                  0101 1
0805                                     04                  0201 1
07                                       08                  0101 1
31                                       07                  0101 1
0502                                     03                  0201 1
18                                       19                  0101 1
20                                       21                  0101 1
22                                       23                  0101 1
24                                       25                  0101 1
39                                       37                  0101 1
29                                       12                  0101 1
3840                                     37                  0201 1
FINISH                                                                      20
```

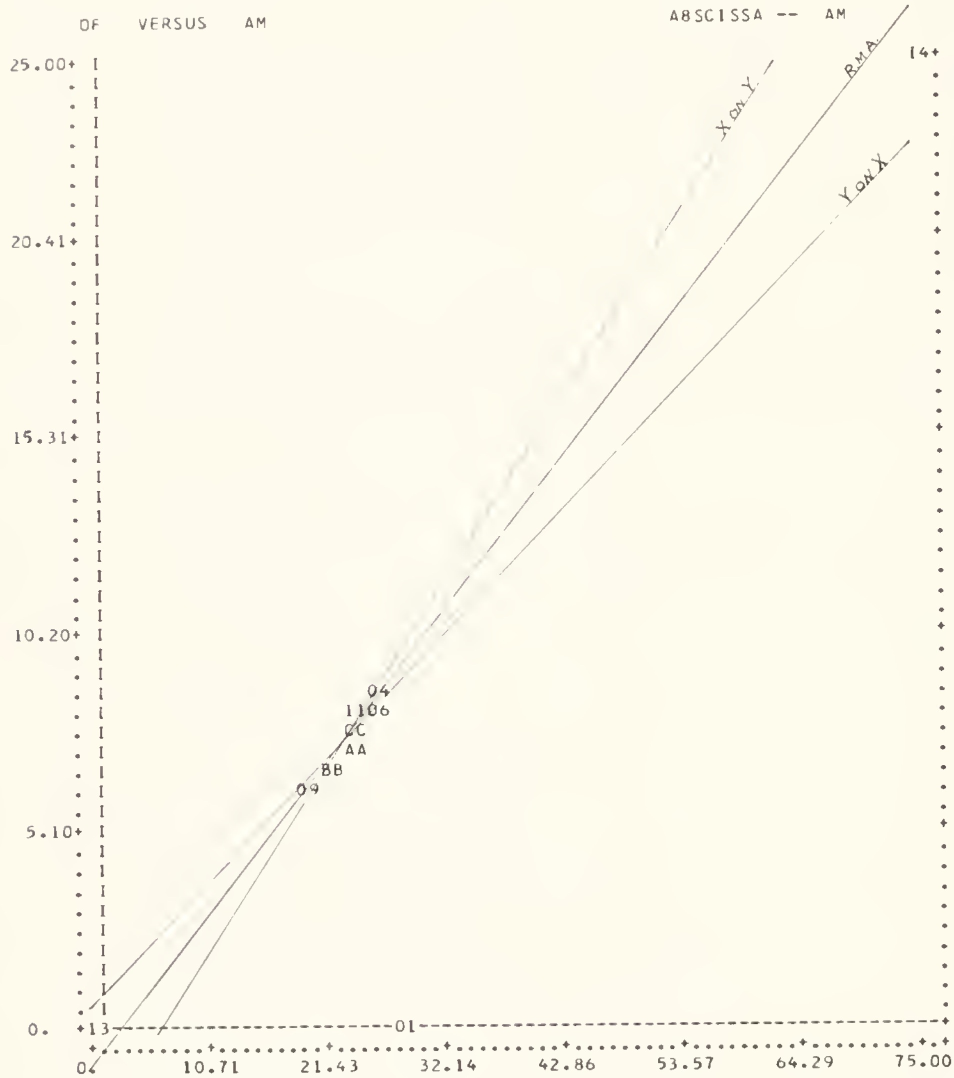
Sample Output from VPLOT

Reproduced below are two of the plots resulting from an execution of VPLOT involving 12 specimens, with 36 variables in the input array, 41 variables in the internal array, and a total of 43 ratios to be plotted.

PLOT FOR 12 SPECIMENS AEQUIPECTEN NUCLEUS -- MIAMI AND LAKE WORTH, FLA., MCZ 197942, 232557, 232553 -- LIVING

PLOT NO. 22 ORDINATE - DF

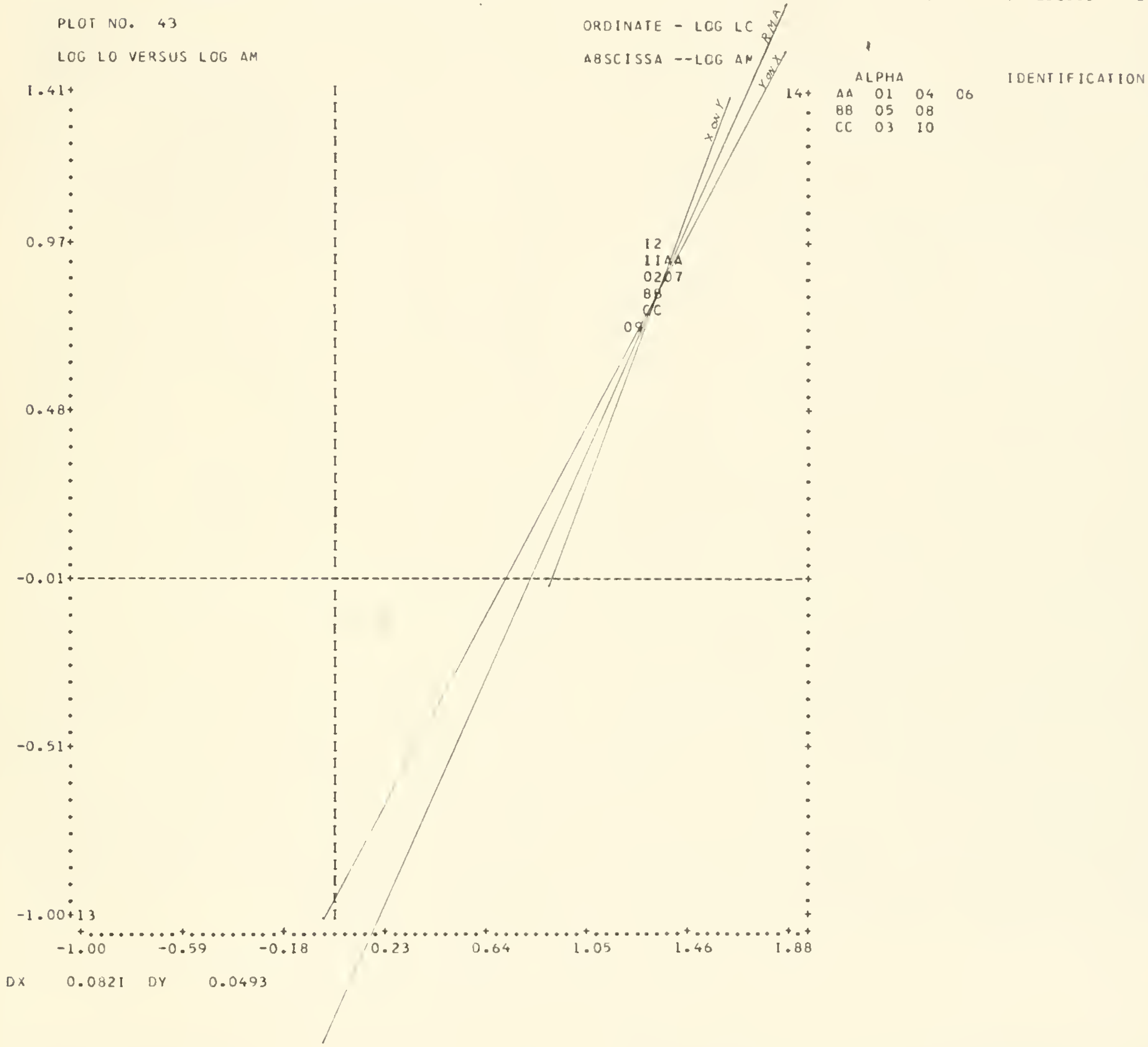
DF VERSUS AM ABSCISSA -- AM



ALPHA				IDENTIFICATION
AA	02	07		
BB	03	08	10	
CC	05	12		

DX 2.1429 DY 0.5102

PLOT FOR 12 SPECIMENS AEQUIPECTEN NUCLEUS -- MIAMI AND LAKE WORTH, FLA., MCZ 197942, 232557, 232553 -- LIVING



Each point on the scatter diagram is a two-digit specimen number, with the lower left-hand corner of each two-digit cell representing the actual point. These specimen numbers are *not* the specimen numbers read in with the data, but rather are numbers, from 1 to n, which are assigned to n specimens in the data deck in the order in which they appear in the deck. The arbitrary set of minimum values is also assigned a specimen number, which is $n + 1$, and so also is the set of maximum values, the specimen number of which is $n + 2$. Where two or more points coincide, a double letter is printed, with the specimen numbers of the coincident points printed after the same double letter on the right side of the diagram.

In the sample output, specimens No. 13 and No. 14 represent, respectively, the plots of the specified minimum and maximum for the plotted variables.

The end points of the reduced major axis for the first diagram (DF *versus* AM) are plotted as follows: The y-intercept (the y-coordinate of the point on the reduced major axis where $x=0$), given as BASE 1 in the output of DASAN, is −1.884. Because this is in the scale units of the diagram, it is only necessary to count down −1.9 dots along an imaginary vertical line through the lower left corner of the two-digit cell occupied by specimen No. 13, which represents the origin. Similarly, the point at which the reduced major axis crosses the right-hand margin of the diagram is indicated in the DASAN output by TOP 1, which is 2.659. This is plotted by counting 2.7 dots downward along a vertical line through the lower left corner of the two-digit cell occupied by specimen No. 14, the maximal point.

The values DX and DY, printed in the lower right corner of each output page, are, respectively, the values between each dot on the y-axis and between every second dot on the x-axis. It will be seen that there are 49 such scale-units on the y-axis and 35 on the x-axis between the minimal and maximal points.

The regression of y on x is plotted in the same manner, but the end points of the regression of x on y are given in terms of units on the x-axis rather than on the y-axis. Thus, TOP 3 in the output of DASAN (on the last page of the output listed below) refers to the number of x-axis units to the left (−) or right (+) of point No. 14, and BASE 3 refers to the number of x-axis units to the left (−) or right (+) of point No. 13.

The second diagram shown is a double log plot (LOG LO *versus* LOG AM) in which the coordinates of the specified minimal point are (−1.0, −1.0). Here the basal end points of the reduced major axis and the regression of y on x have been measured along a vertical line through the dot (drawn for the purpose of illustration) which represents the coordinates (0,0). The basal end point of the regression of x on y is measured along a horizontal line through the same dot with measurement in units of the x-axis. The upper end points of all three lines are plotted as in the preceding example.

It will be found that artificially constructed scales matching the spacing of units on the axes will increase the speed and accuracy of line-plotting. When only a small number of points are plotted, there may be an apparent discordance between the plotted points (specimens) and the hand-drawn line of best fit. This is because the two-digit plots are only approximations, the accuracy of which is determined by the print-spacing of the printer, whereas the regression lines and reduced major axis, which are plotted by hand, are limited only by the accuracy of the hand-plotting operation and by the data themselves.

Error Messages in VPLOT

Only one error message has been written into VPLOT, which reads NEGATIVE VALUE IN INPUT. It is printed out, and the run is terminated, whenever a negative value appears where not permitted on a control card or in the data where this value is to be transformed to a logarithm.

Availability of Program Decks

Duplicates of the FORTRAN II source decks may be obtained through the Smithsonian Institution by writing to the author care of the Department of Paleobiology, Smithsonian Institution, Washington, D.C. 20560.

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