A STUDY OF VARIATION IN THE BRYOZOAN

FISTULIPORA DECORA (MOORE AND DUDLEY) FROM THE

BEIL LIMESTONE MEMBER OF THE LECOMPTON LIMESTONE OF KANSAS

by

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ABSTRACT

An increasing number of bryozoan systematists are recognizing the need for a more quantitative treatment of variation in taxonomic studies of Bryozoa. The principal objective of this study was to isolate, as far as possible, the relative contributions of inter- and intracolony variation to the total variation of a population. Failure of the assumption of homogeneity of variances, for the data as a whole, precluded use of a nested analysis of variance model. This assumption was met by subsets of the data for several localities, and single classification anovas were applied in those instances.

Analysis of between locality differences by the Kruskal-Wallis anova analog revealed highly significant differences between localities. A nested anova (for which the assumptions had not been met) was performed for comparison, and resulted in nonsignificant values for between locality differences. This emphasized the hazard of using anova where assumptions are not met.

Analysis of within locality variance revealed highly significant differences between colonies. Significant intercolony variation within a locality can reasonably be attributed to a high degree of genetic diversity as the broad environment within the small area of the collecting site was seemingly relatively uniform. Partitioning of the total variance by single classification anova revealed that the greatest proportion of within locality variation is explained by differences within one colony. This is attributed to differences in the microenvironment affecting individuals within a single colony. Comparison of coefficients of intra- and intercolony variation, as suggested by Oliver (1968), was not appropriate in this study due

to the significant overlap of 95% confidence limits for most cases.
The independence of characters used in this study (as a measure of
the degree of redundancy of information they provided) was evaluated
by calculating a matrix of Pearson product-moment correlation
coefficients. At least two independent characters could be recognized.

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INTRODUCTION

General Statement

The need for a quantitative approach to the description and differentiation of bryozoan taxa has become evident in recent years. The recognition, by an increasing number of workers, of the importance of intracolony variation in the systematics and evolution of Bryozoa has shown the need to restudy and evaluate the classification of many bryozoan species and genera (Boardman and Cheetham, 1969). Most systematic descriptions of Bryozoa have treated variation superficially, or not at all. However, as pointed out by Oliver (1968, p. 25-26), those studies that have dealt with intracolony variation in bryozoans have indicated that it is extensive.

Intercolony variation in colonial organisms is a function of the interaction of genetic variation, environmentally induced variation, and variations in the astogeny, ontogeny, and polymorphism of individuals. Variation between metazoan colonies is thus comparable to variation between solitary animals (Oliver, 1968, p. 31-32). The individuals of a metazoan colony are assumed to be genetically identical. Intracolony variation must, therefore, arise from factors not strictly genetic in origin. This unique situation provides the opportunity to detect the effects of small scale environmental differences, not normally assessable in solitary forms, unless they are parthenogenetic or monozygotic siblings.

Bryozoan colonies are particularly well suited for quantitative description and statistical analysis because of the large number of individuals typically present in a single colony together with the presence of well defined characters that may be readily measured or counted.

Sources of Variation in Bryozoa

GENETIC VARIATION: The problem of isolating the genetically controlled aspects of variation in Bryozoa is simplified by the colonial nature of their growth. Each bryozoan colony (zoarium) is a clone consisting of an association of daughter individuals that have originated from a single sexually produced larva (ancestrula) by asexual budding. This is the basis for the assumption that all individuals within a colony represent a single genotype. This is not to say that variations in genotype within a colony are not possible by random mutation. Increasing evidence suggests that mitotic division within clones can provide the opportunity for genetic change through extrachromosomal inheritance (Oliver, 1968, p. 17). However, it is generally accepted that random somatic variations are of low frequency and of probably negligible phenotypic expression (Oliver, 1968, p. 17; Boardman and Cheetham, 1969, p. 208). Thus, for all practical purposes the individuals of a clone can be considered genetically identical.

EXTRAGENETIC VARIATION: The occurrence of phenetic variation within a colony can, therefore, be assumed to represent the effects of factors that are not under direct genetic control. It has been suggested (Boardman, 1968, p. 180) that such factors be termed extragenetic, perhaps a somewhat misleading term. As recently suggested by Boardman, Cheetham, and Cook (1970, p. 298), use of this term should not imply that intracolony variation is completely independent of genetic effects. It is assumed that all phenetic variation falls within the possible range of expression of the colony genotype. It is the interaction of genetic and nongenetic factors that gives rise to variations in phenotypic expression. Therefore,

it would seem that all intracolony variation is indirectly genetically based.

Four extragenetic factors responsible for phenotypic variation within a single colony are recognized (Boardman, Cheetham, and Cook, 1970, p. 299-308): (1) ontogeny of the zooids (individuals of a colony); (2) astogeny of the colony; (3) polymorphism; and (4) environment.

Ontogeny: Differences that arise during growth of an individual are termed ontogenetic.

Astogeny: Astogeny is the course of post larvel development of a colony and thus reflects the age of the colony. Astogenetic changes are the observable differences among zooids that have arisen in a sequence of generations away from the ancestrula (founding individual).

In a simple model, colony growth in Bryozoa is characterized by at least two major stages of post larvel development that can be distinguished on the basis of morphology, budding habit, and position of a generation of zooids relative to the ancestrula (Boardman, 1968, p. 179). The first stage is termed the zone of astogenetic change and consists primarily of individuals of the more proximal regions of the colony. Generations of zooids within this zone of change show more or less continuous variation in morphology and budding pattern distally away from the ancestrula. This zone is characterized by a high rate of increase in the number of individuals in each succeeding generation. However, relatively few generations are involved, and thus a small total number of individuals. In order to avoid confusion with the youthful stage of ontogeny, the term neanic (Gr. neanikós, youthful) has been used in bryozoans to describe this stage of

astogeny (e.g., Ryland, 1970, p. 56). It is debatable whether this
term is useful as it has been employed for several decades to describe
the youthful stage of ontogeny of solitary animals.

The zone of astogenetic change is followed by a zone of astogenetic
repetition in which individuals of each succeeding generation of
zooids are characterized by the endless repetition of morphologies
and budding patterns. This stage is characterized by a lower rate of
increase relative to the preceeding zone of change. Despite the lower
rate of increase in the number of new individuals, many generations
are involved, and thus a large total number of individuals. Bryozoan
zooids of this stage are termed ephebic (Gr. éphebos, a young man) in
order to avoid confusion with the mature stage of ontogenetic
development (Ryland, 1970, p. 56).

Polymorphism: In contrast to the continuous types of variation
which characterize ontogenetic and astogenetic changes, polymorphic
variations are discontinuous in nature. Polymorphic differences in
zooids are, in theory, functional modifications of zooidal morphology
which are generally expressed by the presence or absence of some
distinctive structural feature.

Environment: Phenetic variation in a metazoan colony is the
expression of the interaction of the colony genotype and environmental
factors influencing individuals of the colony. Therefore, differences
in environment during the growth of a colony or at specific locations
on the colony at a given time, can be expected to produce variations
in the phenotypic expression of individuals in the colony. The
contributions of polymorphism, astogeny, and ontogeny to intracolony
variation can be removed from consideration by dealing with individuals

in similar states of these three extragenetic factors (Boardman, Cheetham, and Cook, 1970, p. 308). Therefore, if we consider individuals in the same ontogenetic, astogenetic, and polymorphic circumstances within one colony, morphologic variability can be attributed to environmental differences.

Although it is recognized that the environment at a particular point at one instant of time is a complex function of many variables involving numerous interaction effects, it is convenient for the present discussion to consider environmental factors on two levels.

"Gross" environmental factors are defined as average values for the physical parameters characterizing the total environment over a restricted area. Thus, almost by definition, the gross environment is regarded as having been constant for one bedding plane at one locality. Differences in gross environment are expected to occur between localities and these contribute to differences in the average intercolony variation among localities.

Considered in detail, the environment is not constant, even across one colony. Thus, a lower level of variation in "microenviron-mental" factors is recognized. Boardman, Cheetham, and Cook (1970, p. 304-306) summarized the "microenvironmental" factors that may account for morphologic variation within colonies. They include: differences in the availability of nutrients; crowding produced by differential growth of individual zooids or by the competitive growth of other organisms; effect of parasites; differential turbulence; irregularities in substrate; differential sediment accumulation; differences in light intensity and duration; salinity; and temperature. Thus, comparison of colonies originating in

different "gross" environments is expected to include components of variation due to both "gross" and "microenvironmental" factors, in addition to the components contributed by differences in genotype.

The principal objective of this investigation was to isolate, as far as possible, the contributions of each of these sources to the total variation. In addition, it was hoped that the study would provide information on the relative variability of characters and the extent to which they are correlated with one another.

Previous Work

Prior to 1960, published studies of Paleozoic Bryozoa tended to follow a qualitative, often typological approach to classification. Taxonomic descriptions were essentially verbal and pictorial in nature; variation within taxa, although it must have been observed, rarely received discussion and was never quantified.

However, during the past decade, the significance of variation has been recognized by many bryozoan systematists, and the need for more detailed documentation of it accepted. Since 1960, the study of Paleozoic Bryozoa has been characterized by a trend toward progressively more sophisticated statistical techniques. Anstey and Perry (1970) have presented a comprehensive review of work involving use of these techniques, and this is summarized in Table 1. Only a few highlights of that review are presented here.

Prior to 1963, most authors represented variability in taxonomic characters graphically. Scatter diagrams provided information concerning variation in paired characters and histograms revealed the actual form of data distributions. These types of representation of

TABLE 1

Summary of Previous Work Involving Statistical Treatment of Variation
in Paleozoic Bryozoa (Based on Anstey and Perry, 1970)

Year of Publication	Statistical Treatment of Variation		Author(s)
	Descriptive	Analytical	
Pre-1960	--	--	--
1960	Scatter diagrams		Boardman
1960	Histograms		Utgaard & Perry
1962	"		Perry
1963	Means, Standard Deviation		Perry & Horowitz
1964	"		Cuffey & Perry
1964	"		Utgaard & Perry
1965	"		Malone & Perry
1965	"		Brown
1965a., b.	"		Tavener-Smith
1966	"	t-test	Tavener-Smith
1966	Means, Standard Deviations, Coefficients of Variation	Correlation Coefficients	Boardman & Utgaard
1967	"	t-tests	Cuffey
1967	Scatter Diagrams	Correlation Coefficients	Kodsi
1967	Means, Standard Deviations		Bork & Perry
1968a., b.	"	F-max. test, Anova, Mann-Whitney U-test	"
1968	"	t-tests, Correlation Coefficients, Coef. of Determination, Kolmogorov-Smirnov test, Wilcoxen Signed-Ranks test	Horowitz

TABLE 1 (continued)

Statistical Treatment of Variation

Year of Publication	Descriptive	Analytical	Author(s)
1969	Means, Standard Deviations	F-max test, Anova, Kruskal-Wallis test, Kolmogorov-Smirnov test	Anstey & Perry

data displayed the inherent variability in morphologic characters upon which taxonomic classification had been based and provided the necessary impetus for a more quantitative statistical approach.

Where data can be shown to be distributed approximately normally, two parameters, the mean and variance, completely describe the form of the distribution; graphical representations, although they may have some heuristic value, are strictly unnecessary under such circumstances. Perry and Horowitz (1963) were the first to summarize their data in this manner. They presented means and standard deviations of data for unpaired characters of several species of the cyclostome genera Fistulipora, Eridopora, Meekopora, Prismopora, and Tabulipora. Since that time, the use of these simple univariate descriptive statistics has almost become standard procedure in systematic studies of Bryozoa (See Table 1).

In 1966, three well established statistical tools were utilized for the first time in studies of Bryozoa. Several authors presented coefficients of variation and correlation coefficients in which comparisons of the intrinsic variability within taxa, and the covariation of paired characters were made. In the same year, a simple parametric statistical test, the "t" test, was first employed (Tavener-Smith, 1966).

It is indeed unfortunate that this simple parametric test was not used earlier in the study of Paleozoic Bryozoa. Its application greatly enhances the validity of taxonomic interpretations by providing a quantitative method of determining significant differences between colony means for a given character, at a given probability level.

By way of example, one may consider the data published by Perry and Horowitz (1963) for three species of the genus _Fistulipora_. These have been reanalyzed (Table 2) and t values computed for all possible pairs of the 6 species-locality combinations studied. The results of the analysis are presented in the form of a matrix of calculated t-values in Table 2. The level of the significance of differences between means is indicated in each matrix cell by asterisks.

The value of such an approach is evident. Not only does it indicate, for a given character, colonies that differ significantly from one another, but perhaps more importantly, it draws attention to situations in which features are not significantly different. As Perry and Horowitz noted, _Fistulipora_ _perdensa_ from the Golconda and Glen Dean Limestones (Middle Chester) cannot be differentiated from one another on the basis of interzooecial distance. Similarly, although not mentioned by the authors, it is apparent from Table 2 that _F_. _excelens_ and _F_. _perdensa_ from the Glen Dean formation do not differ significantly in zooecial diameter. They can, however, be differentiated on the basis of interzooecial distance.

Cuffey (1967) has provided the most detailed statistical description of a single bryozoan species to date. Through the use of two sample t-tests and coefficients of variation, he was able to reveal the extensive nature of variation within the species _Tabulipora carbonaria_ from the Wreford Megacyclothem (Permian) of Kansas. Based upon a study of 22 characters from some 600 specimens, he concluded (p. 61) that due to the extreme nature of intracolonial variability, reliable estimates of population parameters of a single species cannot be achieved through study of a single zoarium. Substantial

TABLE 2—Matrices of t-values calculated for all possible species-
locality comparisons for two characters, zooecial
diameter and interzooecial distance. Original data are
after Perry and Horowitz (1963). Abbreviations used are:

Fe = _Fistulipora_ _excelens_

Fp = _F_. _perdensa_

Fc = _F_. _confinis_

GD = Glen Dean Limestone

GLC = Golconda Limestone

TABLE 2

t-Test
Zooecial Diameter

	Fe/GD	Fp/GD	Fc/GD	Fe/GLC	Fp/GLC	Fc/GLC
Fe/GD	0					
Fp/GD	0.0 ns	0				
Fc/GD	13.185 ***	12.599 ***	0			
Fe/GLC	2.666 **	2.738 **	15.578 ***	0		
Fp/GLC	7.250 ***	7.135 ***	18.868 ***	4.906 ***	0	
Fc/GLC	5.263 ***	5.369 ***	7.692 ***	8.317 ***	12.078 ***	0

t-Test
Interzooecial Distance

	Fe/GD	Fp/GD	Fc/GD	Fe/GLC	Fp/GLC	Fc/GLC
Fe/GD	0					
Fp/GD	6.346 ***	0				
Fc/GD	13.749 ***	6.741 ***	0			
Fe/GLC	1.928 ns	7.641 ***	14.241 ***	0		
Fp/GLC	6.350 ***	0.000 ns	6.763 ***	7.677 ***	0	
Fc/GLC	10.826 ***	4.458 ***	2.319 *	11.888 ***	4.505 ***	0

*** = .001
* = .05
ns = not significant at α = .05

risks are involved in making statements about a population based upon a single colony, and even when characters known to exhibit low coefficients of variation are relied upon, the results are of questionable taxonomic value.

The maximum F-ratio has been used by several authors (Bork and Perry, 1967; Anstey and Perry, 1969; Horowitz, 1968) to test for the homogeneity of two sample variances. The F distribution was also utilized by Horowitz (1968) who made a significant advance in the application of statistical techniques to bryozoan studies by using a hierarchial analysis of variance (anova) model which enabled him to test the equality of several colony means simultaneously. Such anova models are very powerful statistical tools but, as discussed subsequently, they have distinct limitations if their underlying assumptions are not met.

Nonparametric, distribution free tests have recently been employed in the study of Bryozoa (Bork and Perry, 1968). These tests have the advantage of not requiring the assumptions inherent in parametric tests, but if the assumptions are met, they are less powerful than their parametric equivalents.

Multivariate statistical methods have not previously been applied to studies of Paleozoic Bryozoa, although Cheetham (1968) has utilized them in his investigation of the Tertiary cheilostome Metrarabdotos. To judge from his work and the present study, it seems probable that such methods will be more widely used now that the computational burden is greatly reduced by the ready availability of high speed computers.

MATERIALS AND METHODS

Choice of Species and Geological Horizon

Fistulipora decora, originally described as Cyclotrypa decora by

Moore and Dudley (1944) was chosen for this study for two reasons.

Individual zooecia rapidly attain a stable adult form and the

possibility of inadvertently including measurements of ontogenetically

immature individuals is greatly reduced. In addition, the relative

abundance of F. decora as noted by Perkins, Perry, and Hattin (1962,

p. 10), provided for a reasonable number of colonies from each locality.

Typically, the zoarial form of F. decora is described (Perkins,

Perry, and Hattin, 1962, p. 9) as "...hemispherical, having upper

surface mildly to moderately convex, and displaying concave, less

commonly planar, concentrically wrinkled base; rarely zoarium attached

to brachiopod valves...Monticules nearly flush with surface or

moderately elevated..displaying lunaria directed toward monticular

center." This rather characteristic external morphology (See Plate 1)

simplified identification of the species in the field and, combined

with its relative abundance, made collecting less difficult.

The stratigraphy of the Beil Limestone Member of the Lecompton

Limestone (Virgilian) is known through the work of Brown (1958). A

faunal listing and detailed description and paleoecological interpreta-

tion of the Beil member for selected localities was provided by

Perkins, Perry, and Hattin (1962, p. 2-8). Faunal elements of a

typical Beil assemblage and paleoenvironmental implications were

discussed by Moore (1966, p. 315-318; Suppl. Fig. 1-7, p. 373-379).

Statistical Models

NESTED ANOVA: One of the principal objectives of this study is
to ascertain how the variation observed in Fistulipora decora is
distributed and to attempt to identify the biological and geological
causes of this variation. In statistical terminology, we wish to
partition the variance: to determine how much of the total variation
is associated with intracolony variation for a given character, how
much is attributable to intercolony differences at a single locality,
and finally, the amount of variation that may be ascribed to differences
between localities.

The nature of the questions posed immediately suggests that
analysis of variance is an appropriate technique. Specifically, a
mixed model, two-level nested anova is potentially capable of
providing the maximum amount of desired information, given that a
suitably structured sampling plan is utilized.

According to this model, each variate can be decomposed into the
following sources of variation (Sokal and Rohlf, 1969, p. 256):

$$Y_{ijk} = \mu + \alpha_i + B_{ij} + \varepsilon_{ijk}$$

where Y_{ijk} is the kth observation of the jth subgroup of the ith group,
μ is the parametric mean of the entire population of interest, α_i
is the variation among groups induced by a fixed treatment effect
(the between localities effect in our model), B_{ij} is the random
contribution to the variation among subgroups within groups (the
within localities effect in our model), and ε_{ijk} is the "error"
arising from random variation among items within subgroups (the
within colony variation of the present case).

According to this model, the deviation of a single variate from the parametric mean of the population, μ, can be accounted for by three additive sources of variation. Basically, these components of variation form a heirarchy in which α_i represents the highest level. In a mixed model (Sokal and Rohlf, 1969, p. 254) this highest level is Model I in which variation between groups arises from fixed treatment effects. Each subordinate level of classification partitions components of variation that arise from random effects among subgroups within groups (B_{ij}) or among items within subgroups (ε_{ijk}, the "error" variance). Subordinate levels, because they are influenced by strictly random effects, are always Model II in a nested anova.

The relationship of the statistical model to the biological situation is apparent. It is assumed that all phenotypic variability must fall within the limits of expression of the population genotype. For a given phenetic character, displacements from the parametric mean (μ) of the population can be accounted for by basically three sources whose additive effects result in the observed value of an individual variate. At the highest level, α_i is a measure of the displacement of the mean for a particular locality from the grand mean of the population, μ. It contributes to variation at the highest level in the model, and corresponds to the variance component between localities. Several geological and biological factors may contribute to this potential source of variation. If the sampled localities are widely separated, it is possible that during life, the biological populations at these localities were isolated, to greater or lesser degree, from one another. If that were the case, random genetic mutations and recombinations could occur at one locality independently of events at

another. In this manner, differences in the average genetic

composition of biological populations at different localities could

arise. Differences in the average genetic composition could also be

produced by having collected samples that are not of the same

geological age. If the samples are not contemporaneous, then evolution-

ary changes in genetic composition through time could produce

differences in the mean genetic composition of the sampled biological

populations from different localities. The samples used in this study

are of approximately the same age but a priori, one cannot eliminate

the possible contribution of this source to variation at the highest

level in the nested anova model. Moreover, the localities might differ

in what has been termed their "gross" environment. At one locality

the animals may have lived in relatively shallow water, subjected to

higher mean temperatures and greater temperature fluctuations. At a

second locality, deeper water conditions may have existed, giving rise

to lower mean temperatures and greater thermal stability. These

effects, acting both independently or as an interaction, may contribute

to variation between locality means for any given character.

At the next level in a nested anova model, displacements from

the average at any particular locality occur due to the effects of

smaller genetic variations between colonies at the same locality (B_{ij}).

These genetic variations are those typically found within any

population. Indeed it is unlikely that any two colonies will be

genetically identical. It is noteworthy that the B_{ij} component of

variation is not entirely genetically based, being a composite of

variation arising from genetic dissimilarities, plus variations

induced by differences in genotype-environment interaction. It is

unfortunate that the restrictions imposed by fossil material will not permit the isolation of this interaction term. It is obvious that one cannot study genetic-environmental interactions when dealing with fossil populations, as it is impossible to isolate or recognize genetically pure strains.

At the lowest level in the hierarchic anova model, the variance component symbolized by ε_{ijk} is a measure of the deviation for a particular character of a given individual zooecium from the mean value of the colony to which it belongs. This contributes to the "within colony" component of variation and is attributed to differences in the "microenvironment" in which an individual zooid lived.

SINGLE CLASSIFICATION ANOVA: In situations where a two-level nested anova model is not appropriate, due to sample design or failure of assumptions at the highest level, it may be possible to utilize the more simplified single-classification anova (Sokal and Rohlf, 1969, p. 198). For a Model II situation, the single classification anova model can be expressed by the equation:

$$Y_{ij} = \mu + A_i + \varepsilon_{ij},$$

where Y_{ij} is the jth observation of the ith group, μ is the parametric grand mean of the statistical population of interest, A_i is the <u>random</u> contribution to the variance arising from differences between groups (the within colony component, equivalent to B_{ij} of the previous model), and ε_{ij}, as before, is the random contribution due to the deviation of the jth individual from its expected value $(\mu + A_i)$.

For the biological situation, the structure of the single classification, Model II anova, permits the partitioning of a single variate into components of intercolony and intracolony variation.

However, in order to be able to equate intercolony variation to strictly genetic differences requires a sampling design in which the colonies can be assumed to have been influenced by the same "gross" environment. If this is not the case, then the A_i component will contain, in addition to genetic variation, variation induced by different "gross" environments. That is, they will contain elements of both α_i and B_{ij} of the previous nested model.

Assumptions of the Analysis of Variance

The analysis of variance requires that certain assumptions be met before strictly valid conclusions can be drawn. Briefly, the assumptions for anova are (Sokal and Rohlf, 1969, p. 367-380): (1) that the error variance, ϵ_{ijk}, be a normally distributed, independent variable, (2) that the variance components be homoscedastic (homogeneous), and (3) that the relationship between components be additive. In addition, an underlying assumption of all anovas is that all groups representing subordinate levels of classification be chosen randomly.

With the exception of randomness, all of the above assumptions can be tested, and the significance of departures from the ideal evaluated. Unfortunately, randomness of sample selection is not directly testable and, therefore, must be built into the sampling design in order to avoid the introduction of bias. Lack of randomness may often be reflected in lack of independence of samples or in the heterogeneity of variances (Sokal and Rohlf, 1969, p. 368). The independence of items can be evaluated through the use of a simple runs test (Sokal and Rohlf, 1969, p. 624-629).

Fortunately, as pointed out by Sokal and Rohlf (1969, p. 377), the consequences of non-normality on the F-test in anova are serious only for highly skewed distributions. The nature and degree of departures from normality can be evaluated in several ways. Commonly used methods include the calculation of g_1 and g_2, the Kolmogorov-Smirnov test for goodness of fit, and various graphical techniques.

The effect of moderate departures from homoscedasticity of variances is not too serious for the overall F-test of significance where large degrees of freedom are involved (Sokal and Rohlf, 1969, p. 376). However, at small degrees of freedom, the consequences can be quite serious. Therefore, it should be emphasized that when anova techniques are utilized, departures from homoscedasticity must be evaluated and reported. The most commonly used method for testing this assumption for more than two samples is Bartlett's test of the homogeneity of variances. However, as pointed out by Sokal and Rohlf. (1969, p. 375), this test is particularly sensitive to departures from normality and should only be used for normally-distributed data. An approximate test commonly used in the comparison of two variances is the maximum F-ratio test.

For two-way or higher order anova without replication, the assumption of additivity of variance components must be tested. However, for the models utilized here, additivity is inherent in the structure of the models, and need not be of concern.

In cases where the assumptions of normality and homogeneity of variances are not met, it may be possible to transform the data to a new scale for which the assumptions do hold. If this approach fails, nonparametric tests may be utilized, as they are not dependent on the

form of the distribution. These techniques are concerned only with differences in location of ranked data, and consequently do not depend upon specific statistical parameters. A commonly used nonparametric analog of a single classification analysis of variance is the Kruskal-Wallis test (Sokal and Rohlf, 1969, p. 388). An alternative method, that may be employed when the variances are heterogeneous, is due to Snedecor (1956). It is an approximate test of the equality of means and is discussed in detail by Sokal and Rohlf (1969, p. 376).

Sampling Plan

In order to achieve complete rigor in the extension of statistical inferences derived from a sampled population to the target population, the latter must be completely available for sampling at random (Krumbein and Graybill, 1965, p. 150). For most geological situations, the target population is only rarely the available population and the achievement of a totally randomized sampling design is generally precluded. This introduces a "fixed" or nonrandom effect (Krumbein and Graybill, 1965, pp. 197-198) at the highest level in a hierarchic anova model which invalidates the extension of statistical inferences to the target population on a strict probability basis.

Random sampling of the target population Fistulipora decora was not possible in that the choice of localities was determined by the availability of suitable exposures. Therefore, in the strict sense, statistical conclusions are valid only for the available population defined as all well preserved specimens of Fistulipora decora exposed on selected bedding planes at selected localities. As all specimens

observed at these selected levels and localities were collected, it follows that the available population is identical to the collected population.

It is understood that the available population comprises only a very small part of the target population. However, since there is no a priori reason for believing that the available population of Fistulipora decora should differ significantly from the target population, it becomes possible to extend the conclusions derived from the available population to the target population by substantive geological argument (Krumbein and Graybill, 1965, p. 199).

Collecting

Collecting from the Beil Limestone Member was done from four widely separated localities in a manner consistent with the chosen statistical model, a two-level, mixed model anova. The locations of the exposures of Beil Limestone sampled are indicated on the index map in Figure 1. The four localities are referred to in subsequent discussions as Stull Road, Grover Station, Lake Dabinawa, and the Kansas Turnpike. The details for each locality are provided in Appendix 1. At each locality, specimens were collected in situ from a single bedding surface, in order to avoid the inadvertent collection of materials foreign to the chosen horizon. Specimens embedded in matrix and with zoarial growth surfaces oriented upward, were assumed to be in situ.

As much material as was feasible, within the bounds of reasonable expenditure of time and money, was collected from each locality. Much of the material collected at each locality was not usable due to poor

Figure 1--Map of northeastern Kansas showing the approximate

locations of the Beil Limestone exposures sampled.

o LD   Collection localities

   ⊕   Towns

In this and all subsequent tables and figures the

following abbreviations are used:

ST = Stull Road locality

GS = Grover Station locality

LD = Lake Dabinawa locality

KT = Kansas Turnpike locality

FIGURE 1

Map A (Kansas counties):
WASHINGTON, MARSHALL, NEMAHA, BROWN, DONIPHAN, ATCHISON, CLAY, RILEY, POTTAWATOMIE, JACKSON, JEFFERSON, LEAVEN-WORTH, DICKINSON, GEARY, WABAUNSEE, SHAWNEE, DOUGLAS, JOHNSON, WYAN-DOTTE, MORRIS, LYON, OSAGE, FRANKLIN, MIAMI, MARION, CHASE, COFFEY, ANDERSON, LINN

Map B:
JEFFERSON COUNTY
Oskaloosa
LD
Perry
GS
DOUGLAS COUNTY
ST
KT
Lawrence

0   10   20
Miles
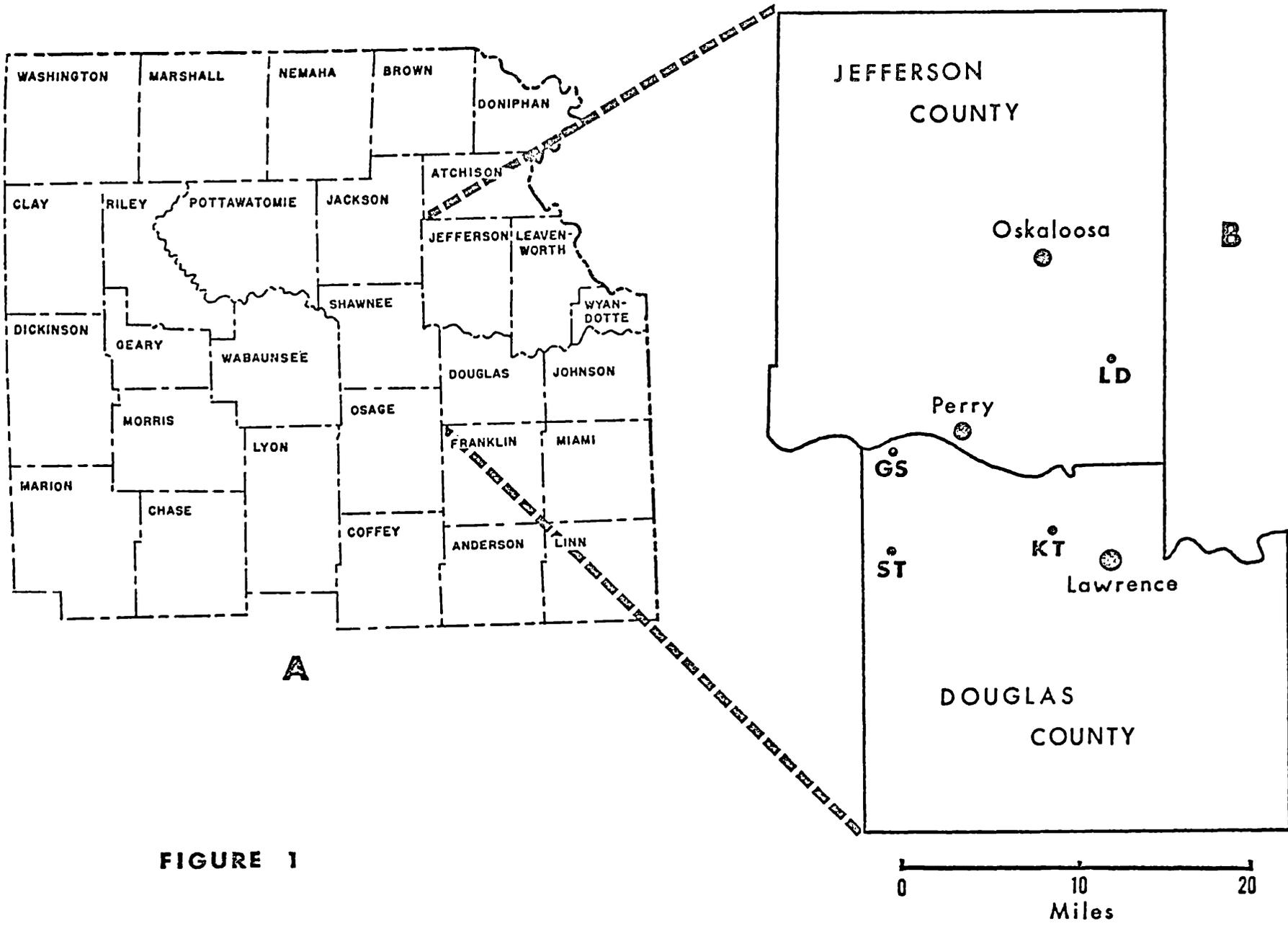
preservation, mainly a consequence of dolomitization or secondary recrystallization of calcite. Of the available specimens, five colonies were chosen randomly from each locality, using a random number table (Sokal and Rohlf, 1969, pp. 153-156). One of the four localities sampled (Kansas turnpike) failed to provide the desired number of usable specimens, and in this particular instance only four colonies were analyzed. Figure 2 shows the relative positions of the analyzed specimens as they were collected from a selected bedding plane at each locality.

Measurements

The acetate peel technique outlined by Boardman and Utgaard (1964) was used in this study to avoid the formidable task of preparing large numbers of thin sections. It was desirable to evaluate the significance of distortion introduced during the process of removing an acetate replica from a specimen. Measurements of an arbitrarily chosen colony dimension were made directly from a specimen and compared to measurements of the same dimension taken from an acetate peel. Statistical analysis of the data using a simple t-test (Table 3) revealed no significant differences between the two sample means at the α = .001 level of significance.

Measurements were made from the acetate peels by projecting character images at a known scale through a standard petrographic microscope onto a sheet of white tracing paper. Characters were measured directly from the projected image using a pair of Helios calipers (J and S Precision Scientific Measuring Instrument Company, Brooklyn, New York), graduated to 1/20 of a millimeter. Measurements

Figure 2-- Large scale maps of each collecting locality showing

relative positions of the randomly chosen colonies used

in the study. Scale for each map is indicated in meters.

LAKE DABINAWA

GROVER STATION

3 Meters

6 Meters

KANSAS TURNPIKE

STULL ROAD

6 Meters

15 Meters
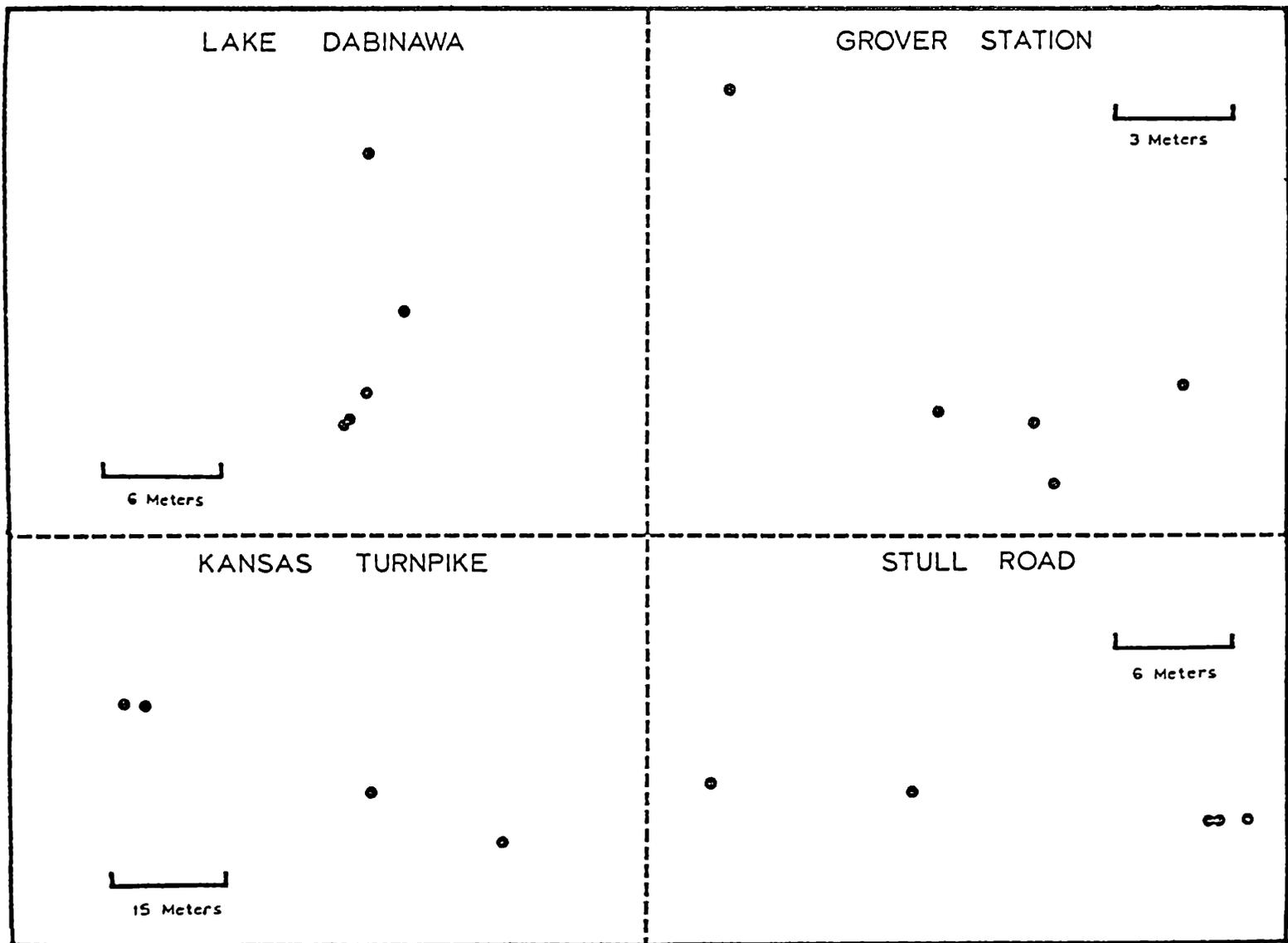
• location of colony

27

TABLE 3

t-test for significance of distortion of peel technique

A.1	Specimen		A.2	Peel
1	1.613 cm.		1	1.605 cm.
2	1.601		2	1.617
3	1.609		3	1.611
4	1.606		4	1.626
5	1.621		5	1.614
6	1.601		6	1.615
7	1.611		7	1.620
8	1.605		8	1.606
9	1.619		9	1.614
10	1.606		10	1.613
	16.092			16.141

$$\overline{Y}_1 = 1.6092 \text{ cm.} \qquad\qquad \overline{Y}_2 = 1.6141 \text{ cm.}$$

$$S_1^2 = .00004728 \qquad\qquad S_2^2 = .00003832$$

$$t_s = \frac{\overline{Y}_1 - \overline{Y}_2}{\sqrt{1/n(S_1^2 + S_2^2)}} \qquad = \quad 1.678 \ (ns)$$

$$t \ \alpha = .05[9] = 2.262$$

$$t \ \alpha = .001[9] = 4.781$$

were recorded to the nearest .001 mm although estimates of precision

of the measurements reveal reproducibility to the nearest .01 mm.

Twenty five measurements for each character for each colony were

taken along randomly chosen traverses utilizing a calibrated mechanical

stage and a random number table. Traverse coordinates were chosen from

a random number table, recorded, and each value set on the appropriate

scale of the calibrated stage. Next, traverses were carried out and

as many measurements as possible were made. If, after completing a

traverse, more measurements were needed, a new set of traverse coordin-

ates were chosen in an identical manner, and the process repeated until

the required number of measurements were obtained. Traverses were

consistently carried out in the same direction in order to avoid the

possible introduction of bias by making arbitrary choices during the

data gathering process.

Choice of Characters

Due to the relatively simple structural morphology of fistuliporoid

bryozoans, only a modest number of phenetic characters are available

for study. This investigation is based upon five characters,

illustrated diagrammatically in Figure 3.

In tangential sections, zooecial diameters (ZD) in millimeters

were determined as the minimum distance between zooecial walls.

Generally only a few zooecia in the central portion of each section

showed circular cross sections. It is obvious (Fig. 4) that for

elliptical cross sections (those most commonly available) the "true"

zooecial diameter must correspond to the minor axis of the ellipse, if

the zooecium is essentially cylindrical.

Figure 3

Diagramatic representation of a fistuliporoid bryozoan showing the
five characters utilized in the study. For tangential sections they
include: zooecial diameter (ZD), interzooecial distance for nearest
neighbor zooecia (IZD), and counts of the number of vesicles between
nearest neighbor zooecia (VCT). For longitudinal sections they include:
diaphragm counts per millimeter (DC/MM), and the number of complete
vesicles in circle of radius .25 mm (VC/.25).
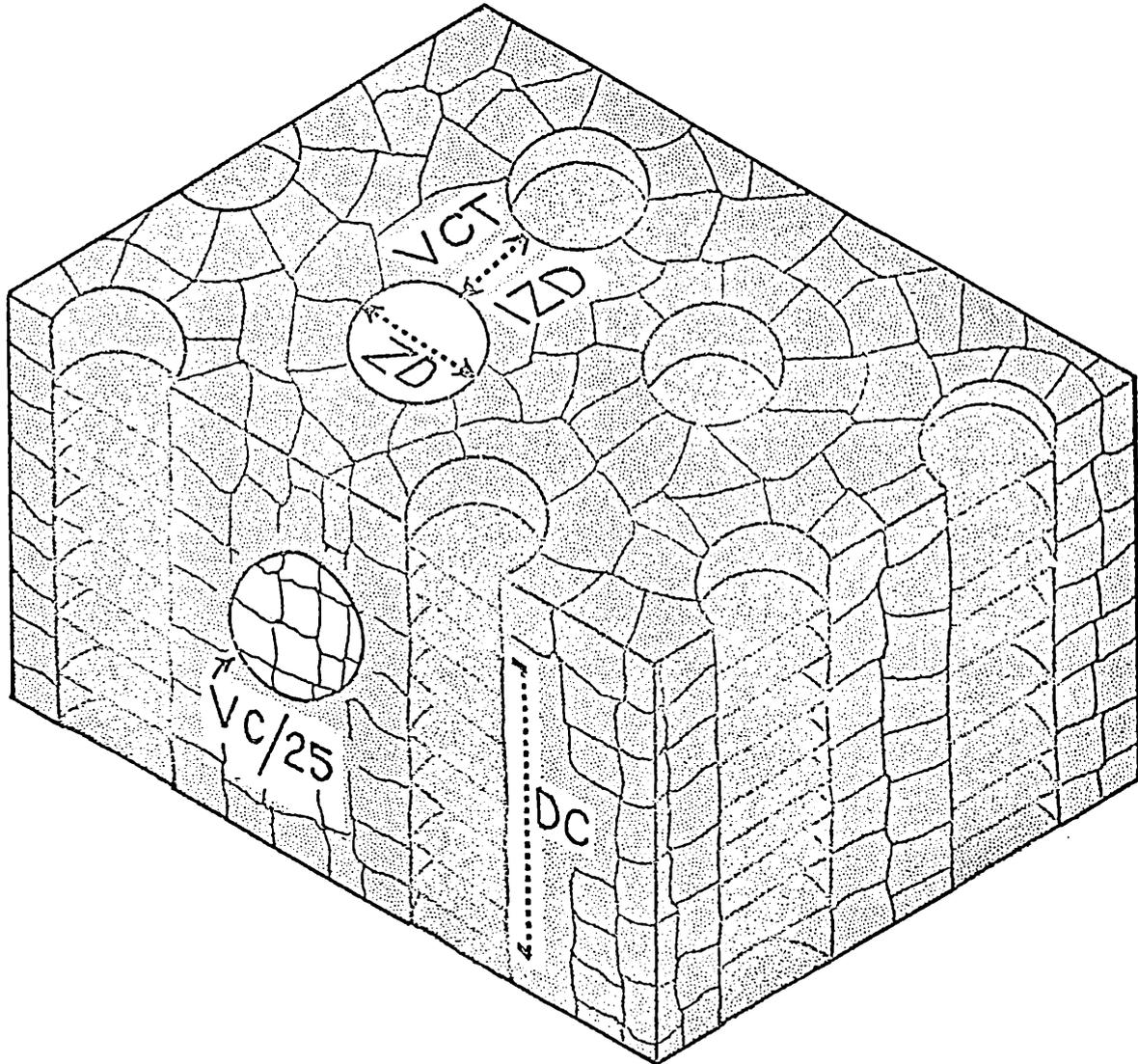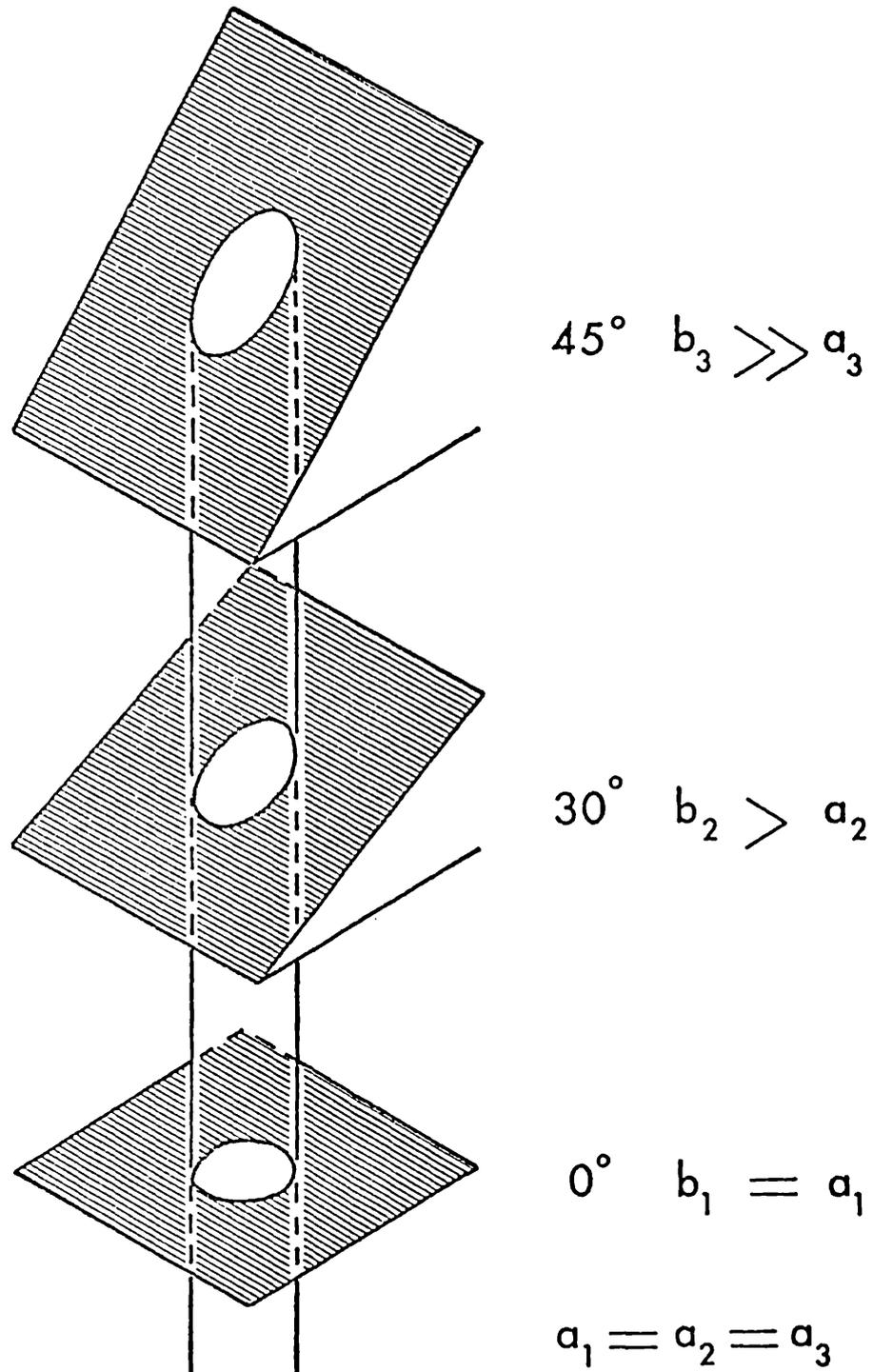
Figure 4

Diagram showing how the cross sectional form of a cylindrical zooecium is controlled by the obliquity between the plane and the zooecial axis. a_i is the minor axis of the ellipse, b_i is its major axis.

The interzooecial distance, IZD, is the distance between nearest neighbor zooecia in millimeters, as measured in tangential section. Related to this character is the number of vesicles (VCT) between nearest neighbor zooecia, also measured in tangential section.

In longitudinal section, two characters were measured:--the number of diaphragms (DC/MM) in a distance of one millimeter, and the number of complete vesicles enclosed in a circle of radius .25 millimeters (VC/.25).

RESULTS AND DISCUSSION

Twenty-five measurements were obtained for each of five characters from a total of nineteen colonies representing four localities. These data are presented in Appendix 2.

Tests of the Assumptions of Analysis of Variance

In order to apply analysis of variance techniques, it is necessary to first test the data for the assumptions of anova. Seemingly, this has rarely been done in previous studies. However, as emphasized earlier, failure to test for these assumptions, or to recognize the limitations imposed when they are not met, can have serious effects on the final outcome of the analysis. Under such circumstances probability levels are unknown and evaluation of the validity of conclusions so based is not possible.

To carry out these tests, some basic descriptive statistics are needed for the data from each colony. These are presented in Appendix 3. The required computations for this, and all subsequent data processing, were carried out utilizing the Honeywell-GE 635 computer facilities at the University of Kansas. Two statistical computer program packages were employed in this study, the "Biometry" programs (Sokal and Rohlf, 1969) and the NT-SYS package (available from the University of Kansas Computation Center). The latter is primarily for multivariate statistics and was developed by Rohlf and his associates.

The Kolmogorov-Smirnov (Dmax test) for goodness of fit was used to test the data for normality. The results of this test are presented

in matrix form in Table 4. With few exceptions, the distribution of
the data for ZD, IZD, VC/.25, and DC/MM does not differ significantly
from a normal distribution at α = .01. Only one character, VCT, (the
number of vesicles between nearest neighbor zooecia) deviates
consistently from normality. Values for this character are all
significant at the α = .01 probability level. This is not surprising
due to the small number of classes involved (counts ranged from 0 to
2), and the relatively low frequencies in classes 0 and 2 for most
samples.

The second assumption inherent in analysis of variance, the
homogeneity of the within colony variances, was investigated using
Bartlett's test. This test was run at two levels. In order to
utilize a nested anova, it is necessary that the variances of all
colonies be homoscedastic. This required equality of variances does
not exist; Table 5 shows that the variances are markedly heteroscedastic
for the four characters studied (VCT was not tested as it had failed
the test for normality). Data were transformed to Log_{10} in an attempt
to solve the problem of inhomogeneity. However, Bartlett's test on
the transformed data still indicated significant heterogeneity.
Consequently, it is not possible to perform a nested anova in any
meaningful fashion with the raw data.

Although it is not justifiable to run an anova on the full data
set, it is possible that some subsets of the data are homoscedastic.
Only one form of subset is of either biological or geological interest,
the subsets of data from each locality. Bartlett's test was run at
this second level, the test being applied separately for each locality
and each of the four characters. In 9 of the 16 subsets of the raw

TABLE 4

Kolomogorov-Smirnov Dmax-Test of Normality

Values of Dmax

ZD

		Locality			
		ST	GS	LD	KT
	1	.095 ns	.154 ns	.068 ns	.112 ns
	2	.131 ns	.149 ns	.115 ns	.094 ns
Colony	3	.114 ns	.108 ns	.125 ns	.151 ns
	4	.088 ns	.106 ns	.121 ns	.096 ns
	5	.098 ns	.082 ns	.113 ns	--

IZD

		Locality			
		ST	GS	LD	KT
	1	.087 ns	.093 ns	.085 ns	.080 ns
	2	.119 ns	.118 ns	.119 ns	.149 ns
Colony	3	.091 ns	.179 ns	.168 ns	.166 ns
	4	.102 ns	.148 ns	.227 ns	.143 ns
	5	.085 ns	.126 ns	.089 ns	--

VCT

		Locality			
		ST	GS	LD	KT
	1	.960**	.539**	.415**	.506**
	2	.385**	.494**	.539**	.494**
Colony	3	.404**	.425**	.448**	.494**
	4	.356**	.459**	.348**	.460**
	5	.448**	.499**	.488**	--

VC/.25

		Locality			
		ST	GS	LD	KT
	1	.155 ns	.191 ns	.194 ns	.214 ns
	2	.146 ns	.183 ns	.160 ns	.155 ns
Colony	3	.148 ns	.179 ns	.165 ns	.204 ns
	4	.166 ns	.190 ns	.229 ns	.200 ns
	5	.144 ns	.148 ns	.191 ns	--

DC/MM

		Locality			
		ST	GS	LD	KT
	1	.221 ns	.200 ns	.248 ns	.178 ns
	2	.221 ns	.201 ns	.230 ns	.155 ns
Colony	3	.392**	.209 ns	.240 ns	.269 ns
	4	.288*	.156 ns	.154 ns	.220 ns
	5	.350*	.244 ns	.248 ns	--

TABLE 4 (Continued)

In this and all subsequent tables and figures the following

abbreviations are used:

Characters

ZD = zooecial diameter

IZD = interzooecial distance for nearest neighbor zooecia

VCT = number of vesicles between nearest neighbor zooecia

VC/.25 = number of complete vesicles contained in circle
of radius .25 mm.

DC/MM = number of diaphragms in distance of one millimeter

TABLE 5

Values for Bartlett's Test for the Homogeneity of Variances,
Between Localities

ZD: ***

IZD: ***

DC/MM: ***

VC/.25: ***

***, α = .005

TABLE 6

Matrix of Values Calculated For
Bartlett's Test for Homogeneity of Variances
Within Localities

	Stull	Grover Station	Lake Dabinawa	Turnpike
ZD-Zooecial Diameter	ns.	***	***	***
IZD-Inter-Zooecial Distance	***	ns.	ns.	ns.
DC/MM-Diaphragm Counts/mm.	***	***	ns.	ns.
VC/.25-Vesicle Counts/.25	ns.	ns.	***	ns.

***, α = .005

data the variances were homoscedastic (Table 6). Transformation of

the within-locality data to Log_{10} provided two additional subsets

which met the assumption of homoscedasticity. In these nine cases,

it is justifiable to perform a parametric single classification anova.

Homogeneity of the Sampled Population

DICE DIAGRAMS: Dice diagrams were plotted for the four characters

(Figures 5, 6, 7 and 8) which were normally distributed. These

diagrams show in graphic form the basic statistics for each colony

given in Appendix 3. They depict the relative locations of colony

means and their 95% confidence limits. In addition, they show the

broader 95% confidence limits for data of each colony and the extent

to which colonies overlap in any character. They also provide a

visual estimate of the population variance; it is proportional to the

square of half the length of the line representing the 95% confidence

limits for the population. (This line is of length $t_{(n-1).95}s$

either side of the mean; as n = 25 in all cases, this reduces to ±2.064

s). For data not distributed normally, the mean as a measure of

central tendency is no longer informative. Similarly, confidence

limits are not an appropriate measure of dispersion because they are

based on the t distribution. In such circumstances, central tendency

is best expressed by the median or mode. Nonnormal, meristic data

are best represented graphically as a bar diagram. The data for VCT

are presented in this manner in Figure 9. It is worth noting that

the modal class for VCT is invariably 1 for all colonies. This is

also reflected in consistently positive g_2 values, indicative of

Homogeneity of the Sampled Population

DICE DIAGRAMS: Dice diagrams were plotted for the four characters (Figures 5, 6, 7 and 8) which were normally distributed. These diagrams show in graphic form the basic statistics for each colony given in Appendix 3.
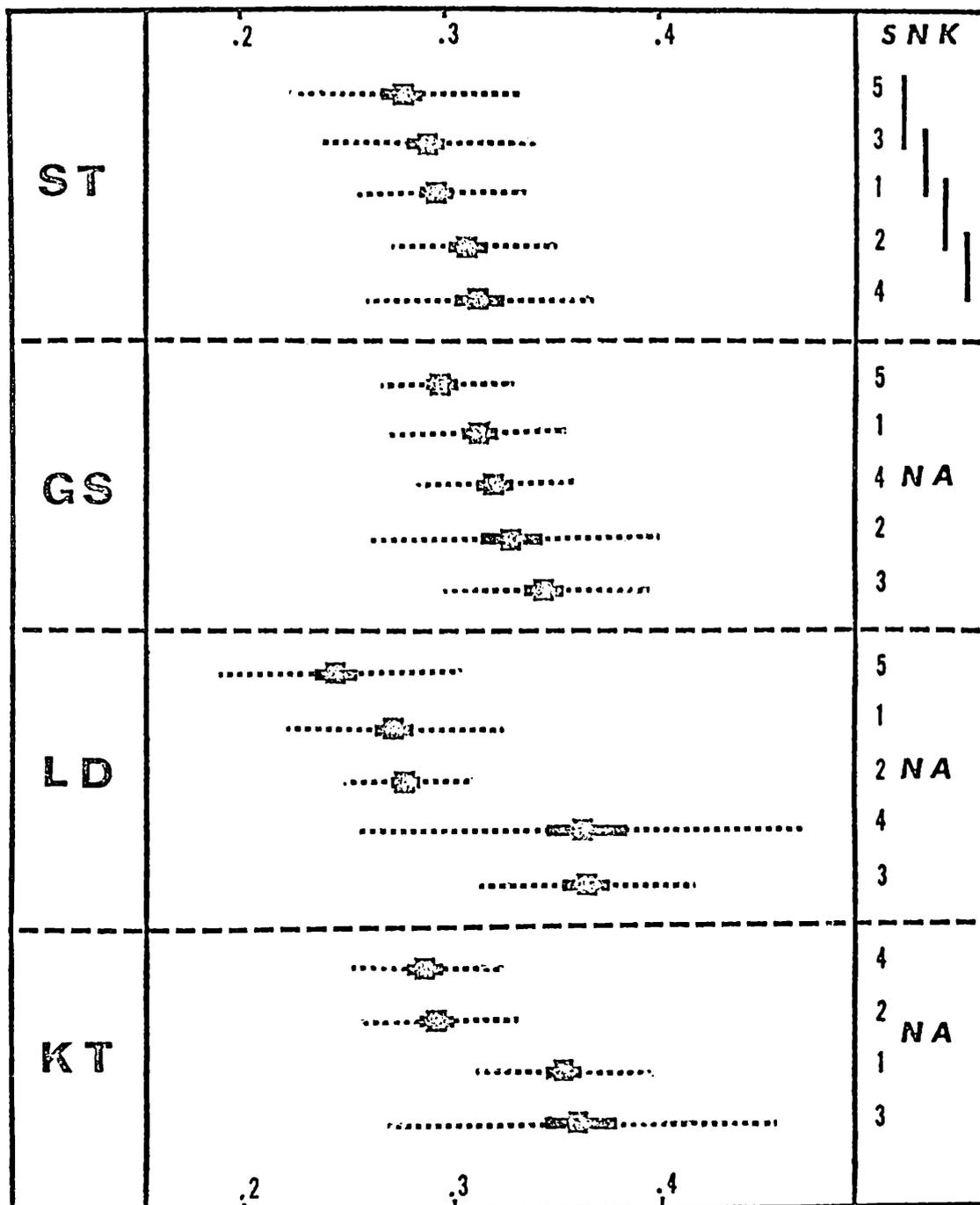
Figure 5

Dice diagrams for zooecial diameter for each colony, dimensions in mm.
Black square is location of mean, black bar is 95% confidence limit of
mean, broken bar 95% confidence limit of character for colony.
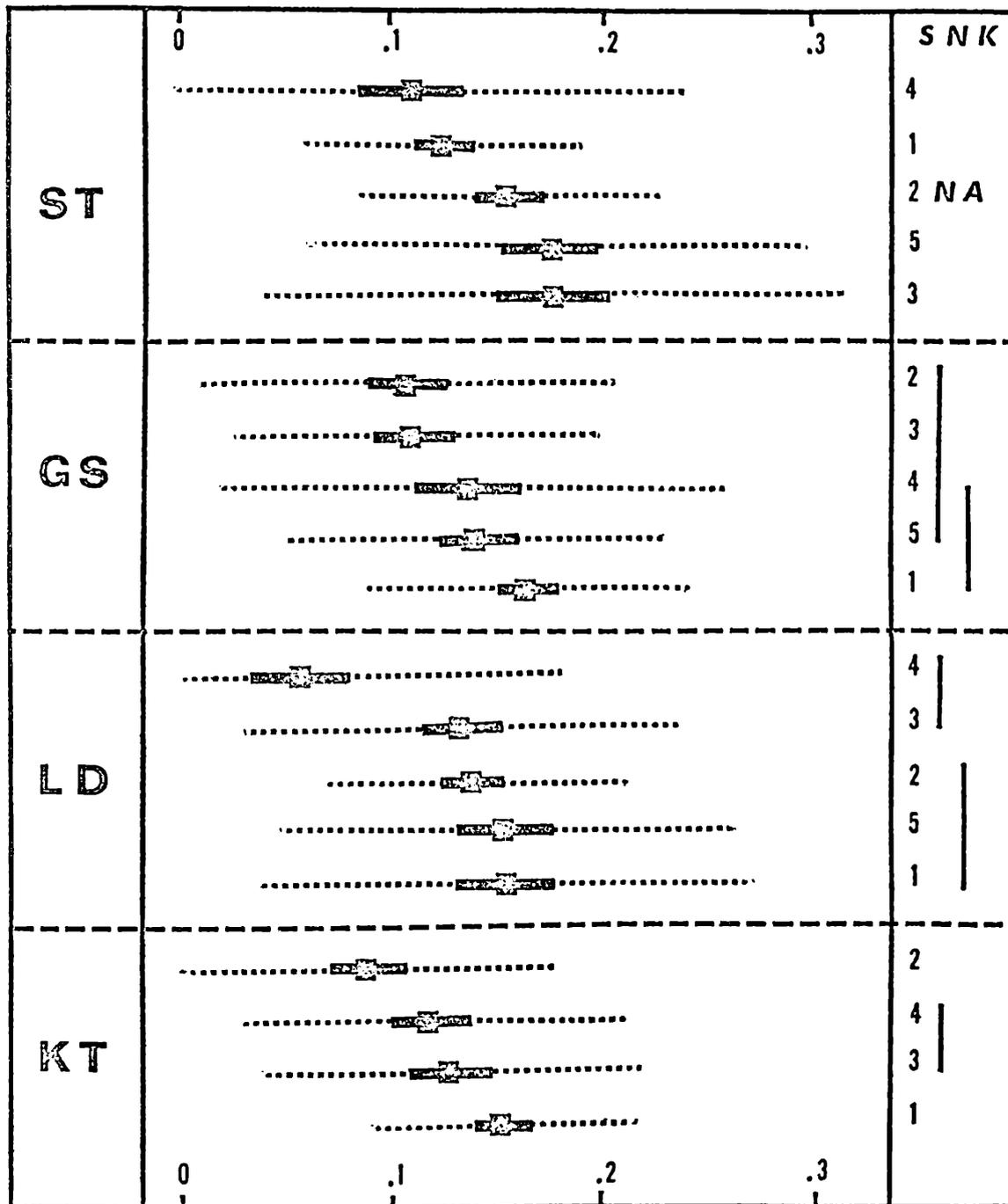
Figure 6

Dice diagrams for interzooecial distance for each colony. Dimensions in mm. Black square is location of mean, black bar is 95% confidence limit of mean, broken bar 95% confidence limit of character for colony.
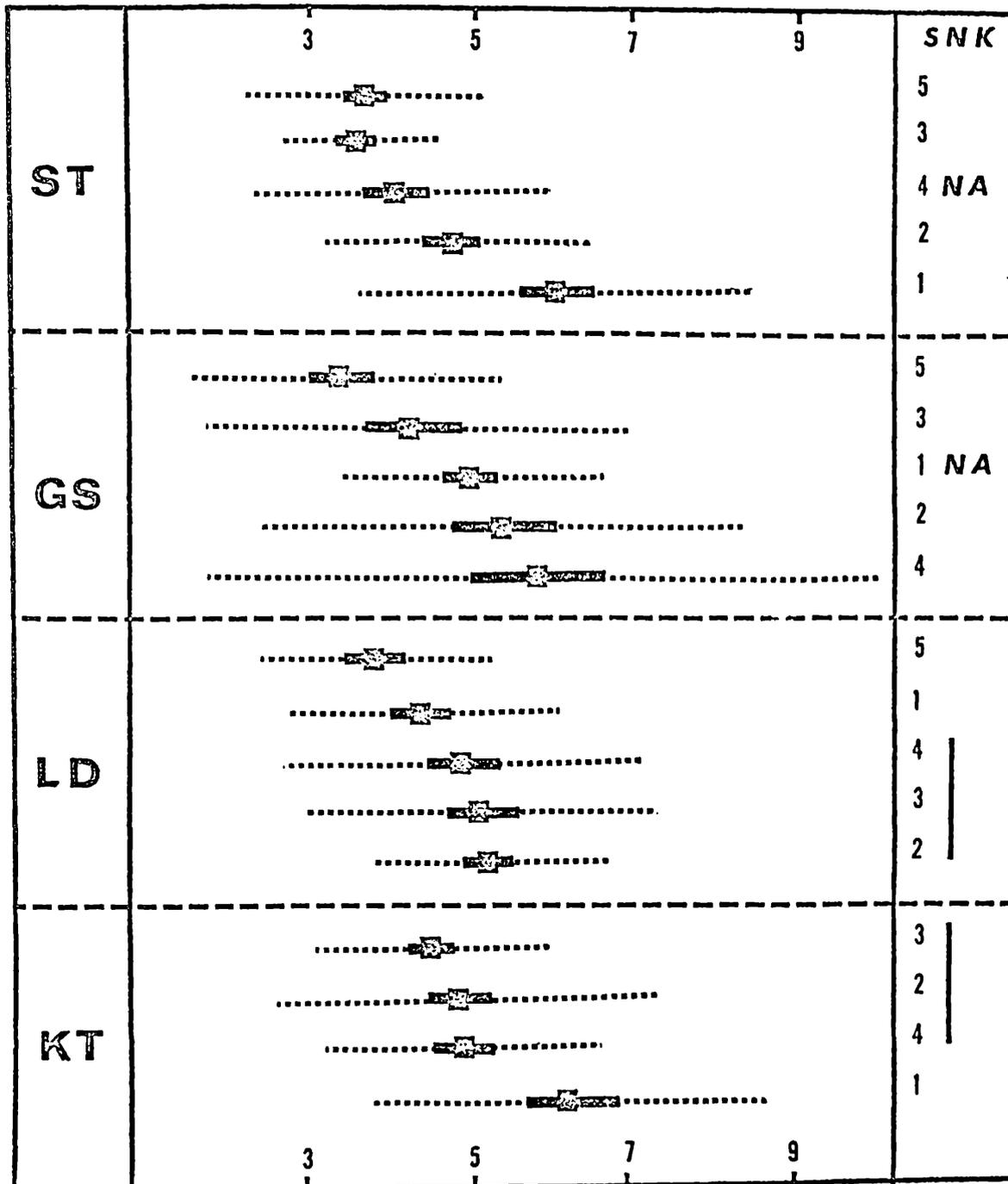
Figure 7

Dice diagrams for the number of diaphragms in a one millimeter distance.
Black square is location of mean, black bar is 95% confidence limit of
mean, broken bar 95% confidence limit of character for colony.
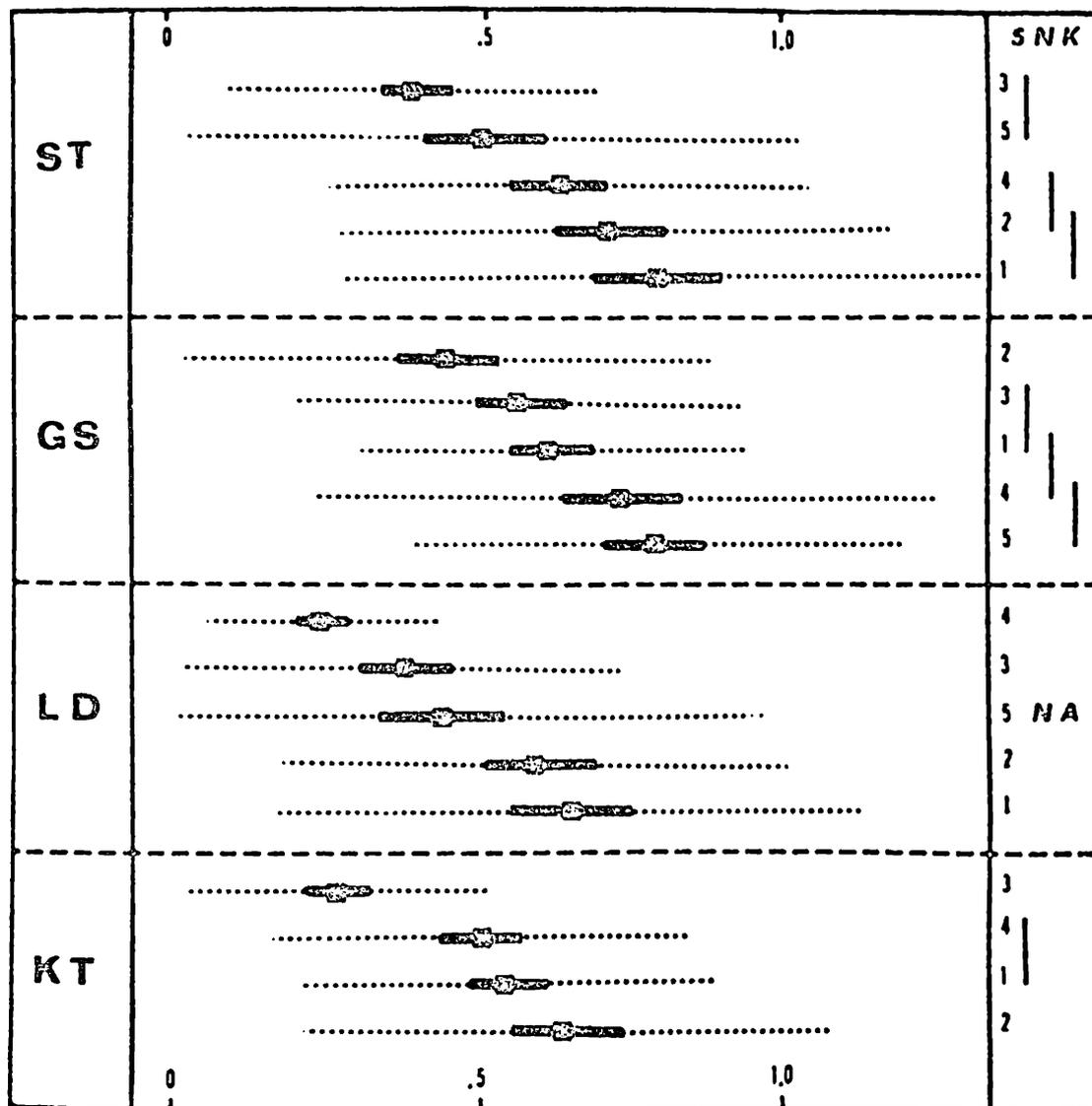
Figure 8

Dice diagrams for the number of complete vesicles in a circle of radius
.25 mm., as measured in longitudinal section. Black square is location
of mean, black bar is 95% confidence limit of mean, broken bar 95%
confidence limit of character for colony.
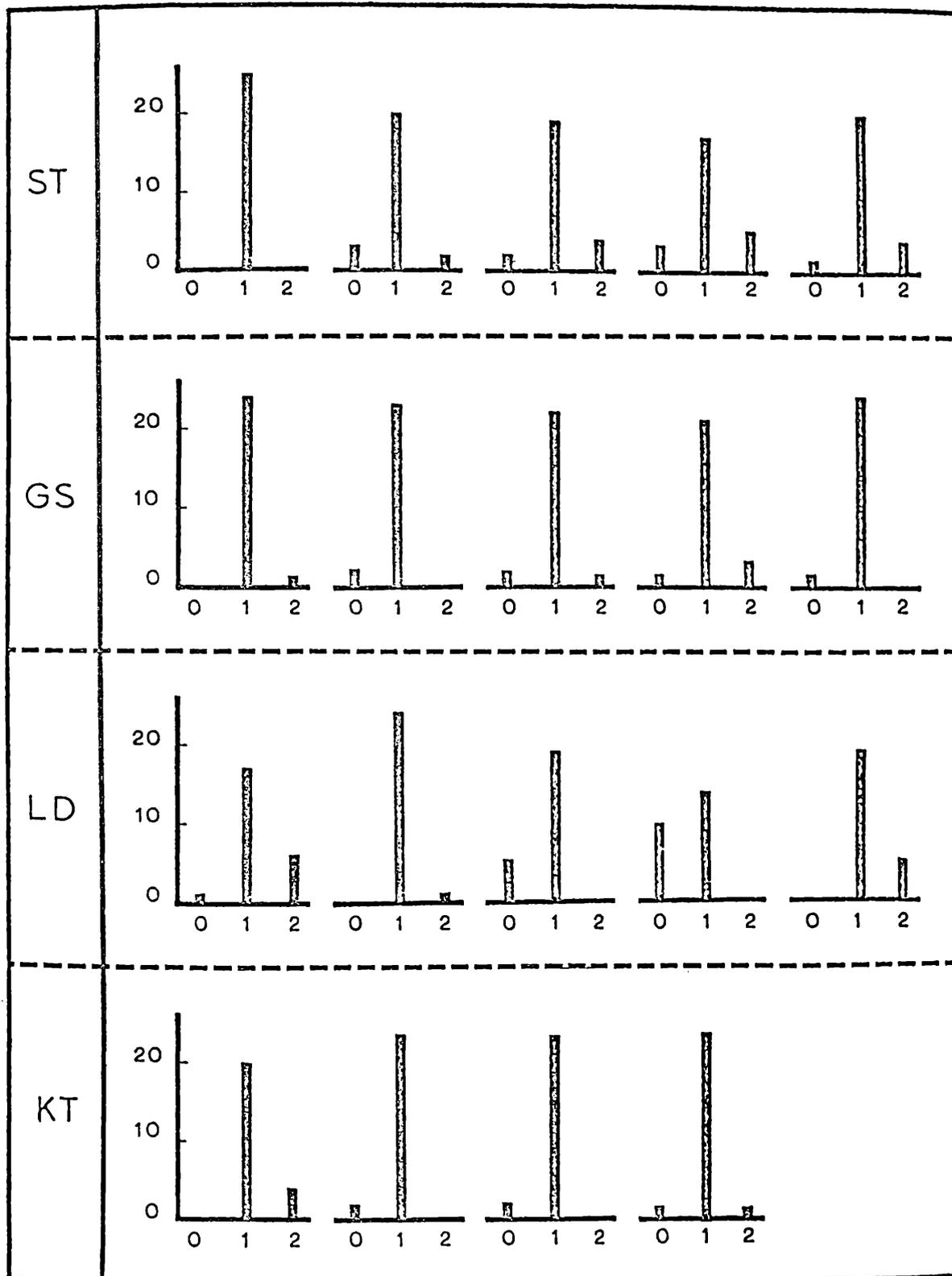
Figure 9

Bar diagrams of frequency distribution of the number of vesicles
between nearest neighbor zooecia (VCT).

leptokurtic distributions (See Appendix 3). It is also apparent
(Fig. 9) that there exists no consistent pattern of skewness for
the VCT data; this is reflected in positive and negative values of
g_1, in almost equal proportions (Appendix 3).

For all colonies and characters, the Dice diagrams reveal an
obvious overlap of 95% confidence intervals for the populations.
However, colony variances, as reflected in the width of the confidence
intervals are often quite variable, even within a single locality.
When examined in detail, two colonies in particular (the fourth from
Lake Dabinawa, and the third from the Kansas Turnpike) appear to
deviate consistently from the group norm, not only in the location of
their means, but to a lesser extent, in the magnitude of their variances
for at least two characters (ZD and VC/.25). This suggests the
possibility that these two colonies in particular may belong to a
different population.

PRINCIPAL COMPONENTS ANALYSIS: The above tentative hypothesis is
based primarily on two characters; in order to obtain a better
impression of the phenetic relationships among all the colonies one
needs information based on a simultaneous consideration of all the
characters that have been employed. Several techniques are available
for this purpose. One of the most elegant, first used by Rohlf (1968)
in taxonomic work, involves computing R mode principal components
(Seal, 1964) and projecting the OTUs (Operational Taxonomic Units,
colonies in this case) into the new character space defined by the
first three principal components. This technique has been used in
paleontological work by Kaesler (1970) and Rowell (1970), both of
whom provide more detailed accounts of the method. The resulting

projections provide the best three dimensional representation of the

n dimensional phenetic relationships. Reducing the dimensionality of

the data inevitably introduces some distortion; this is often modest

and its extent is always known. Moreover the distortion is not uniformly

distributed; the small phenetic distances are more heavily distorted,

but the larger ones, giving the overall view of phenetic relationships,

suffer least.

Two principal components analyses were run. In the first, both

the five characters and the variances of the four normally distributed

ones (ZD, IZD, VC/.25 and DC/MM) were all treated as characters (Fig.

10). In the second (Fig. 11), only the five measured characters were

utilized. The amount of distortion in the models is given in Table 7.

As may be seen, it is relatively small. Although the two models do

not give identical results [indeed it was not expected that they would,

for the variances (the 4 extra characters in Figure 10) were not

heavily correlated with their associated means] their gross form is

similar. The correlation coefficient between the distances between

all pairs of colonies in the 9 and 5 space was 0.874, while the same

coefficient between distances in the first three components space of

both models was 0.861.

When Figures 10 and 11 are inspected, the two colonies which

initially seemed anomalous, the third colony for the turnpike locality

(0403 in Figures 10 and 11) and the fourth colony from Lake Dabinawa

(0304), no longer appear so. Neither lies close to the centroid of

the colonies in the projections, but subjectively, there appears no

good reason to claim that they are not part of the population. It is

apparent from the figures, that intuitive confidence in this statement

Figure 10 -- Projection of colony mean values into first 3 principal

component space based on 9 characters. First two digits

of colony number refer to locality, the last two, the

number of the colony at the locality. 01 = Stull,

02 = Grover Station, 03 = Lake Dabinawa, 04 = Kansas

Turnpike.
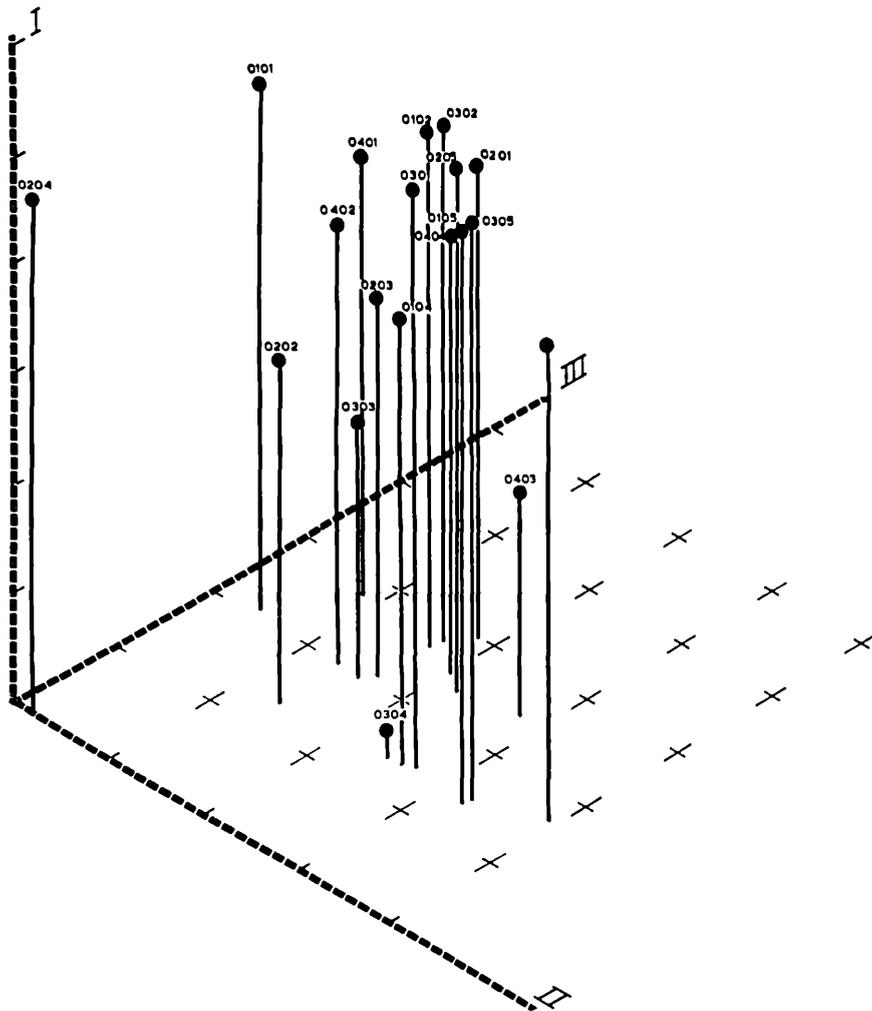
Figure 11 -- Projection of colony mean values into first 3 principal

component space based on 5 characters. First two

digits of colony number refer to locality, the last

two, the number of the colony at the locality. 01 =

Stull, 02 = Grover Station, 03 = Lake Dabinawa, 04 =

Kansas Turnpike.
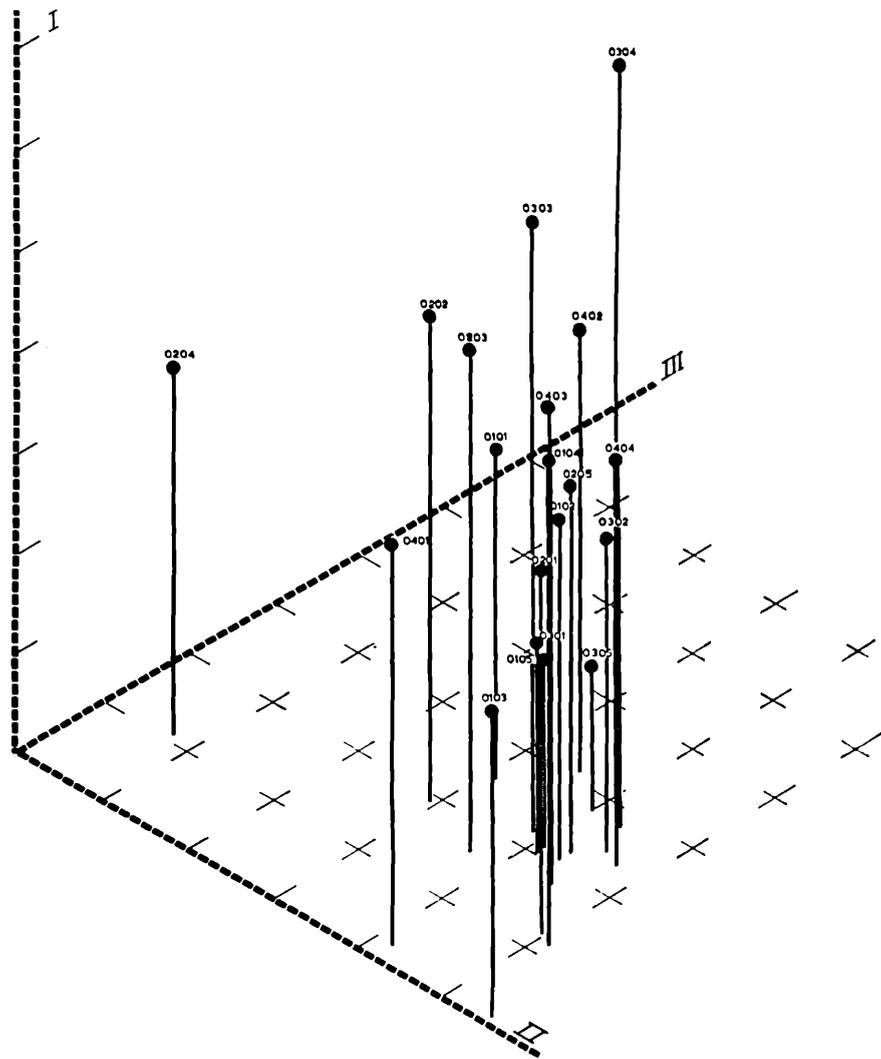
TABLE 7

Number of characters	% Variance explained by first 3 principal components.	Correlation between distances of all possible pairs of OTUs in n space and 3 principal component space
9	78.86	0.973
5	93.91	0.993

would be enhanced by having data for more than nineteen colonies.
Such data would be expected to close the discontinuities between the
more peripheral colonies of the projections.

Between Locality Variance

At this point, we can summarize the present situation with regard
to the assumptions of anova. The assumption of normality is, with
few exceptions, met by the data for the characters ZD, IZD, DC/MM,
and VC/.25 (Table 4). However, in every character these data
failed to meet the assumption of homoscedasticity at the highest
level, for all the colonies in the study.

The use of a two-level nested anova model is, thus, precluded.
In a number of cases, the assumption of homoscedasticity was met at
the next lower level, within localities (Table 6). For these data
it is appropriate to partition the variance components within localities
by a single classification anova model.

Although it was not possible to partition the variance using a
two-level nested anova, the significance of variation between
localities was tested using the Kruskal-Wallis nonparametric anova
analog. The results are presented in Table 8. For purposes of
comparison only, a nested anova was carried out for the four normally
distributed characters and the results are presented in Table 9.
Comparison of these two tables reveals the serious limitations imposed
on the parametric analysis of variance test by deviations from
homoscedasticity. At the highest level in this nested anova (Table
9), between locality effects are seemingly nonsignificant in all
cases at the α = .05 probability level. However, for the

TABLE 8

Results for the Nonparametric Kruskal-Wallis Test,
Between Localities

Character	Kruskal-Wallis
ZD	***
IZD	***
VCT	ns
VC/.25	***
DC	***

(***, α = .005)

TABLE 9

Results of the F-test of Significance for Nested Anova

F-ratio for each character

Source of Variation	ZD	IZD	DC/MM	VC/.25
Among Localities	0.6276 ns	0.8588 ns	0.4312 ns	1.3164 ns
Within Localities	43.2857***	11.0138***	16.3007***	15.0016***

(***, α = .001)

nonparametric Kruskal-Wallis anova, which is even less powerful than the parametric equivalent in detecting significant differences, the between locality effects are highly significant at α = .005. This example should re-emphasize the importance of testing the assumptions of anova; failure to meet them may give rise to spurious F-values and subsequent gross misinterpretations.

It follows from the results of the Kruskal-Wallis analysis of variance (Table 8, that highly significant differences exist between localities. As discussed previously (p. 16), several sources of variation may contribute to this between locality effect, including genetic differences between local populations, differences in the "gross" environment of localities, and the interaction of the two. Unfortunately, it is not possible to make probabilistic statements concerning the relative importance of each of these factors.

Within-Locality Analysis of Variance

Analysis of variance within localities was accomplished using single classification anova (where appropriate) and the Kruskal-Wallis nonparametric anova analog. In addition, a modified version of the Snedecor approximate test for the equality of means when variances are heterogeneous (Sokal and Rohlf, 1969, p. 376) was employed to test for the significance of differences between colony means within localities. The results of these three tests are presented in Table 10. Examination and comparison of results for the three methods consistently reveals highly significant differences between colonies at each locality.

TABLE 10

Comparison of Results for Parametric and Nonparametric Tests
Between Colonies, Within Localities

Character	Locality	Anova	Kruskal-Wallis	Snedecor
ZD	Stull	***	***	***
	Grov. St.	na	***	***
	L. Dabin.	na	***	***
	K. Turnp.	na	***	***
IZD	Locality	Anova	Kruskal-Wallis	Snedecor
	Stull	na	***	***
	Grov. Sta.	***	***	***
	L. Dabin.	***	***	***
	K. Turnp.	***	***	***
DC/MM	Locality	Anova	Kruskal-Wallis	Snedecor
	Stull	na[***]	***	***
	Grov. Sta.	na	***	***
	L. Dabin.	***	***	***
	K. Turnp.	***	***	***
VC/.25	Locality	Anova	Kruskal-Wallis	Snedecor
	Stull	***	***	***
	Grov. St.	***	***	***
	L. Dabin.	na[***]	***	***
	K. Turnp.	***	***	***

***, α = .001
na - test not applicable
[***] - Brackets enclose results for $Log_{10}Y$ transformed data

As elaborated upon earlier, variations between colonies at a single locality are ultimately genetically based, arising in part from actual differences in colony genotype, but including an indeterminate component of variation due to genotype-environment interaction.

The Significance of Differences Between Colonies Within a Locality

In order to better understand the distribution of intercolony variation within localities it was useful to apply an a posteriori test of means to determine if most of the observed variation could be related consistently to deviations of a single colony or subset of colonies. In other words, are the tests showing differences between colony means within a locality significant because one or two colonies at each locality consistently differ from the remainder in all characters, or are the significant differences more uniformly distributed? The Student-Newman-Keuls (SNK) a posteriori multiple range test (Sokal and Rohlf, 1969, p. 239) was used to compare means within those localities which met the assumptions for analysis of variance.

The results for this test are presented diagrammatically in Figures 5-8. Colony means (numbered 1 through 5) are arrayed by magnitude for each locality and sets of means not significantly different are underlined. The SNK method is applied in "stepwise" manner (Sokal and Rohlf, 1969, p. 239), by testing differences among sets of means only if they are contained within a larger significant set. Thus, means contained within any nonsignificant range are themselves not significantly different from each other and need not be tested.

Detailed examination of the SNK results in Figures 5-8 reveals that the highly significant differences among means are not attributable to a single colony or subset of colonies in any regular manner. The observed differences are therefore attributed to a high genetic diversity within localities, as expressed phenotypically.

Partitioning of Variance at Localities

Variance components partitioned by single classification anova within localities have been expressed as a percent of the total within locality variance in Table 11. The results reveal that a substantial proportion of the total variance is contributed by intracolony variation, and with one exception (for $Log_{10}Y$ transformed data for the number of diaphragms per mm) the within colony component of variation exceeds the between colony variance. It is accepted that intracolony variation arises from differences in the microenvironment affecting the individuals of a colony. Therefore, it follows that microenvironmental factors generally contribute a greater proportion to the total within locality variance than genetically-based, intercolony variation.

Coefficient of Variation

USE: Although it is not possible to partition the within locality variance for those cases where the assumptions of analysis of variance are violated, it is possible to obtain information about the intrinsic variability of the data through comparison of coefficients of variation. Oliver (1968) offered an interesting approach to the

TABLE 11

Partitioning of Variance Components By Single Classification Anova

Values are expressed as a percentage of the
total within locality variance.

Zooecial Diameter (ZD)

	Stull	Grover Station	Lake Dabinawa	Kansas Turnpike
Between Colonies	24.96	na	na	na
Within Colonies	75.04	na	na	na

Inter-Zooecial Distance (IZD)

	Stull	Grover Station	Lake Dabinawa	Kansas Turnpike
Between	na	17.47	41.46	25.82
Within	na	82.53	58.53	74.18

Diaphragm Counts Per Millimeter (DC/MM)

	Stull	Grover Station	Lake Dabinawa	Kansas Turnpike
Between	[50.43]*	na	28.36	35.30
Within	[49.57]*	na	71.64	64.70

Vesicle-Counts Per Area (VC/.25)

	Stull	Grover Station	Lake Dabinawa	Kansas Turnpike
Between	31.82	29.54	[42.41]*	45.78
Within	68.18	70.46	[57.59]*	54.22

*Values given in brackets are for $Log_{10}Y$ transformed data.

na - anova not applicable due to failure of assumptions.

TABLE 12

Intra- and Intercolony Coefficients of Variation

All Characters and Localities

Locality	Character: ZD CV			Character: IZD CV		
	Intracolony	Intercolony	Oliver's Class	Intracolony	Intercolony	Oliver's Class
Stull	7.79	5.58	II	26.94	20.00	II
	7.31			23.78		
	9.98			38.02		
	9.55			55.22		
	10.90			33.03.		
Grover Station	7.29	6.31	II	22.90	17.77	II
	11.61			45.94		
	7.92			39.16		
	6.64			42.20		
	5.74			30.59		
Lake Dabinawa	10.93	20.48	I	37.18	38.15	
	6.29			25.38		
	7.93			59.37		
	15.98			105.94		
	13.91			34.70		
Kansas Turnpike	6.55	13.76	I	21.10	21.13	II
	6.85			47.59		
	13.98			34.88		
	7.21			37.87		

TABLE 12 (Continued)

Locality	Character: VC/.25 CV			Character: DC/MM CV		
	Intracolony	Intercolony	Oliver's Class	Intracolony	Intercolony	Oliver's Class
Stull	34.42	25.62	II	19.06	20.82	I
	31.23			13.63		
	37.50			12.31		
	30.55			20.74		
	50.16			19.24		
Grover Station	25.07	21.66	II	15.67	19.92	II
	47.37			26.32		
	31.08			29.03		
	34.54			34.13		
	25.20			26.64		
Lake Dabinawa	35.26	35.66		18.56	12.53	II
	33.96			13.81		
	45.53			20.69		
	35.15			22.15		
	58.18			17.92		
Kansas Turnpike	30.32	32.24		18.67	14.38	II
	33.07			22.66		
	44.42			15.80		
	32.10			16.33		

TABLE 12 (Continued)

Locality	Character:	VCT CV	
	Intracolony	Intercolony	Oliver's Class
Stull	0.00	6.27	II
	47.35		
	45.67		
	52.92		
	39.26		
Grover Station	19.23	6.63	II
	30.10		
	36.58		
	37.04		
	20.83		
Lake Dabinawa	41.67	26.16	II
	19.23		
	51.03		
	83.33		
	34.02		
Kansas Turnpike	32.26	11.31	II
	30.10		
	30.10		
	28.87		

study of the distribution of variation within and between colonies of several species of Devonian rugose corals by comparing intra- and intercolony coefficients of variation. He classified the observed variation into two types--Class I, in which intercolony variation exceeded intracolony, and Class II, in which the intercolony variation was exceeded by intracolony. Class I variation was attributed to a narrow range of phenotypic expression due either to strict genetic control or to uniform ecological influences. Class II variation was related to less restrictive genetic control over phenotypic expression or to fluctuations in the environment.

Inter- and intracolony coefficients of variation have been computed for all colonies within each locality. The results are presented in Table 12.

LIMITATIONS: Prior to making generalizations about the distribution of variation for the data, it was desirable to ascertain if the observed differences between intra- and intercolony coefficients of variation were indeed significant.

The standard error for the coefficient of variation of normally distributed data is given by the equation (Sokal & Rohlf, 1969, p. 137).

$$S_{cv} = \frac{CV}{\sqrt{2n}} \sqrt{1 + 2 \left(\frac{CV}{100}\right)^2}$$

From this equation, it is apparent that for a given sample size 'n', the standard error increases as the coefficient of variation increases; for small values of the latter

$$S_{cv} \approx \frac{CV}{\sqrt{2n}}.$$

Standard errors and 95% confidence limits were calculated for the coefficients of variation of one of the characters, zooecial diameter (ZD). Upon examination of the results (see Table 13), it is apparent that typically the 95% confidence limits of the intercolony coefficient of variation overlap with those of the intracolony for all colonies at each locality. Although the observed CV value is the best estimate for the population, we have no guarantee that is is the true value. Confidence intervals for a given Coefficient of Variation imply that there is a probability of .95 that the true value for the population lies within the computed range. For data with high coefficients of variation, confidence limits are broad, making the resolution of small differences impossible. Even for data exhibiting relatively low coefficients of variation (as in the case of ZD; see Tables 12 and 13), where confidence limits are shorter, there is typically overlap of the 95% limits of the inter- and intracolony coefficients of variation.

Oliver's approach, although initially attractive has some recognizable limitations. Unless the inter- and intracolony coefficients of variation are tested against each other and shown to be significantly different, it is not possible to say whether a given colony belongs to his type I or type II class. Unless such tests are made, it is premature to erect hypotheses concerning the amount of genetic control or the uniformity, or otherwise, of ecological influences at a particular locality. It is apparent from Table 13, that unless the differences between the intracolony coefficients of variation based on 25 observations and the intercolony coefficient calculated from 4 or 5 colonies are relatively large, they will not be shown to be significantly different from one another.

TABLE 13

Intra- and Intercolony Coefficients of Variation and 95% Confidence Limits for Zooecial Diameter

Locality	Intracolony	L_1	L_2	Intercolony	L_1	L_2
Stull	7.79	9.95	5.63	5.58	9.04	2.12
	7.31	9.37	5.25			
	9.98	12.75	7.21			
	9.55	12.20	6.90			
	10.90	13.92	7.88			
Grover Station	7.29	9.31	5.27	6.31	10.22	2.40
	11.61	14.83	8.39			
	7.92	10.12	5.73			
	6.64	8.48	4.80			
	5.74	7.33	4.15			
Lake Dabinawa	10.93	13.96	7.90	20.48	33.18	7.79
	6.29	8.03	4.55			
	7.93	10.13	5.73			
	15.98	20.41	11.55			
	13.91	17.77	10.05			
Kansas Turnpike	6.55	8.37	4.73	13.76	22.29	5.23
	6.85	8.75	4.95			
	13.98	17.86	10.12			
	7.21	9.21	5.21			

Results such as those shown in Table 12 must be handled with caution; they are the best estimates of inter- and intracolony coefficients of variation, but differences between the two may be more apparent than real.

Correlations Between Characters

In preceding discussions, characters have been treated as though they were independent variables. However, it can be argued on geometrical grounds that some characters (for example IZD and VCT) must be correlated to some degree. Particularly for studies limited to only a few characters, it is desirable to reduce the amount of redundancy (in the form of highly-correlated characters) to a minimum in order to obtain a maximum amount of meaningful information. With this in mind, a matrix of Pearson product-moment correlation coefficients (r) for all possible pairs of character means and variances was calculated (Table 14). It should be pointed out that the variance for VCT (number of vesicles between nearest neighbor zooecia) was not used in the matrix because of the pronounced deviation of the data from normality. In this circumstance, the variance is a poor measure of dispersion. For convenience of interpretation, a simplified version of the correlation matrix, showing only the significant r values (α = .05), is presented in Table 15.

Two characters stand out in displaying a high degree of independence from the other variables. Correlation coefficients for DC/MM (diaphragms/mm) and VC/.25 (vesicle counts per unit area) are not significantly correlated with any of the other four principal characters. This is useful information in that it emphasized the relatively high

TABLE 14

Matrix of Correlation Coefficients between Character Means and Variances

	ZD	VAR/ZD	IZD	VAR/IZD	VCT	VC/.25	VAR/VC/.25	DC/MM	VAR/DC/MM
ZD	1.00								
VAR/ZD	.51	1.00							
IZD	-.55	-.46	1.00						
VAR/IZD	-.12	.33	.02	1.00					
VCT	-.63	-.59	.81	.05	1.00				
VC/.25	-.42	-.77	.30	-.36	.42	1.00			
VAR/VC/.25	-.64	-.50	.36	-.00	.55	.59	1.00		
DC/MM	.40	-.07	-.27	-.47	-.13	.14	.01	1.00	
VAR/DC/MM	.33	-.06	-.29	.03	-.10	.25	.27	.55	1.0

TABLE 15

Simplified Matrix of Significant Correlation Coefficients between Character Means and Variances

	ZD	VAR/ZD	IZD	VAR/IZD	VCT	VC/.25	VAR/VC/.25	DC/MM	VAR/DC/MM
ZD	1.00								
VAR/ZD	.51	1.00							
IZD	-.55	-.46	1.00						
VAR/IZD	--	--	--	1.00					
VCT	-.63	-.59	.81	--	1.00				
VC/.25	--	-.77	--	--	--	1.00			
VAR/VC/.25	-.64	-.50	--	--	.55	.59	1.00		
DC/MM	--	--	--	-.47	--	--	--	1.00	
VAR/DC/MM	--	--	--	--	--	--	--	.55	1.0

information content of these two characters, independent of the others. Both of these characters are count data, rather easily obtained, and for this study, normally distributed.

For the significant correlations (Table 15), it is interesting to draw attention to the negative correlations of ZD (zooecial diameter) with IZD (interzooecial distance) and VCT (vesicles between nearest neighbors). Biologically, these correlations are not entirely unexpected. As zooecial diameter increases, crowding occurs with a decrease in the interzooecial distance, also reflected by a decrease in number of vesicles between zooecia. The high positive correlation between IZD and VCT ($r = .811$) seemingly reflects some uniformity in the size of vesicles, although this is not apparent through cursory observation. The relatively high negative correlation (-.77) of VC/.25 and the variance of ZD is also notable. This can seemingly be interpreted as a decrease in the average vesicle size as the variance of zooecial diameters increases. Perhaps related to this is the positive correlation between VCT and the variance of VC/.25, interpreted as an increase in the number of vesicles between zooecia with an increased variation in the size of the vesicles. A clear cut biological explanation for these correlations is not apparent, but they may possibly reflect the influence of monticular areas on those characters.

Although most characters are correlated to some extent with one another, the fact that no r value is 1.0 indicates that varying degrees of independence exist; thus, varying amounts of information are obtainable from all characters. However, in evaluating the usefulness of a particular character it is important to consider not

only the degree of independence, but also the nature of the data obtained. The data obtained for VCT, as discussed earlier, could not be handled well statistically due to the lack of normality of the data and the limited number of size classes. This, coupled with the fact that it has a moderately high correlation with ZD (-.633) and IZD (.811) makes it a relatively undesirable character. It is clear that the potential information content of IZD is much greater because it is a continuous variable; moreover it can be more effectively handled statistically.

Conclusions

Through a statistical study of variation in the bryozoan species
Fistulipora decora, it has been possible to reach the following
conclusions: 1) In this study (as in most previous statistical
studies of Paleozoic Bryozoa) data were found to be normally distributed
for the majority of the characters utilized, thus fulfilling one
fundamental assumption of parametric anova. However, when all the
colonies were considered together, variances were not homogeneous. It
is not yet known how widespread deviation from homoscedasticity is
among Bryozoa; seemingly, with the exception of Anstey and Perry
(1969), this assumption has not been tested by previous investigators.
Failure to meet this second assumption inherent in analysis of
variance may have serious effects, as was emphasized by comparison of
the results obtained for a nested anova and the Kruskal-Wallis
nonparametric test. Results for the nested anova indicated no
significant differences between localities for all characters tested.
However, the Kruskal-Wallis test, although less powerful than an
anova, consistently indicated highly significant locality differences
(α = .005) for all characters tested. It is apparent that in cases
where the underlying assumptions are not met, interpretations based
on analysis of variances can be grossly misleading.

2) Failure of the assumption of homoscedasticity of variances at the
highest level in the nested anova model could not be related to
abnormal variances of a single colony or subset of colonies. Although
Dice diagrams of colony means and confidence limits gave the visual
impression that at least two colonies might differ significantly

enough from the rest to be considered as representing a different

population, simultaneous treatment of all character means and variances

by multivariate principal components analysis failed to show

justification for this hypothesis. This result was also corroborated

by an SNK a posteriori multiple range test of colony means.

3) Failure of the assumption of homogeneity of variances at the

highest level in the nested anova model precluded parametric analysis

of variance between localities. However, nonparametric Kruskal-Wallis

tests at this level revealed highly significant differences between

localities for all characters. Basically, three sources of variation

can account for these differences; they are: genetic differences

between localities, differences in "gross" environmental factors, and

the interaction of the two. However, it is not possible to isolate

these components, nor to assess their relative importance.

4) Partitioning of variance components within localities by single

classification anova was appropriate for 11 cases in which the

assumption of homoscedasticity was met at this lower level. Results

of the analyses revealed significant differences (α = .001) between

colonies within localities in all cases. Additional analysis of

within locality data was accomplished using both the Kruskal-Wallis

nonparametric test and the Snedecor test for the equality of means

when variances are heterogenous. Results for these tests are consistent

with those of the single classification anova in revealing highly

significant differences between colonies. This is interpreted as most

probably reflecting a high genetic diversity within localities, as

expressed phenotypically, since the "gross" environment within the

limited area of the collecting locality was seemingly relatively

uniform (as suggested by field evidence). The intercolony and intracolony components of variation, expressed as a percentage of the total variance, revealed that the intracolony component accounts for a larger proportion of the total within locality variation in all but one case. This is interpreted as reflecting a strong influence of microenvironmental factors on the phenetic expression of individual zooids, within a single colony.

5) Comparison of coefficients of intra- and intercolony variation in the manner proposed by Oliver (1968) was attempted in order to understand the distribution of within locality variation for data which could not be appropriately handled by single classification anova. However, 95% confidence limits computed for the least variable character, zooecial diameter (ZD), showed significant overlap for the majority of cases. It is concluded that this approach, although interesting, can have serious limitations; unless differences between intra- and intercolony coefficients are large, it may be impossible to distinguish Oliver's two classes of variation. Although the computed coefficients are best estimates for the population and provide us with a measure of inherent variability, apparent differences between them may not be real.

6) A matrix of correlation coefficients for character means and variances was computed to determine the degree of correlation between the characters used. It is desirable, particularly for studies based on only a few characters, to minimize redundancy in the form of heavily correlated characters by utilizing characters that contain a maximum amount of information. The results revealed that two characters, diaphragm counts per millimeter and the number of vesicles per unit

area, both measured in longitudinal section, are not significantly correlated with the other characters measured. Zooecial diameter, interzooecial distance between nearest neighbor zooecia and the number of vesicles between nearest neighbor zooecia, all measured in tangential section, were found to be significantly correlated with one another. It was concluded that VCT, being heavily correlated with IZD (r = .81) and difficult to handle statistically, could be eliminated with little loss of information.

In conclusion, this study has shown the need for more broadly based taxonomic studies of bryozoan populations. The available population of Fistulipora decora is characterized by extensive and significant variation between individuals within a colony, between colonies at one locality, and between localities. Phenetically, the group is quite flexible, responding readily to differences in environment and genetic makeup. This may be typical of most bryozoan taxa. In future studies, the maximum amount of information will be obtained only through utilization of a logical sampling plan, where possible, and the application of appropriate statistical techniques, both to describe the variation and to assess its significance.

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Explanation of Plate 1

Fistulipora decora (Moore and Dudley), 1944

Figures 1 and 2. KU 71997. Zoarium encrusting the brachial

valve of a specimen of Meekella. Specimen collected

from Grover Station. (Magnification, X 1.4).

Figure 3. KU 71998. Enlarged view of zoarial surface showing

the conspicuous development of moderately elevated

lunaria and monticules. Specimen collected from

Kansas Turnpike. (Magnification, X 2).

Figures 4a and 4b. KU 71999. Stereographic view of an

irregularly-encrusting form showing well-developed

monticules. Specimen collected from the Kansas

Turnpike. (Magnification, X 1).

Figures 5 and 6. KU 72000. Colony exhibiting the character-

istic hemispherical form with moderately convex

upper surface (Figure 6) and concave, concentrically

wrinkled base (Figure 5). Specimen collected from

Stull Road (Magnification, X 1).
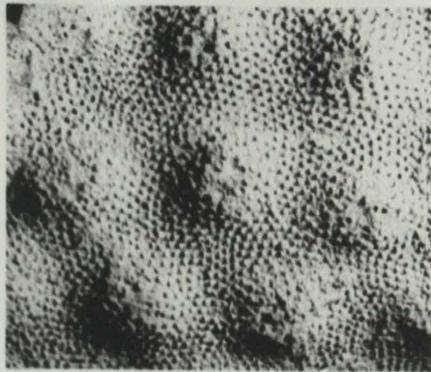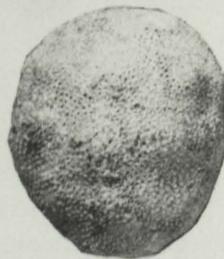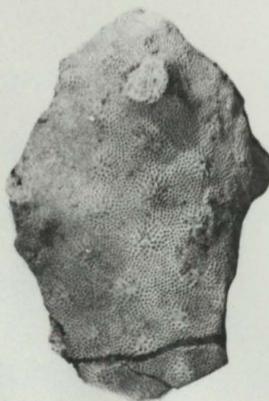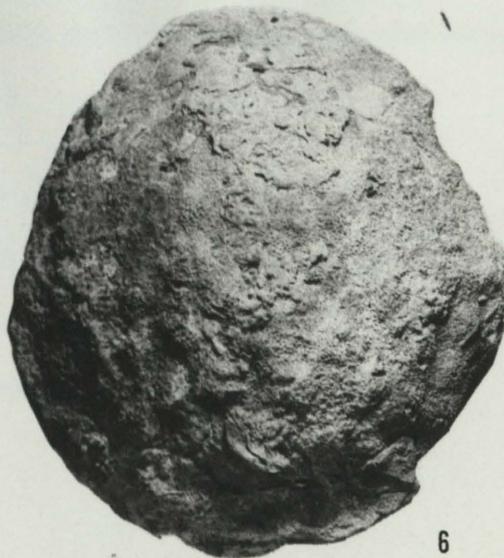
PLATE 1

Appendix 1

List of Localities

1. Stull Road: NE 1/4, NE 1/4, NW 1/4, NW 1/4, sec. 36, T. 12S.,
R. 17E.; upper contact of highest limestone bench exposed on south
side of Highway 40, about 1.25 miles west of Stull, Douglas County
(Clinton 7.5' Quadrangle).

2. Grover Station: SE 1/4, SE 1/4, NE 1/4, NE 1/4, sec. 35, T. 11S.,
R. 17E; floor of small quarry on north side of road near Santa
Fe Railroad, approximately 1.25 miles west of Grover Station,
Douglas County (Perry 7.5' Quadrangle).

3. Lake Dabinawa: NW 1/4, NW 1/4, NW 1/4, NE 1/4, sec. 31, T. 10S.,
R. 20E; bed in a small gully on northeast side of lake, southeast
of junction of main (E-W) road and private (N-S) road, Jefferson
County (McLouth 7.5' Quadrangle).

4. Kansas Turnpike: SE 1/4, SE 1/4, NE 1/4, NE 1/4, sec. 24,
T. 12S., R. 18E; zone about 2 to 3 feet above second prominent
limestone bed on north side of turnpike about 100 feet west of
overpass, Douglas County (Lawrence East 7.5' Quadrangle).

APPENDIX 2

DISCUSSION * MEASUREMENTS FOR NUMERICAL CHARACTERS
ARE EXPRESSED IN THE ORIGINAL CALIPER UNITS.
CONVERSION OF VALUES TO MILLIMETERS IS ACCOMPLISHED
BY THE FOLLOWING *

Y (MM.) = Y (CAL.UNITS) / 4.93

FIRST EIGHT COLUMNS ARE FOR SPECIMEN IDENTIFICATION.
FIRST NUMBER IDENTIFIES LOCALITY ACCORDING TO THE CODE*

01 = STULL ROAD
02 = GROVER STATION
03 = LAKE DABINAWA
04 = KANSAS TURNPIKE

SECOND NUMBER IDENTIFIES THE COLONY WITHIN A GIVEN LOCALITY.
THIRD NUMBER IS THE NUMBER OF CHARACTER MEASUREMENTS
FOR THE COLONY.
EXAMPLE* FOR CHARACTER ZD, 010325 IS INTERPRETED AS THE
THIRD COLONY FROM THE STULL ROAD LOCALITY, THE SAMPLE
FOR THAT CHARACTER BEING BASED ON 25 MEASUREMENTS.

MEASUREMENTS OF ZOOECIAL DIAMETER
IN TANGENTIAL SECTION (ZD)

STULL ROAD

```
 010125 1.506 1.736 1.641 1.561 1.562 1.462 1.240 1.751 1.561 1.450 1.756 1.540
1.635 1.582 1.566 1.745 1.599 1.440 1.586 1.723 1.635 1.815 1.641 1.658 1.640

 010225 1.716 1.866 1.565 1.570 1.487 1.540 1.660 1.668 1.731 1.636 1.560 1.756
1.547 1.729 1.739 1.633 1.758 1.630 1.766 1.745 1.780 1.688 1.618 2.066 1.576

 010325 1.467 1.645 1.656 1.610 1.381 1.253 1.464 1.480 1.405 1.519 1.548 1.470
1.475 1.580 1.945 1.695 1.600 1.474 1.550 1.799 1.610 1.339 1.503 1.615 1.841

 010425 1.988 1.910 1.856 1.601 1.483 1.734 1.809 1.819 1.779 1.650 2.082 1.485
1.823 1.750 1.757 1.760 1.560 1.592 1.752 1.513 1.494 1.825 1.634 1.471 1.672

 010525 1.466 1.526 1.684 1.741 1.489 1.476 1.590 1.513 1.506 1.766 1.499 1.309
1.288 1.222 1.356 1.761 1.436 1.331 1.555 1.733 1.441 1.496 1.596 1.274 1.251
```

GROVER STATION

```
 020125 1.758 1.544 1.574 1.905 2.068 1.897 1.754 1.588 1.646 1.530 1.845 1.584
1.696 1.786 1.750 1.716 1.694 1.700 1.570 1.650 1.710 1.744 1.651 1.728 1.691

 020225 1.714 2.143 2.010 1.804 1.782 1.524 1.682 1.805 1.590 1.518 1.725 1.720
1.984 2.394 2.105 1.713 1.631 1.862 1.881 1.635 1.738 1.591 2.052 1.845 1.799

 020325 1.930 1.689 1.709 1.831 1.594 1.916 1.825 1.907 2.011 1.908 2.071 2.149
2.088 1.775 2.171 1.787 1.981 2.027 1.785 1.800 1.957 2.074 1.743 1.797 1.883

 020425 1.599 1.824 1.859 1.821 1.830 1.959 1.834 1.840 1.685 1.676 1.601 1.849
1.898 1.735 1.642 1.574 1.847 1.787 2.019 1.815 1.789 1.747 1.770 1.694 1.569

 020525 1.700 1.448 1.554 1.656 1.539 1.568 1.604 1.549 1.614 1.706 1.582 1.716
1.473 1.661 1.412 1.492 1.708 1.671 1.713 1.741 1.521 1.525 1.619 1.571 1.654
```

LAKE DABINAWA

030125 1.787 1.442 1.491 1.585 1.658 1.530 1.346 1.329 1.149 1.271 1.548 1.436
1.614 1.504 1.504 1.716 1.633 1.569 1.463 1.401 1.510 1.212 1.210 1.367 1.589

030225 1.338 1.369 1.431 1.535 1.434 1.479 1.552 1.423 1.446 1.529 1.534 1.462
1.576 1.474 1.560 1.457 1.464 1.345 1.615 1.593 1.580 1.426 1.612 1.575 1.737

030325 1.854 1.886 2.007 2.106 2.520 2.185 1.994 2.040 2.059 1.846 2.070 2.124
1.916 1.899 2.200 2.341 2.058 1.884 1.902 1.937 1.985 1.860 2.114 2.069 1.921

030425 1.723 2.042 2.393 2.683 2.065 1.892 1.650 1.954 1.670 1.803 2.565 2.518
2.478 2.377 2.251 1.907 2.007 2.147 2.091 1.810 1.664 1.647 1.724 1.852 1.675

030525 1.485 1.066 1.251 1.088 1.063 1.211 1.215 1.423 1.393 1.561 1.160 1.410
1.426 1.286 1.457 1.214 1.286 1.758 1.416 1.129 1.077 1.039 1.272 1.421 1.193

KANSAS TURNPIKE

040125 1.912 2.001 1.933 1.934 1.919 2.323 1.855 1.741 2.055 2.026 2.011 1.971
1.783 1.875 2.010 2.117 2.112 1.897 1.980 1.869 2.112 1.820 1.856 1.880 2.108

040225 1.625 1.743 1.850 1.664 1.655 1.649 1.526 1.630 1.575 1.483 1.438 1.583
1.520 1.527 1.634 1.464 1.418 1.599 1.546 1.642 1.479 1.474 1.587 1.795 1.694

040325 1.825 2.004 1.674 1.640 1.853 1.916 2.057 2.340 2.218 1.771 1.755 2.459
2.621 2.245 2.161 1.926 1.635 1.874 1.832 1.820 1.861 2.221 2.550 2.290 1.971

040425 1.495 1.367 1.556 1.533 1.440 1.529 1.585 1.606 1.523 1.455 1.500 1.541
1.623 1.714 1.591 1.582 1.210 1.579 1.580 1.617 1.611 1.685 1.650 1.732 1.441

MEASUREMENTS OF INTERZOOECIAL DISTANCE
FOR NEAREST NEIGHBOR ZOOECIA
IN TANGENTIAL SECTION (IZD)

STULL ROAD

010125 0.740 0.291 0.761 0.737 0.545 0.534 0.373 0.424 0.861 0.801 0.539 0.345
0.796 0.642 0.366 0.385 0.797 0.609 0.671 0.681 0.555 0.491 0.839 0.659 0.759

010225 0.765 0.617 0.604 0.689 0.827 0.655 0.664 0.780 0.900 0.911 1.187 0.526
0.781 0.855 0.615 0.740 0.957 1.201 0.810 0.954 0.891 0.522 0.579 0.587 0.646

010325 0.746 0.892 1.152 0.302 0.034 0.679 0.954 0.864 0.930 1.111 1.122 0.705
0.484 1.411 0.854 0.565 0.783 0.746 1.413 1.145 1.419 0.636 1.044 0.930 1.145

010425 0.000 0.761 1.084 0.448 0.381 0.375 0.734 0.755 0.000 0.000 0.341 0.789
0.816 0.445 0.473 0.691 0.705 0.622 1.029 0.840 0.828 0.548 0.843 0.405 0.115

010525 0.912 1.125 1.441 1.168 0.928 0.763 0.569 0.620 0.800 0.814 0.887 0.805
1.011 1.110 0.892 1.372 0.910 0.636 0.871 0.659 0.585 0.000 0.974 1.011 1.126

GROVER STATION

020125 0.758 0.753 1.176 1.026 0.760 1.139 0.903 0.909 0.991 0.486 0.874 0.789
0.910 0.814 0.914 0.765 0.879 0.554 0.705 1.070 0.735 0.606 0.550 0.725 0.528

020225 0.161 0.000 0.706 0.837 0.442 0.324 0.356 0.684 0.681 0.580 0.571 0.536
0.588 0.436 0.681 0.814 1.074 0.580 0.434 0.689 0.616 0.391 0.000 0.523 0.600

020325 0.644 0.639 0.630 0.261 0.510 0.716 0.377 0.550 0.504 0.555 0.505 0.597
0.000 0.674 0.616 0.424 0.556 0.000 0.774 0.957 0.676 0.749 0.546 0.693 0.544

020425 0.000 0.861 0.828 1.126 1.511 0.577 0.634 0.745 0.288 0.710 0.585 0.792
0.609 0.460 0.517 0.809 0.925 0.782 0.791 0.785 0.644 0.305 0.556 0.742 0.480

020525 0.736 0.581 0.529 0.856 0.769 0.663 0.790 0.815 0.799 0.640 0.951 0.789
0.826 0.793 0.714 0.844 1.019 0.289 0.626 0.520 0.000 0.529 0.809 0.727 0.881

LAKE DABINAWA

```
 030125 0.702 1.075 0.826 0.871 1.142 0.000 0.910 0.596 0.626 0.535 0.179 0.920
0.724 0.842 0.615 1.311 0.691 0.841 1.045 1.029 0.598 0.927 0.576 1.057 0.738

 030225 0.750 0.981 0.931 0.571 0.552 0.894 0.161 0.600 0.739 0.823 0.526 0.875
0.672 0.578 0.810 0.901 0.599 0.700 0.595 0.760 0.610 0.605 0.770 0.520 0.766

 030325 0.520 0.510 0.000 0.363 0.000 0.760 0.850 0.496 0.404 0.000 0.390 0.441
0.455 0.505 0.424 0.000 0.500 0.457 0.820 0.000 0.410 0.600 0.705 0.436 0.521

 030425 0.315 0.266 0.000 0.624 0.000 0.000 0.000 0.132 0.579 0.330 0.000 0.000
0.685 0.998 0.000 0.000 0.144 0.000 0.390 0.519 0.715 0.626 0.281 0.000 0.384

 030525 0.937 1.021 0.796 0.558 0.973 0.310 0.905 0.750 0.146 0.544 0.742 0.597
1.030 1.029 0.751 0.443 1.071 1.356 0.665 0.535 0.896 0.565 0.857 0.894 0.859
```

KANSAS TURNPIKE

```
 040125 0.627 0.970 0.785 0.711 0.804 0.920 0.621 0.710 0.813 1.019 0.726 0.835
0.832 0.894 0.480 0.410 0.980 0.629 0.632 0.610 0.915 0.691 0.701 1.025 0.739

 040225 0.169 0.644 0.419 0.540 0.512 0.795 0.496 0.471 0.260 0.743 0.510 0.360
0.151 0.511 0.000 0.464 0.386 0.440 0.423 0.470 0.504 0.674 0.866 0.000 0.457

 040325 0.634 0.671 0.768 0.826 0.740 0.719 0.000 0.935 0.851 0.697 0.631 0.900
0.698 0.599 0.564 0.786 0.771 0.796 0.594 0.586 0.543 0.000 0.485 0.730 0.586

 040425 0.824 0.414 0.945 0.619 0.761 0.695 0.614 0.720 0.618 0.700 0.637 0.273
0.281 0.623 0.429 0.409 0.000 0.746 0.811 0.355 0.350 0.847 0.805 0.580 0.686
```

STULL ROAD

```
010125    6  6  6  6  5  6  5  5  7  7  7  6  8  8  8  8  7  4  6  5  6  6  5
   6   4

010225    6. 5  5  5  4  4  5  3  5  5  6  4  4  5  4  6  6  5  4  5  5  4  4
   5   5

010325    4  4  3  4  4  4  4  4  5  4  3  4  4  4  4  4  4  4  4  3  4  3  3
   4   4

010425    5  4  4  4  4  6  6  5  4  5  3  4  4  4  4  5  5  3  4  4  2  4  4
   5   4

010525    4  4  4  4  2  4  4  5  4  4  4  3  3  4  4  4  3  4  5  3  4  4  4
   4   2
```

GROVER STATION

```
020125    4  5  4  6  4  4  6  5  5  6  5  5  4  5  4  6  4  5  6  6  5  6  5
   5   6

020225    7  5  5  5  4  4  6  5  5  5  3  5  8  7  7  7  7  5  6  7  3  6  4
   3   5

020325    5  3  7  5  3  5  3  3  3  5  5  4  2  5  4  5  5  5  3  6  6  3  4
   3   5

020425    2  7  5  6  5  5  9  6  5  5  6  6 10  6  8  7  4  4  5  3  4  4  9
   9   7

020525    3  4  3  4  2  3  3  3  4  3  6  2  3  3  4  4  4  3  4  5  2  4  3
   4   3
```

LAKE DABINAWA

```
030125   5  3  4  4  4  3  4  5  4  4  4  4  5  4  5  5  5  6  3  4  5  5
   5   6

030225   4  6  6  4  6  6  4  5  5  5  5  5  4  5  5  5  5  6  5  6  6  5  6
   6   6

030325   6  6  5  5  6  5  6  3  4  7  3  4  5  5  5  5  7  5  5  5  6  5  4
   7   5

030425   6  6  5  6  4  6  5  7  5  6  6  5  5  4  4  3  5  6  3  4  3  4  5
   6   5

030525   5  5  4  4  5  3  4  4  4  3  3  4  4  3  3  4  4  3  4  3  4  3  4
   4   5
```

KANSAS TURNPIKE

```
040125   7  7  5  4  7  4  6  8  6  5  8  6  6  6  7  4  6  7  6  7  6  8  7
   6   7

040225   5  6  6  5  5  6  6  6  4  5  4  4  4  5  4  5  7  3  5  3  4  6  6
   6   3

040325   6  5  4  5  5  5  5  4  4  4  5  5  5  5  5  5  5  4  4  4  4  3  3
   5   4

040425   6  5  5  5  5  6  5  5  4  4  3  4  5  4  5  6  6  5  6  6  4  5  5
   6   5
```

MEASUREMENTS OF THE NUMBER OF COMPLETE VESICLES
CONTAINED IN A CIRCLE OF RADIUS = .25 MM.
IN LONGITUDINAL SECTION (VC/.25)

8

STULL ROAD

```
010125   8  5  8  7  6  9 12 11  8 10  9  7  4  6  7  5  5 14  7 10  5 12  7
         6  9

010225   8  4  7  8  6  7 12  8  6  5  8  6  6  7  7  8  5  9  7  9 12  4  6
         3 10

010325   2  5  4  5  4  4  5  3  5  5  6  5  5  7  2  1  3  6  3  4  3  4  2
         2  5

010425   6  8  8  4  8  3  6  4  6  8  6  6  4  5  5  9  3  5  8 10  6  9  7
         8  6

010525   4  3  5  4  6 11  4  6  9  2  8  7  9  7  4  2  6  2  2  5  6  7  4
         2  2
```

GROVER STATION

```
020125   6  7  7  5  7  4  9  5  6  5  9  6  9  3  5  6  5  8  6  5  8  7  6
         5  6

020225   9  5  2  6  4  6  3  2  8  3  8  5  4  4  1  3  3  3  4  2  7  6  4
         6  3

020325   6  5  4  4  7  6  6  5  8  6  6  6  4  2  4  5  4  5  4  7  5  9  7
         6 10

020425   9  8  5 11  9  6  7  5 10  7 11  4  5  5  4  8  7 13  6  7 12  7  5
         7  5

020525  10 10 11  6  5  8  8  9  9  9  7 12  8  8  8  6  5  6  6  7  5 11  6
         9  8
```

030125	14	7	6	6	8	8	8	7	7	5	7	3	5	5	3	5	7	7	3	7	10	5	6
8	8
030225	3	7	10	7	5	7	10	6	7	4	6	8	2	5	7	3	4	7	6	4	5	6	7
9	6
030325	3	5	4	5	2	1	2	4	6	3	2	3	3	5	3	1	7	6	5	4	4	8	3
3	4
030425	4	2	2	2	3	2	3	3	4	3	2	2	3	2	2	3	3	1	1	2	4	3	1
2	3
030525	10	2	5	6	2	8	6	4	2	6	4	2	2	3	3	9	10	5	3	5	2	5	2
3	2

KANSAS TURNPIKE

040125	7	5	9	5	5	4	5	5	9	6	5	4	8	6	6	3	4	5	4	4	8	5	6
3	6
040225	6	8	7	6	4	5	7	5	9	7	5	3	5	12	5	6	8	7	5	5	7	8	10
3	9
040325	3	5	5	2	4	3	4	4	1	2	2	2	2	3	3	1	2	3	2	4	4	1	3
1	2
040425	6	5	4	4	4	5	6	5	5	2	5	2	5	6	5	6	6	5	7	5	2	8	9
5	5

STULL ROAD

010125	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
1 1																							
010225	1	1	0	2	1	1	1	1	1	1	1	1	1	1	1	1	2	1	0	1	1	1
1 0																							
010325	1	1	2	1	1	1	0	1	1	2	1	1	1	2	1	1	1	1	1	1	1	0 2
1 1																							
010425	0	2	1	1	1	1	2	1	0	0	1	1	1	1	1	1	1	2	2	2	1	1
1 1																							
010525	1	1	2	1	1	1	1	1	1	1	1	1	2	1	1	2	1	1	1	1	1	0 1
2 1																							

GROVER STATION

020125	1	1	2	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
1 1																							
020225	1	0	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	0
1 1																							
020325	1	1	1	1	1	1	1	1	1	1	1	1	0	1	1	1	1	0	1	1	1	1
2 1																							
020425	0	1	1	2	2	1	1	1	1	1	1	1	1	1	1	2	1	1	1	1	1	1
1 1																							
020525	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	0	1	1
1 1																							

030125   1 2 1 2 2 0 1 1 1 1 1 2 1 1 1 2 1 1 1 1 1 2 1
  1   1

030225   1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1
  2   1

030325   1 1 0 1 0 1 1 1 1 0 1 1 1 1 1 0 1 1 1 0 1 1 1
  1   1

030425   1 1 0 1 0 0 0 1 1 1 0 0 1 1 0 0 1 0 1 1 1 1 1
  0   1

030525   2 2 1 1 1 1 1 1 1 1 2 1 2 2 1 1 1 1 1 1 1 1 1
  1   1

KANSAS TURNPIKE

040125   1 2 1 1 2 2 1 1 1 2 1 1 1 1 1 1 1 1 1 1 1 1
  1   1

040225   1 1 1 1 1 1 1 1 1 1 1 1 1 0 1 1 1 1 1 1 1 1
  0   1

040325   1 1 1 1 1 1 0 1 1 1 1 1 1 1 1 1 1 1 1 1 0 1
  1   1

040425   1 1 2 1 1 1 1 1 1 1 1 1 1 1 0 1 1 1 1 1 1
  1   1

Appendix 3

Basic Statistics for Each Colony

Zooecial Diameter (ZD)

BASIC STATISTICS — 0101

N= 25   0 CLASSES   TRANSFORMATION CODE = 0

	STATISTIC	STAND. ERROR	CONFIDENCE LIMITS (95,00, PER CENT)	
MEAN	1.60124	0.02497	1.54930	1.65268
MEDIAN	1.59900	0.03129	1.53453	1.66347
VARIANCE	0.01559			
STAND. DEV.	0.12485			
COEFF VAR	7.79700	1.10935	5.51175	10.08225
G1	-0.79894	0.46368	-1.70794	0.11006
G2	1.62346	0.90172	-0.14425	3.39119
K-S DMAX	0.09507			

BASIC STATISTICS — 0102

N= 25   0 CLASSES   TRANSFORMATION CODE = 0

	STATISTIC	STAND. ERROR	CONFIDENCE LIMITS (95,00, PER CENT)	
MEAN	1.68120	0.02460	1.63053	1.73187
MEDIAN	1.66800	0.03083	1.60450	1.73150
VARIANCE	0.01512			
STAND. DEV.	0.12298			
COEFF. VAR	7.31515	1.04004	5.17267	9.45764
G1	1.15448	0.46368	0.24548	2.06349
G2	2.71416	0.90172	0.94644	4.48189
K-S DMAX	0.13088			

BASIC STATISTICS — 0103

N= 25   0 CLASSES   TRANSFORMATION CODE = 0

	STATISTIC	STAND. ERROR	CONFIDENCE LIMITS (95,00, PER CENT)	
MEAN	1.55696	0.03109	1.49291	1.62101
MEDIAN	1.54800	0.03897	1.46772	1.62828
VARIANCE	0.02417			
STAND. DEV.	0.15547			
COEFF VAR	9.98532	1.42615	7.04745	12.92318
G1	0.59083	0.46368	-0.31817	1.49983
G2	0.77980	0.90172	-0.98792	2.54753
K-S DMAX	0.11445			

BASIC STATISTICS — 0104

N= 25   0 CLASSES   TRANSFORMATION CODE = 0

	STATISTIC	STAND.ERROR	CONFIDENCE LIMITS	
			(95.00,PER CENT)	
MEAN	1.71196	0.03271	1.64458	1.77934
MEDIAN	1.75000	0.04099	1.66556	1.83444
VARIANCE	0.02674			
STAND.DEV.	0.16353			
COEFF. VAR	9.55243	1.36319	6.74425	12.36060
G1	0.25635	0.46368	-0.65255	1.16535
G2	-0.37383	0.90172	-2.14155	1.39390
K-S DMAX	0.08813			

BASIC STATISTICS — 0105

N= 25   0 CLASSES   TRANSFORMATION CODE = 0

	STATISTIC	STAND.ERROR	CONFIDENCE LIMITS	
			(95.00,PER CENT)	
MEAN	1.49220	0.03254	1.42517	1.55923
MEDIAN	1.49500	0.04078	1.41199	1.56001
VARIANCE	0.02647			
STAND.DEV.	0.16270			
COEFF. VAR	10.90356	1.56022	7.68951	14.11762
G1	0.13521	0.46368	-0.77373	1.04421
G2	-0.78028	0.90172	-2.54800	0.98745
K-S DMAX	0.04772			

BASIC STATISTICS — 0201

N= 25   0 CLASSES   TRANSFORMATION CODE = 0

	STATISTIC	STAND.ERROR	CONFIDENCE LIMITS	
			(95.00,PER CENT)	
MEAN	1.71116	0.02495	1.65977	1.76255
MEDIAN	1.70000	0.03126	1.63559	1.76441
VARIANCE	0.01556			
STAND.DEV.	0.12473			
COEFF. VAR	7.28922	1.03631	5.15441	9.42403
G1	0.97001	0.46368	0.06111	1.87902
G2	1.52266	0.90172	-0.24505	3.29039
K-S DMAX	0.15363			

BASIC STATISTICS — 0202

N = 25   0 CLASSES   TRANSFORMATION CODE = 0

	STATISTIC	STAND.ERROR	CONFIDENCE LIMITS (95.00, PER CENT)	
MEAN	1.80968	0.04202	1.72332	1.89644
MEDIAN	1.78200	0.05266	1.67352	1.89048
VARIANCE	0.04414			
STAND.DEV.	0.21009			
COEFF. VAR	11.60819	1.66362	8.18113	15.03525
G1	0.99613	0.46368	0.09713	1.90514
G2	1.07457	0.90172	-0.69315	2.84229
K-S DMAX	0.14927			

BASIC STATISTICS — 0203

N = 25   0 CLASSES   TRANSFORMATION CODE = 0

	STATISTIC	STAND.ERROR	CONFIDENCE LIMITS (95.00, PER CENT)	
MEAN	1.89632	0.03005	1.83442	1.95822
MEDIAN	1.90700	0.03766	1.82943	1.98457
VARIANCE	0.02257			
STAND.DEV.	0.15023			
COEFF. VAR	7.92238	1.12740	5.59993	10.24483
G1	0.07661	0.46368	-0.53220	0.98581
G2	-0.65134	0.90172	-2.41937	1.11639
K-S DMAX	0.10834			

BASIC STATISTICS — 0204

N = 25   0 CLASSES   TRANSFORMATION CODE = 0

	STATISTIC	STAND.ERROR	CONFIDENCE LIMITS (95.00, PER CENT)	
MEAN	1.77052	0.02351	1.72209	1.81895
MEDIAN	1.78900	0.02946	1.72831	1.84969
VARIANCE	0.01382			
STAND.DEV.	0.11754			
COEFF. VAR	6.63869	0.94298	4.59615	8.58124
G1	-0.08018	0.46368	-0.98919	0.82882
G2	-0.38171	0.90172	-2.14944	1.38602
K-S DMAX	0.10579			

BASIC STATISTICS — 0205

N= 25   0 CLASSES   TRANSFORMATION CODE =   0

	STATISTIC	STAND.ERROR	CONFIDENCE LIMITS (95,00,PER CENT)	
MEAN	1.59988	0.01840	1.56193	1.63778
MEDIAN	1.60400	0.02366	1.55650	1.65150
VARIANCE	0.00646			
STAND.DEV.	0.09200			
COEFF. VAR	5.75030	0.81590	4.06955	7.43105
G1	-0.26994	0.46368	-1.17895	0.63906
G2	-0.84918	0.90172	-2.61691	0.91854
K-S DMAX	0.06183			

BASIC STATISTICS — 0301

N= 25   0 CLASSES   TRANSFORMATION CODE =   0

	STATISTIC	STAND.ERROR	CONFIDENCE LIMITS (95.00,PER CENT)	
MEAN	1.47456	0.03224	1.40814	1.54098
MEDIAN	1.50400	0.04041	1.42075	1.58725
VARIANCE	0.02599			
STAND.DEV.	0.16122			
COEFF. VAR	10.93321	1.56456	7.71021	14.15621
G1	-0.26731	0.46368	-1.17611	0.64189
G2	-0.32488	0.90172	-2.09261	1.44285
K-S DMAX	0.06630			

BASIC STATISTICS — 0302

N= 25   0 CLASSES   TRANSFORMATION CODE =   0

	STATISTIC	STAND.ERROR	CONFIDENCE LIMITS (95,00,PER CENT)	
MEAN	1.50184	0.01890	1.46290	1.54078
MEDIAN	1.47900	0.02369	1.43020	1.52780
VARIANCE	0.00893			
STAND.DEV.	0.09452			
COEFF. VAR	6.29342	0.89354	4.45272	8.13411
G1	0.30187	0.46368	-0.60713	1.21088
G2	0.15939	0.90172	-1.60834	1.92712
K-S DMAX	0.11547			

BASIC STATISTICS — 0303

N= 25   0 CLASSES   TRANSFORMATION CODE =   0

	STATISTIC	STAND.ERROR	CONFIDENCE LIMITS (95.00 PER CENT)	
MEAN	2.03198	0.03222	1.96470	2.09746
MEDIAN	2.00700	0.04038	1.92331	2.09019
VARIANCE	0.02596			
STAND.DEV.	0.16111			
COEFF. VAR	7.93212	1.12891	5.59677	10.25746
G1	1.36046	0.45368	0.45145	2.26946
G2	2.37004	0.90172	0.60231	4.13777
K-S DMAX	0.12455			

BASIC STATISTICS — 0304

N= 25   0 CLASSES   TRANSFORMATION CODE =   0

	STATISTIC	STAND.ERROR	CONFIDENCE LIMITS (95.00 PER CENT)	
MEAN	2.02352	0.06469	1.89025	2.15678
MEDIAN	1.95400	0.08108	1.78628	2.12102
VARIANCE	0.10462			
STAND.DEV.	0.32345			
COEFF. VAR	15.98452	2.31759	11.21025	20.75875
G1	0.59801	0.45368	-0.31033	1.50701
G2	-0.85545	0.90172	-2.62319	0.91228
K-S DMAX	0.12067			

BASIC STATISTICS — 0305

N= 25   0 CLASSES   TRANSFORMATION CODE =   0

	STATISTIC	STAND.ERROR	CONFIDENCE LIMITS (95.00 PER CENT)	
MEAN	1.29200	0.03594	1.21795	1.36604
MEDIAN	1.27200	0.04505	1.17920	1.36480
VARIANCE	0.03230			
STAND.DEV.	0.17971			
COEFF. VAR	13.90962	2.00484	9.77934	18.03980
G1	0.59618	0.46368	-0.31232	1.50519
G2	0.20236	0.90172	-1.56537	1.97008
K-S DMAX	0.11332			

BASIC STATISTICS — 0401

N= 25   0 CLASSES   TRANSFORMATION CODE =   0

	STATISTIC	STAND. ERROR	CONFIDENCE LIMITS (95.00 PER CENT)	
MEAN	1.96400	0.02572	1.91102	2.01698
MEDIAN	1.93400	0.03223	1.86750	2.00040
VARIANCE	0.01653			
STAND. DEV.	0.12858			
COEFF. VAR	6.54703	0.92985	4.53154	8.46252
G1	0.75122	0.46368	-0.15779	1.66022
G2	1.11247	0.90172	-0.65525	2.88019
K-S DMAX	0.11224			

BASIC STATISTICS — 0402

N= 25   0 CLASSES   TRANSFORMATION CODE =   0

	STATISTIC	STAND. ERROR	CONFIDENCE LIMITS (95.00 PER CENT)	
MEAN	1.59200	0.02131	1.54707	1.63693
MEDIAN	1.58700	0.02734	1.53059	1.64331
VARIANCE	0.01189			
STAND. DEV.	0.10906			
COEFF. VAR	6.85043	0.97333	4.84536	8.85550
G1	0.51343	0.46368	-0.39557	1.42243
G2	0.04199	0.90172	-1.72574	1.80972
K-S DMAX	0.09456			

BASIC STATISTICS — 0403

N= 25   0 CLASSES   TRANSFORMATION CODE =   0

	STATISTIC	STAND. ERROR	CONFIDENCE LIMITS (95.00 PER CENT)	
MEAN	2.02076	0.05651	1.90434	2.13718
MEDIAN	1.92600	0.07083	1.78009	2.07191
VARIANCE	0.07985			
STAND. DEV.	0.28257			
COEFF. VAR	13.98342	2.01585	9.83077	18.13608
G1	0.61311	0.46368	-0.29539	1.52211
G2	-0.56225	0.90172	-2.32998	1.20548
K-S DMAX	0.15132			

BASIC STATISTICS — 0404

N=	25	0 CLASSES	TRANSFORMATION CODE =	0

	STATISTIC	STAND.ERROR	CONFIDENCE LIMITS (95.00,PER CENT)	
MEAN	1.54980	0.02235	1.50375	1.59585
MEDIAN	1.57900	0.02801	1.52129	1.63671

VARIANCE	0.01249			
STAND.DEV.	0.11176			
COEFF. VAR	7.21148	1.02515	5.09969	9.32328
G1	-1.09891	0.46368	-2.00731	-0.18991
G2	2.47672	0.90172	0.70599	4.24444
K-S DMAX	0.09625			

Interzooecial Distance (IZD)

BASIC STATISTICS — O1O1

N= 25   0 CLASSES   TRANSFORMATION CODE =   0

	STATISTIC	STAND.ERROR	CONFIDENCE LIMITS	
			(95.00 PER CENT)	
MEAN	0.61604	0.03319	.54766	0.68442
MEDIAN	0.64200	0.04160	.55630	0.72770
VARIANCE	0.02755			
STAND.DEV.	0.16597			
COEFF. VAR	26.94204	4.07736	18.54264	35.34145
G1	-0.38520	0.45366	-1.29420	0.52380
G2	-0.89356	0.90172	-2.66129	0.87416
K-S DMAX	0.08693			

BASIC STATISTICS — O1O2

N= 25   0 CLASSES   TRANSFORMATION CODE =   0

	STATISTIC	STAND.ERROR	CONFIDENCE LIMITS	
			(95.00 PER CENT)	
MEAN	0.77052	0.03664	.69504	0.84600
MEDIAN	0.76500	0.04592	0.67040	0.85960
VARIANCE	0.03356			
STAND.DEV.	0.18320			
COEFF. VAR	23.77636	3.54748	16.46855	31.08418
G1	0.82342	0.45368	-0.08558	1.73242
G2	0.39029	0.90172	-1.37744	2.15802
K-S DMAX	0.11953			

BASIC STATISTICS — O1O3

N= 25   0 CLASSES   TRANSFORMATION CODE =   0

	STATISTIC	STAND.ERROR	CONFIDENCE LIMITS	
			(95.00 PER CENT)	
MEAN	0.88264	0.06712	0.74438	1.02090
MEDIAN	0.89200	0.08412	0.71871	1.06529
VARIANCE	0.11262			
STAND.DEV.	0.33559			
COEFF. VAR	38.02139	6.10507	25.44495	50.59783
G1	-0.47989	0.45368	-1.38659	0.42912
G2	0.53590	0.90172	-1.23182	2.30363
K-S DMAX	0.09109			

BASIC STATISTICS — 0104

N= 25   0 CLASSES   TRANSFORMATION CODE = 0

	STATISTIC	STAND. ERROR	CONFIDENCE LIMITS	
			(95.00. PER CENT)	
MEAN	0.56112	0.06197	0.43345	0.68873
MEDIAN	0.62200	0.07767	0.46201	0.78199
VARIANCE	0.09600			
STAND. DEV.	0.30984			
COEFF. VAR	55.21894	9.90815	34.80615	75.62972
G1	-0.43630	0.46368	-1.34530	0.47270
G2	-0.54466	0.90172	-2.31239	1.22307
K-S DMAX	0.10246			

BASIC STATISTICS — 0105

N= 25   0 CLASSES   TRANSFORMATION CODE = 0

	STATISTIC	STAND. ERROR	CONFIDENCE LIMITS	
			(95.00. PER CENT)	
MEAN	0.87956	0.05810	0.76948	0.99924
MEDIAN	0.89200	0.07281	0.74201	1.04199
VARIANCE	0.08436			
STAND. DEV.	0.29048			
COEFF. VAR	33.02504	5.15472	22.40631	43.64377
G1	-0.76405	0.46368	-1.67305	0.14495
G2	2.61411	0.90172	0.84639	4.38184
K-S DMAX	0.08545			

BASIC STATISTICS — 0201

N= 25   0 CLASSES   TRANSFORMATION CODE = 0

	STATISTIC	STAND. ERROR	CONFIDENCE LIMITS	
			(95.00. PER CENT)	
MEAN	0.81276	0.03722	0.73609	0.88943
MEDIAN	0.78900	0.04665	0.69230	0.88510
VARIANCE	0.03463			
STAND. DEV.	0.18610			
COEFF. VAR	22.89745	3.40373	15.88576	29.90914
G1	0.09700	0.46368	-0.81200	1.00600
G2	-0.47478	0.90172	-2.24250	1.29295
K-S DMAX	0.09322			

BASIC STATISTICS — 0202

| N= | 25 | 0 CLASSES | TRANSFORMATION CODE = | 0 |

	STATISTIC	STAND.ERROR	CONFIDENCE LIMITS (95.00 PER CENT)	
MEAN	0.53216	0.04890	0.43143	0.63289
MEDIAN	0.58000	0.06128	0.45375	0.70624
VARIANCE	0.05977			
STAND.DEV.	0.24448			
COEFF. VAR	45.94145	7.74798	29.98052	61.90229
G1	-0.44026	0.46368	-1.34926	0.46874
G2	0.88660	0.90172	-0.89113	2.65432
K-S DMAX	0.11853			

BASIC STATISTICS — 0203

| N= | 25 | 0 CLASSES | TRANSFORMATION CODE = | 0 |

	STATISTIC	STAND.ERROR	CONFIDENCE LIMITS (95.00 PER CENT)	
MEAN	0.54788	0.04290	0.45950	0.63626
MEDIAN	0.55600	0.05327	0.44523	0.66677
VARIANCE	0.04602			
STAND.DEV.	0.21452			
COEFF. VAR	39.15493	6.52960	26.11595	52.19390
G1	-1.17860	0.46368	-2.08750	-0.26960
G2	2.20417	0.90172	0.43644	3.97190
K-S DMAX	0.17896			

BASIC STATISTICS — 0204

| N= | 25 | 0 CLASSES | TRANSFORMATION CODE = | 0 |

	STATISTIC	STAND.ERROR	CONFIDENCE LIMITS (95.00 PER CENT)	
MEAN	0.68248	0.05761	0.56331	0.80115
MEDIAN	0.71000	0.07220	0.56127	0.85873
VARIANCE	0.08296			
STAND.DEV.	0.28803			
COEFF. VAR	42.20309	6.95063	27.88479	56.52139
G1	0.42566	0.46368	-0.48335	1.33466
G2	2.67020	0.90172	0.90247	4.43793
K-S DMAX	0.14769			

BASIC STATISTICS - 0205

N=   25   0 CLASSES   TRANSFORMATION CODE =   0

	STATISTIC	STAND.ERROR	CONFIDENCE LIMITS (95.00,PER CENT)	
MEAN	0.69980	0.04281	0.61152	0.78798
MEDIAN	0.76900	0.05365	0.55848	0.87952
VARIANCE	0.04581			
STAND.DEV.	0.21403			
COEFF. VAR	30.58481	4.71261	20.37683	40.29280
G1	-1.66542	0.46368	-2.57442	-0.75642
G2	3.94745	0.90172	2.17972	5.71518
K-S DMAX	0.12645			

BASIC STATISTICS - 0301

N=   25   0 CLASSES   TRANSFORMATION CODE =   0

	STATISTIC	STAND.ERROR	CONFIDENCE LIMITS (95.00,PER CENT)	
MEAN	0.77504	0.05763	0.55633	0.89375
MEDIAN	0.82600	0.07222	0.57722	0.97478
VARIANCE	0.08302			
STAND.DEV.	0.28813			
COEFF. VAR	37.17666	5.93994	24.94038	49.41295
G1	-0.79413	0.46368	-1.70313	0.11488
G2	1.40853	0.90172	-0.35920	3.17625
K-S DMAX	0.08485			

BASIC STATISTICS - 0302

N=   25   0 CLASSES   TRANSFORMATION CODE =   0

	STATISTIC	STAND.ERROR	CONFIDENCE LIMITS (95.00,PER CENT)	
MEAN	0.69156	0.03510	0.61925	0.76386
MEDIAN	0.70000	0.04399	0.60939	0.79061
VARIANCE	0.03079			
STAND.DEV.	0.17549			
COEFF. VAR	25.37508	3.81265	17.52132	33.22913
G1	-0.85020	0.46368	-1.75920	0.05881
G2	2.09306	0.90172	0.32533	3.86079
K-S DMAX	0.11895			

BASIC STATISTICS — 0303

N= 25   0 CLASSES   TRANSFORMATION CODE = 0

	STATISTIC	STAND.ERROR	CONFIDENCE LIMITS (95.00,PER CENT)	
MEAN	0.42268	0.05019	0.31929	0.52607
MEDIAN	0.45580	0.05290	0.32542	0.58458
VARIANCE	0.06298			
STAND.DEV.	0.25095			
COEFF. VAR	59.37190	10.95374	36.78660	81.95720
G1	-0.47738	0.45358	-1.38938	0.43162
G2	-0.19619	0.90172	-1.96392	1.57153
K-S DMAX	0.16819			

BASIC STATISTICS — 0304

N= 25   0 CLASSES   TRANSFORMATION CODE = 0

	STATISTIC	STAND.ERROR	CONFIDENCE LIMITS (95.00,PER CENT)	
MEAN	0.27952	0.05923	0.15752	0.40152
MEDIAN	0.26600	0.07423	0.11399	0.41891
VARIANCE	0.08769			
STAND.DEV.	0.29613			
COEFF. VAR	105.94104	26.98774	50.34629	161.53579
G1	0.73562	0.46368	-0.17339	1.64462
G2	-0.41202	0.90172	-2.17975	1.35571
K-S DMAX	0.22740			

BASIC STATISTICS — 0305

N= 25   0 CLASSES   TRANSFORMATION CODE = 0

	STATISTIC	STAND.ERROR	CONFIDENCE LIMITS (95.00,PER CENT)	
MEAN	0.76920	0.05339	0.65922	0.87918
MEDIAN	0.79600	0.06691	0.65817	0.93383
VARIANCE	0.07125			
STAND.DEV.	0.26693			
COEFF. VAR	34.70268	5.46687	23.44093	45.96443
G1	-0.28615	0.45368	-1.19515	0.62286
G2	0.38532	0.90172	-1.38241	2.15305
K-S DMAX	0.08911			

BASIC STATISTICS — 0401

N= 25   0 CLASSES   TRANSFORMATION CODE = 0

	STATISTIC	STAND. ERROR	CONFIDENCE LIMITS (95.00 PER CENT)	
MEAN	0.76315	0.03220	0.69683	0.82949
MEDIAN	0.73980	0.04035	0.55597	0.82213
VARIANCE	0.02592			
STAND. DEV.	0.16099			
COEFF. VAR	21.09492	3.11320	14.68174	27.50811
G1	-0.18610	0.45368	-1.09510	0.72290
G2	-0.34871	0.90172	-2.11644	1.41901
K-S DMAX	0.07965			

BASIC STATISTICS — 0402

N= 25   0 CLASSES   TRANSFORMATION CODE = 0

	STATISTIC	STAND. ERROR	CONFIDENCE LIMITS (95.00 PER CENT)	
MEAN	0.45140	0.04296	0.36290	0.53990
MEDIAN	0.47000	0.05384	0.35909	0.58091
VARIANCE	0.04614			
STAND. DEV.	0.21480			
COEFF. VAR	47.58531	8.11144	31.37544	64.29458
G1	-0.38085	0.45368	-1.29935	0.52815
G2	0.43576	0.90172	-1.33196	2.20349
K-S DMAX	0.14872			

BASIC STATISTICS — 0403

N= 25   0 CLASSES   TRANSFORMATION CODE = 0

	STATISTIC	STAND. ERROR	CONFIDENCE LIMITS (95.00 PER CENT)	
MEAN	0.64440	0.04495	0.55179	0.73701
MEDIAN	0.69700	0.05634	0.58094	0.81306
VARIANCE	0.05052			
STAND. DEV.	0.22477			
COEFF. VAR	34.88053	5.50038	23.54935	46.21142
G1	-1.88600	0.45368	-2.79510	-0.97700
G2	4.16780	0.90172	2.40007	5.93553
K-S DMAX	0.16595			

BASIC STATISTICS — 0404

| N= | 25 | 0 CLASSES | TRANSFORMATION CODE = | 0 |

	STATISTIC	STAND.ERROR	CONFIDENCE LIMITS	
			(95.00 PER CENT)	
MEAN	0.58968	0.04466	0.49767	0.68169
MEDIAN	0.62300	0.05598	0.50763	0.73831
VARIANCE	0.04987			
STAND.DEV.	0.22331			
COEFF. VAR	37.87043	6.07542	25.35515	50.38580
G1	-0.80571	0.46358	-1.71472	0.10322
G2	0.43883	0.90172	-1.32889	2.20656
K-S DMAX	0.14336			

Diaphragm Counts per Millimeter
(DC/MM)

BASIC STATISTICS — 0101

N = 25   0 CLASSES   TRANSFORMATION CODE = 0

	STATISTIC	STAND. ERROR	CONFIDENCE LIMITS (95.00 PER CENT)	
MEAN	6.12000	0.23324	5.63953	6.60047
MEDIAN	6.00000	0.29232	5.39733	6.60217
VARIANCE	1.36000			
STAND. DEV.	1.16619			
COEFF. VAR	19.05540	2.79098	13.30599	24.80481
G1	0.09156	0.45368	-0.81744	1.00056
G2	-0.50279	0.90172	-2.27052	1.26494
K-S DMAX	0.22098			

BASIC STATISTICS — 0102

N = 25   0 CLASSES   TRANSFORMATION CODE = 0

	STATISTIC	STAND. ERROR	CONFIDENCE LIMITS (95.00 PER CENT)	
MEAN	4.76000	0.15578	4.43910	5.08090
MEDIAN	5.00000	0.19524	4.59781	5.40219
VARIANCE	0.60667			
STAND. DEV.	0.77889			
COEFF. VAR	16.36320	2.37526	11.47016	21.25623
G1	-0.11226	0.45368	-1.02126	0.79675
G2	-0.25037	0.90172	-2.01810	1.51736
K-S DMAX	0.22101			

BASIC STATISTICS — 0103

N= 25   0 CLASSES   TRANSFORMATION CODE = 0

	STATISTIC	STAND.ERROR	CONFIDENCE LIMITS (95.00 PER CENT)	
MEAN	3.84000	0.09452	3.64530	4.03470
MEDIAN	4.00000	0.11846	3.75598	4.24402
VARIANCE	0.22333			
STAND.DEV.	0.47258			
COEFF. VAR	12.30681	1.76661	8.66750	15.94603
G1	-0.56849	0.46358	-1.47749	0.34052
G2	1.21271	0.90172	-0.55501	2.98044
K-S DMAX	0.39253			

BASIC STATISTICS — 0104

N= 25   0 CLASSES   TRANSFORMATION CODE = 0

	STATISTIC	STAND.ERROR	CONFIDENCE LIMITS (95.00 PER CENT)	
MEAN	4.24000	0.17589	3.87769	4.60231
MEDIAN	4.00000	0.22043	3.54592	4.45408
VARIANCE	0.77333			
STAND.DEV.	0.87939			
COEFF. VAR	20.74042	3.05671	14.44350	27.03721
G1	-0.11380	0.46358	-1.02210	0.79520
G2	1.16224	0.90172	-0.60549	2.92997
K-S DMAX	0.28754			

BASIC STATISTICS — 0105

N= 25   0 CLASSES   TRANSFORMATION CODE = 0

	STATISTIC	STAND.ERROR	CONFIDENCE LIMITS (95.00 PER CENT)	
MEAN	3.76000	0.14468	3.46195	4.05805
MEDIAN	4.00000	0.18133	3.52646	4.37354
VARIANCE	0.52333			
STAND.DEV.	0.72342			
COEFF. VAR	19.23934	2.81985	13.43095	25.04872
G1	-1.03014	0.46358	-1.93914	-0.12114
G2	1.53127	0.90172	-0.23646	3.29900
K-S DMAX	0.34996			

BASIC STATISTICS — 0201

N= 25   0 CLASSES   TRANSFORMATION CODE =   0

	STATISTIC	STAND.ERROR	CONFIDENCE LIMITS (95.00 PER CENT)	
MEAN	5.04000	0.15790	4.71472	5.36528
MEDIAN	5.00000	0.19790	4.59233	5.40767
VARIANCE	0.62333			
STAND.DEV.	0.78951			
COEFF. VAR	15.66497	2.26907	10.99059	20.33926
G1	-0.07333	0.46369	-0.99233	0.83567
G2	-1.35091	0.90172	-3.11854	0.41682
K-S DMAX	0.20020			

BASIC STATISTICS — 0202

N= 25   0 CLASSES   TRANSFORMATION CODE =   0

	STATISTIC	STAND.ERROR	CONFIDENCE LIMITS (95.00 PER CENT)	
MEAN	5.36000	0.28213	4.77880	5.94120
MEDIAN	5.00000	0.35360	4.27159	5.72841
VARIANCE	1.99000			
STAND.DEV.	1.41067			
COEFF. VAR	26.31854	3.97145	18.13734	34.49973
G1	-0.02849	0.46368	-0.93719	0.88081
G2	-0.76647	0.90172	-2.53420	1.00126
K-S DMAX	0.20071			

BASIC STATISTICS — 0203

N= 25   0 CLASSES   TRANSFORMATION CODE =   0

	STATISTIC	STAND.ERROR	CONFIDENCE LIMITS (95.00 PER CENT)	
MEAN	4.28000	0.24846	3.76817	4.79183
MEDIAN	5.00000	0.31140	4.35852	5.64148
VARIANCE	1.54333			
STAND.DEV.	1.24231			
COEFF. VAR	29.02593	4.43727	19.38516	38.16670
G1	0.12608	0.46368	-0.78232	1.03509
G2	-0.64103	0.90172	-2.40875	1.12669
K-S DMAX	0.20857			

BASIC STATISTICS   0204

N=   25   0 CLASSES   TRANSFORMATION CODE =   0

	STATISTIC	STAND.ERROR	CONFIDENCE LIMITS (95.00 PER CENT)	
MEAN	5.88000	0.40133	5.05326	6.70674
MEDIAN	6.00000	0.50299	4.96384	7.03616
VARIANCE	4.02667			
STAND.DEV.	2.00666			
COEFF. VAR	34.12680	5.55895	23.08737	45.16622
G1	0.34658	0.45368	-0.56242	1.25559
G2	-0.29109	0.90172	-2.05652	1.47663
K-S DMAX	0.15616			

BASIC STATISTICS   0205

N=   25   0 CLASSES   TRANSFORMATION CODE =   0

	STATISTIC	STAND.ERROR	CONFIDENCE LIMITS (95.00 PER CENT)	
MEAN	3.44000	0.18330	3.06240	3.81760
MEDIAN	3.00000	0.22973	2.52675	3.47325
VARIANCE	0.84000			
STAND.DEV.	0.91652			
COEFF. VAR	26.64288	4.02646	18.34838	34.93739
G1	0.72118	0.45368	-0.18732	1.63018
G2	1.36937	0.90172	-0.39855	3.13690
K-S DMAX	0.24441			

BASIC STATISTICS   0301

N=   25   0 CLASSES   TRANSFORMATION CODE =   0

	STATISTIC	STAND.ERROR	CONFIDENCE LIMITS (95.00 PER CENT)	
MEAN	4.40000	0.16330	4.06350	4.73640
MEDIAN	4.00000	0.20466	3.57839	4.42161
VARIANCE	0.66667			
STAND.DEV.	0.81650			
COEFF. VAR	18.55674	2.71318	12.96758	24.14590
G1	0.09984	0.45368	-0.80915	1.00885
G2	-0.27421	0.90172	-2.04174	1.49352
K-S DMAX	0.24790			

BASIC STATISTICS - 0302

N= 25   0 CLASSES   TRANSFORMATION CODE =   0

	STATISTIC	STAND.ERROR	CONFIDENCE LIMITS (95.00 PER CENT)	
MEAN	5.24000	0.14468	4.94195	5.53805
MEDIAN	5.00000	0.18133	4.62646	5.37354
VARIANCE	0.52333			
STAND.DEV.	0.72342			
COEFF. VAR	13.80568	1.98928	9.70775	17.90361
G1	-0.40540	0.46368	-1.31440	0.50361
G2	-0.90772	0.90172	-2.67545	0.86001
K-S DMAX	0.22996			

BASIC STATISTICS - 0303

N= 25   0 CLASSES   TRANSFORMATION CODE =   0

	STATISTIC	STAND.ERROR	CONFIDENCE LIMITS (95.00 PER CENT)	
MEAN	5.16000	0.21354	4.72010	5.59990
MEDIAN	5.00000	0.26763	4.44859	5.55132
VARIANCE	1.14000			
STAND.DEV.	1.06771			
COEFF. VAR	20.69201	3.04901	14.41115	26.97297
G1	-0.12038	0.46368	-1.02938	0.78863
G2	0.12080	0.90172	-1.64692	1.88853
K-S DMAX	0.23956			

BASIC STATISTICS - 0304

N= 25   0 CLASSES   TRANSFORMATION CODE =   0

	STATISTIC	STAND.ERROR	CONFIDENCE LIMITS (95.00 PER CENT)	
MEAN	4.96000	0.21970	4.50742	5.41258
MEDIAN	5.00000	0.27535	4.43279	5.56721
VARIANCE	1.20667			
STAND.DEV.	1.09848			
COEFF. VAR	22.14685	3.26207	15.38580	28.90791
G1	-0.32539	0.46368	-1.23439	0.58361
G2	-0.65072	0.90172	-2.41845	1.11700
K-S DMAX	0.15452			

BASIC STATISTICS — 0305

N= 25   0 CLASSES   TRANSFORMATION CODE = 0

	STATISTIC	STAND.ERROR	CONFIDENCE LIMITS	
			(95.00 PER CENT)	
MEAN	3.84000	0.13760	3.55655	4.12345
MEDIAN	4.00000	0.17245	3.64475	4.35525
VARIANCE	0.47333			
STAND.DEV.	0.68799			
COEFF. VAR	17.91646	2.61384	12.53195	23.30097
G1	0.21629	0.45368	-0.69271	1.12529
G2	-0.73120	0.90172	-2.49893	1.03653
K-S DMAX	0.24805			

BASIC STATISTICS — 0401

N= 25   0 CLASSES   TRANSFORMATION CODE = 0

	STATISTIC	STAND.ERROR	CONFIDENCE LIMITS	
			(95.00 PER CENT)	
MEAN	6.24000	0.23295	5.76012	6.71988
MEDIAN	6.00000	0.29196	5.39856	6.60144
VARIANCE	1.35667			
STAND.DEV.	1.16476			
COEFF. VAR	18.66603	2.73020	13.04132	24.29025
G1	-0.50984	0.45368	-1.41885	0.39916
G2	-0.16549	0.90172	-1.93322	1.60223
K-S DMAX	0.17838			

BASIC STATISTICS — 0402

N= 25   0 CLASSES   TRANSFORMATION CODE = 0

	STATISTIC	STAND.ERROR	CONFIDENCE LIMITS	
			(95.00 PER CENT)	
MEAN	4.92000	0.22301	4.46060	5.37940
MEDIAN	5.00000	0.27950	4.42423	5.57577
VARIANCE	1.24333			
STAND.DEV.	1.11505			
COEFF. VAR	22.66359	3.35572	15.73021	29.59697
G1	-0.22298	0.45368	-1.13193	0.68603
G2	-0.82969	0.90172	-2.59742	0.93804
K-S DMAX	0.15534			

BASIC STATISTICS — 0403

| N= | 25 | 0 CLASSES | TRANSFORMATION CODE = | 0 |

	STATISTIC	STAND.ERROR	CONFIDENCE LIMITS (95.00 PER CENT)	
MEAN	4.52000	0.14283	4.22577	4.81423
MEDIAN	5.00000	0.17901	4.63125	5.36875
VARIANCE	0.51000			
STAND.DEV.	0.71414			
COEFF. VAR	15.79962	2.28950	11.08325	20.51599
G1	-0.44885	0.46366	-1.35786	0.46015
G2	0.04665	0.90172	-1.72108	1.81438
K-S DMAX	0.26925			

BASIC STATISTICS — 0404

| N= | 25 | 0 CLASSES | TRANSFORMATION CODE = | 0 |

	STATISTIC	STAND.ERROR	CONFIDENCE LIMITS (95.00 PER CENT)	
MEAN	5.00000	0.16330	4.66360	5.33640
MEDIAN	5.00000	0.20466	4.57839	5.42161
VARIANCE	0.66667			
STAND.DEV.	0.81650			
COEFF. VAR	16.32993	2.37019	11.44735	21.21251
G1	-0.49922	0.46366	-1.40822	0.40979
G2	-0.04298	0.90172	-1.81071	1.72474
K-S DMAX	0.22000			

The Number of Complete Vesicles per Unit Area
(VC/.25)

BASIC STATISTICS — 0101

N= 25   0 CLASSES   TRANSFORMATION CODE =   0

	STATISTIC	STAND.ERROR	CONFIDENCE LIMITS (95.00 PER CENT)	
MEAN	7.88000	0.51095	6.82745	8.93255
MEDIAN	7.00000	0.64027	5.68034	8.31916
VARIANCE	6.52667			
STAND.DEV.	2.55473			
COEFF. VAR	32.42048	5.04390	22.03005	42.81091
G1	0.66665	0.45366	-0.24235	1.57565
G2	-0.07169	0.90172	-1.83852	1.69664
K-S DMAX	0.15475			

BASIC STATISTICS — 0102

N= 25   0 CLASSES   TRANSFORMATION CODE =   0

	STATISTIC	STAND.ERROR	CONFIDENCE LIMITS (95.00 PER CENT)	
MEAN	7.12000	0.44467	6.20398	8.03602
MEDIAN	7.00000	0.55731	5.85195	8.14805
VARIANCE	4.94333			
STAND.DEV.	2.22336			
COEFF. VAR	31.22698	4.82762	21.28207	41.17188
G1	0.47902	0.45366	-0.42999	1.38802
G2	0.43329	0.90172	-1.33444	2.20102
K-S DMAX	0.14613			

BASIC STATISTICS — 0103

N= 25   0 CLASSES   TRANSFORMATION CODE =   0

	STATISTIC	STAND.ERROR	CONFIDENCE LIMITS (95.00 PER CENT)	
MEAN	4.00000	0.30000	3.38200	4.61800
MEDIAN	4.00000	0.37599	3.22546	4.77454
VARIANCE	2.25000			
STAND.DEV.	1.50000			
COEFF. VAR	37.50000	6.00293	25.13397	49.86603
G1	-0.16103	0.45368	-1.07003	0.74797
G2	-0.56039	0.90172	-2.32811	1.20734
K-S DMAX	0.14751			

BASIC STATISTICS — 0104

N= 25   0 CLASSES   TRANSFORMATION CODE =   0

	STATISTIC	STAND.ERROR	CONFIDENCE LIMITS (95.00, PER CENT)	
MEAN	6.32000	0.38609	5.52465	7.11535
MEDIAN	6.00000	0.48389	5.00319	6.99681
VARIANCE	3.72667			
STAND.DEV.	1.93046			
COEFF. VAR	30.54522	4.70555	24.85177	40.23866
G1	-0.00429	0.45368	-0.91329	0.90471
G2	-0.81875	0.90172	-2.54648	0.94898
K-S DMAX	0.16583			

BASIC STATISTICS — 0105

N= 25   0 CLASSES   TRANSFORMATION CODE =   0

	STATISTIC	STAND.ERROR	CONFIDENCE LIMITS (95.00, PER CENT)	
MEAN	5.08000	0.50964	4.03014	6.12986
MEDIAN	5.00000	0.63873	3.58421	6.31579
VARIANCE	6.49333			
STAND.DEV.	2.54820			
COEFF. VAR	50.16146	8.69758	32.24444	68.07847
G1	0.51071	0.45368	-0.39529	1.41972
G2	-0.39080	0.90172	-2.15852	1.37693
K-S DMAX	0.14415			

BASIC STATISTICS — 0201

N= 25   0 CLASSES   TRANSFORMATION CODE =   0

	STATISTIC	STAND.ERROR	CONFIDENCE LIMITS (95.00, PER CENT)	
MEAN	6.20000	0.31091	5.55952	6.84048
MEDIAN	6.00000	0.38967	5.19729	6.80271
VARIANCE	2.41667			
STAND.DEV.	1.55456			
COEFF. VAR	25.07360	3.76227	17.32332	32.82388
G1	0.28933	0.45368	-0.51958	1.19833
G2	-0.20864	0.90172	-1.97657	1.55889
K-S DMAX	0.19118			

BASIC STATISTICS — 0202

N= 25   0 CLASSES   TRANSFORMATION CODE =   0

	STATISTIC	STAND.ERROR	CONFIDENCE LIMITS (95.00 PER CENT)	
MEAN	4.44000	0.42063	3.57349	5.30651
MEDIAN	4.00000	0.52718	2.91411	5.08599
VARIANCE	4.42333			
STAND.DEV.	2.10317			
COEFF. VAR	47.36874	8.05315	30.75854	63.97884
G1	0.55853	0.45368	-0.35042	1.46759
G2	-0.42554	0.90172	-2.19327	1.34219
K-S DMAX	0.18286			

BASIC STATISTICS — 0203

N= 25   0 CLASSES   TRANSFORMATION CODE =   0

	STATISTIC	STAND.ERROR	CONFIDENCE LIMITS (95.00 PER CENT)	
MEAN	5.64000	0.35062	4.91773	6.36227
MEDIAN	6.00000	0.43943	5.09477	6.90523
VARIANCE	3.07333			
STAND.DEV.	1.75309			
COEFF. VAR	31.08320	4.80179	21.19151	40.97489
G1	0.55354	0.45368	-0.35556	1.46234
G2	0.83541	0.90172	-0.93252	2.60284
K-S DMAX	0.17865			

BASIC STATISTICS — 0204

N= 25   0 CLASSES   TRANSFORMATION CODE =   0

	STATISTIC	STAND.ERROR	CONFIDENCE LIMITS (95.00 PER CENT)	
MEAN	7.32000	0.50570	6.27825	8.36174
MEDIAN	7.00000	0.63379	5.59438	8.30562
VARIANCE	6.39333			
STAND.DEV.	2.52850			
COEFF. VAR	34.54241	5.43675	23.34270	45.74211
G1	0.73368	0.45368	-0.17532	1.64269
G2	-0.30075	0.90172	-2.06848	1.46698
K-S DMAX	0.19035			

BASIC STATISTICS — 0205

| N= | 25 | 0 CLASSES | TRANSFORMATION CODE = | 0 |

| | STATISTIC | STAND.ERROR | CONFIDENCE LIMITS |
| | | | (95.00 PER CENT) |

	STATISTIC	STAND.ERROR	CONFIDENCE LIMITS	
MEAN	7.88000	0.39716	7.06186	8.69814
MEDIAN	8.00000	0.49776	6.97462	9.02538
VARIANCE	3.94333			
STAND.DEV.	1.98578			
COEFF. VAR	25.20029	3.79342	17.40644	32.99413
G1	0.28495	0.46368	-0.52424	1.19306
G2	-0.68003	0.90172	-2.44835	1.08709
K-S DMAX	0.14821			

BASIC STATISTICS — 0301

| N= | 25 | 0 CLASSES | TRANSFORMATION CODE = | 0 |

| | STATISTIC | STAND.ERROR | CONFIDENCE LIMITS |

| | | | (95.00 PER CENT) |

	STATISTIC	STAND.ERROR	CONFIDENCE LIMITS	
MEAN	6.60000	0.46547	5.64112	7.55888
MEDIAN	7.00000	0.58338	5.79824	8.20176
VARIANCE	5.41667			
STAND.DEV.	2.32737			
COEFF. VAR	35.26323	5.57270	23.78345	46.74300
G1	1.06934	0.46368	0.16014	1.97815
G2	3.31417	0.90172	1.54645	5.08190
K-S DMAX	0.19374			

BASIC STATISTICS — 0302

| N= | 25 | 0 CLASSES | TRANSFORMATION CODE = | 0 |

| | STATISTIC | STAND.ERROR | CONFIDENCE LIMITS |
| | | | (95.00 PER CENT) |

	STATISTIC	STAND.ERROR	CONFIDENCE LIMITS	
MEAN	6.04000	0.41020	5.19498	6.88502
MEDIAN	6.00000	0.51411	4.94094	7.05906
VARIANCE	4.20667			
STAND.DEV.	2.05102			
COEFF. VAR	33.95722	5.32732	22.98294	44.93150
G1	0.06753	0.46368	-0.84133	0.97663
G2	-0.14244	0.90172	-1.91017	1.62529
K-S DMAX	0.15937			

BASIC STATISTICS — 0303

N= 25   0 CLASSES   TRANSFORMATION CODE = 0

	STATISTIC	STAND.ERROR	CONFIDENCE LIMITS (95.00 PER CENT)	
MEAN	3.84000	0.34967	3.11353	4.56031
MEDIAN	4.00000	0.43824	3.09723	4.90277
VARIANCE	3.05667			
STAND.DEV.	1.74833			
COEFF. VAR	45.52949	7.65813	29.75375	61.30524
G1	0.51963	0.46368	-0.38937	1.42861
G2	0.12597	0.90172	-1.64255	1.89279
K-S DMAX	0.16455			

BASIC STATISTICS — 0304

N= 25   0 CLASSES   TRANSFORMATION CODE = 0

	STATISTIC	STAND.ERROR	CONFIDENCE LIMITS (95.00 PER CENT)	
MEAN	2.48000	0.17436	2.12083	2.83917
MEDIAN	2.00000	0.21852	1.54985	2.45015
VARIANCE	0.76000			
STAND.DEV.	0.87178			
COEFF. VAR	35.15241	5.55172	23.71587	46.58895
G1	0.06628	0.46368	-0.84272	0.97528
G2	-0.48709	0.90172	-2.25432	1.28054
K-S DMAX	0.22905			

BASIC STATISTICS — 0305

N= 25   0 CLASSES   TRANSFORMATION CODE = 0

	STATISTIC	STAND.ERROR	CONFIDENCE LIMITS (95.00 PER CENT)	
MEAN	4.44000	0.51666	3.37569	5.50431
MEDIAN	4.00000	0.64752	2.56610	5.33390
VARIANCE	6.67333			
STAND.DEV.	2.58328			
COEFF. VAR	58.18197	10.65550	36.23155	80.13229
G1	0.96537	0.46368	0.05637	1.87433
G2	-0.02172	0.90172	-1.78945	1.74601
K-S DMAX	0.19138			

BASIC STATISTICS — 0401

N= 25   0 CLASSES   TRANSFORMATION CODE = 0

	STATISTIC	STAND. ERROR	CONFIDENCE LIMITS (95.00 PER CENT)	
MEAN	5.48000	0.33226	4.79553	6.16447
MEDIAN	5.00000	0.41643	4.14215	5.85784
VARIANCE	2.76000			
STAND. DEV.	1.66132			
COEFF. VAR	30.31615	4.55477	20.70671	39.92559
G1	0.74919	0.45368	-0.15932	1.65812
G2	0.05231	0.90172	-1.71542	1.82004
K-S DMAX	0.21368			

BASIC STATISTICS — 0402

N= 25   0 CLASSES   TRANSFORMATION CODE = 0

	STATISTIC	STAND. ERROR	CONFIDENCE LIMITS (95.00 PER CENT)	
MEAN	6.48000	0.42864	5.59700	7.36300
MEDIAN	6.00000	0.53722	4.39333	7.10667
VARIANCE	4.59333			
STAND. DEV.	2.14321			
COEFF. VAR	33.07417	5.16377	22.43651	43.71153
G1	0.60952	0.45368	-0.29949	1.51853
G2	0.50162	0.90172	-1.26511	2.26935
K-S DMAX	0.15508			

BASIC STATISTICS — 0403

N= 25   0 CLASSES   TRANSFORMATION CODE = 0

	STATISTIC	STAND. ERROR	CONFIDENCE LIMITS (95.00 PER CENT)	
MEAN	2.72000	0.24166	2.22218	3.21782
MEDIAN	3.00000	0.30287	2.37508	3.62392
VARIANCE	1.46000			
STAND. DEV.	1.20830			
COEFF. VAR	44.42296	7.41925	29.13932	59.70661
G1	0.28195	0.45368	-0.62705	1.19095
G2	-0.78692	0.90172	-2.55454	0.98081
K-S DMAX	0.20437			

BASIC STATISTICS — 0404

| N= | 25 | 0 CLASSES | TRANSFORMATION CODE = | 0 |

	STATISTIC	STAND.ERROR	CONFIDENCE LIMITS (95.00 PER CENT)	
MEAN	5.08000	0.32619	4.40815	5.75195
MEDIAN	5.00000	0.40861	4.15734	5.84216
VARIANCE	2.66000			
STAND.DEV.	1.63095			
COEFF. VAR	32.10533	4.98647	21.33321	42.37745
G1	0.04871	0.46368	-0.86030	0.95771
G2	1.12418	0.90172	-0.64355	2.89191
K-S DMAX	0.20044			

Number of Vesicles between Nearest Neighbor Zooecia
(VCT)

BASIC STATISTICS — 0101

N= 25   0 CLASSES   TRANSFORMATION CODE =   0

	STATISTIC	STAND.ERROR	CONFIDENCE LIMITS (95.00,PER CENT)	
MEAN	1.00000	0.	1.00000	1.00000
MEDIAN	1.00000	0.	1.00000	1.00000
VARIANCE	0.			
STAND.DEV.	0.			
COEFF. VAR	0.	0.	0.	0.
G1	0.17014E 39	0.45368	0.17014E 39	0.17014E 39
G2	0.17014E 39	0.90172	0.17014E 39	0.17014E 39
K-S DMAX	0.96000			

BASIC STATISTICS — 0102

N= 25   0 CLASSES   TRANSFORMATION CODE =   0

	STATISTIC	STAND.ERROR	CONFIDENCE LIMITS (95.00,PER CENT)	
MEAN	0.96000	0.09092	0.77270	1.14730
MEDIAN	1.00000	0.11395	0.76526	1.23474
VARIANCE	0.20667			
STAND.DEV.	0.45461			
COEFF. VAR	47.35430	8.06005	30.75110	63.95849
G1	-0.19436	0.45368	-1.10337	0.71464
G2	2.71024	0.90172	0.94252	4.47797
K-S DMAX	0.36494			

BASIC STATISTICS — 0103

N= 25   0 CLASSES   TRANSFORMATION CODE =   0

	STATISTIC	STAND.ERROR	CONFIDENCE LIMITS (95.00,PER CENT)	
MEAN	1.08000	0.09866	0.87677	1.28323
MEDIAN	1.00000	0.12365	0.74529	1.25471
VARIANCE	0.24333			
STAND.DEV.	0.49329			
COEFF. VAR	45.67484	7.68977	29.83391	61.51577
G1	0.22095	0.46368	-0.68805	1.12996
G2	1.63569	0.90172	-0.13204	3.40342
K-S DMAX	0.40442			

BASIC STATISTICS — 0104

N = 25   0 CLASSES   TRANSFORMATION CODE = 0

	STATISTIC	STAND. ERROR	CONFIDENCE LIMITS (95.00, PER CENT)	
MEAN	1.08000	0.11431	0.84452	1.31548
MEDIAN	1.00000	0.14326	0.70438	1.29512
VARIANCE	0.32667			
STAND. DEV.	0.57155			
COEFF. VAR	52.92107	9.34811	33.66377	72.17818
G1	0.02552	0.45368	-0.88339	0.93462
G2	0.42917	0.90172	-1.33855	2.19690
K-S DMAX	0.35566			

BASIC STATISTICS — 0105

N = 25   0 CLASSES   TRANSFORMATION CODE = 0

	STATISTIC	STAND. ERROR	CONFIDENCE LIMITS (95.00, PER CENT)	
MEAN	1.12000	0.08774	0.93884	1.30116
MEDIAN	1.00000	0.11021	0.77296	1.22704
VARIANCE	0.19333			
STAND. DEV.	0.43970			
COEFF. VAR	39.25865	6.35042	26.17699	52.34030
G1	0.68536	0.45368	-0.22355	1.59436
G2	2.27919	0.90172	0.51146	4.04692
K-S DMAX	0.44754			

BASIC STATISTICS — 0201

N = 25   0 CLASSES   TRANSFORMATION CODE = 0

	STATISTIC	STAND. ERROR	CONFIDENCE LIMITS (95.00, PER CENT)	
MEAN	1.04000	0.04000	0.95750	1.12240
MEDIAN	1.00000	0.05013	0.89673	1.10327
VARIANCE	0.04000			
STAND. DEV.	0.20000			
COEFF. VAR	19.23077	2.81843	13.42431	25.03673
G1	5.00000	0.45368	4.09110	5.90900
G2	25.00001	0.90172	23.23228	26.76773
K-S DMAX	0.53926			

BASIC STATISTICS — 0202

N= 25   0 CLASSES   TRANSFORMATION CODE = 0

	STATISTIC	STAND.ERROR	CONFIDENCE LIMITS (95.00, PER CENT)	
MEAN	0.92000	0.05538	0.80592	1.03408
MEDIAN	1.00000	0.06940	0.85713	1.14297
VARIANCE	0.07567			
STAND.DEV.	0.27509			
COEFF. VAR	30.09546	4.62578	20.56735	39.62556
G1	-3.29753	0.45358	-4.20653	-2.38852
G2	9.64083	0.90172	7.87310	11.40856
K-S DMAX	0.49358			

BASIC STATISTICS — 0203

N= 25   0 CLASSES   TRANSFORMATION CODE = 0

	STATISTIC	STAND.ERROR	CONFIDENCE LIMITS (95.00, PER CENT)	
MEAN	0.96000	0.07024	0.81531	1.10469
MEDIAN	1.00000	0.08803	0.81856	1.18134
VARIANCE	0.12333			
STAND.DEV.	0.35119			
COEFF. VAR	36.58213	5.82434	24.58297	48.58129
G1	-0.67235	0.45358	-1.58135	0.23645
G2	6.67895	0.90172	4.91122	8.44668
K-S DMAX	0.42534			

BASIC STATISTICS — 0204

N= 25   0 CLASSES   TRANSFORMATION CODE = 0

	STATISTIC	STAND.ERROR	CONFIDENCE LIMITS (95.00, PER CENT)	
MEAN	1.08000	0.08000	0.91520	1.24480
MEDIAN	1.00000	0.10026	0.79346	1.20654
VARIANCE	0.16000			
STAND.DEV.	0.40000			
COEFF. VAR	37.03704	5.91283	24.85661	49.21746
G1	0.75418	0.45358	-0.15423	1.66308
G2	3.92478	0.90172	2.15705	5.69251
K-S DMAX	0.45926			

BASIC STATISTICS — 0205

N= 25   0 CLASSES   TRANSFORMATION CODE = 0

	STATISTIC	STAND. ERROR	CONFIDENCE LIMITS (95.00 PER CENT)	
MEAN	0.96000	0.04000	0.87750	1.04240
MEDIAN	1.00000	0.05013	0.89673	1.10327
VARIANCE	0.04000			
STAND.DEV.	0.20000			
COEFF. VAR	20.83333	3.07149	14.50615	27.16061
G1	-5.00000	0.46368	-5.90900	-4.09100
G2	25.00000	0.90172	23.23227	26.76773
K-S DMAX	0.49926			

BASIC STATISTICS — 0301

N= 25   0 CLASSES   TRANSFORMATION CODE = 0

	STATISTIC	STAND. ERROR	CONFIDENCE LIMITS (95.00 PER CENT)	
MEAN	1.20000	0.10000	0.99410	1.40600
MEDIAN	1.00000	0.12533	0.74182	1.25818
VARIANCE	0.25000			
STAND.DEV.	0.50000			
COEFF. VAR	41.66667	6.83948	27.57733	55.75601
G1	0.43478	0.46368	-0.47422	1.34379
G2	0.49012	0.90172	-1.27761	2.25785
K-S DMAX	0.41542			

BASIC STATISTICS — 0302

N= 25   0 CLASSES   TRANSFORMATION CODE = 0

	STATISTIC	STAND. ERROR	CONFIDENCE LIMITS (95.00 PER CENT)	
MEAN	1.04000	0.04000	0.95760	1.12240
MEDIAN	1.00000	0.05013	0.89673	1.10327
VARIANCE	0.04000			
STAND.DEV.	0.20000			
COEFF. VAR	19.23077	2.81843	13.42431	25.03673
G1	5.00000	0.46368	4.09100	5.90900
G2	25.00000	0.90172	23.23227	26.76773
K-S DMAX	0.53926			

BASIC STATISTICS — 0303

N=	25	0 CLASSES	TRANSFORMATION CODE =	0

	STATISTIC	STAND.ERROR	CONFIDENCE LIMITS (95.00 PER CENT)	
MEAN	0.80000	0.03165	0.63180	0.96820
MEDIAN	1.00000	0.10233	0.78920	1.21080
VARIANCE	0.16667			
STAND.DEV.	0.40825			
COEFF. VAR	51.03104	8.90000	32.59703	69.36504
G1	-1.59749	0.45368	-2.50650	-0.68849
G2	0.59289	0.90172	-1.17434	2.36061
K-S DMAX	0.44790			

BASIC STATISTICS — 0304

N=	25	0 CLASSES	TRANSFORMATION CODE =	0

	STATISTIC	STAND.ERROR	CONFIDENCE LIMITS (95.00 PER CENT)	
MEAN	0.60000	0.10000	0.39400	0.80600
MEDIAN	1.00000	0.12533	0.74132	1.25818
VARIANCE	0.25000			
STAND.DEV.	0.50000			
COEFF. VAR	83.33333	18.21511	45.81021	120.85645
G1	-0.43478	0.45368	-1.34379	0.47422
G2	-1.97628	0.90172	-3.74431	-0.20856
K-S DMAX	0.34814			

BASIC STATISTICS — 0305

N=	25	0 CLASSES	TRANSFORMATION CODE =	0

	STATISTIC	STAND.ERROR	CONFIDENCE LIMITS (95.00 PER CENT)	
MEAN	1.20000	0.03165	1.03130	1.36820
MEDIAN	1.00000	0.10233	0.78920	1.21080
VARIANCE	0.16667			
STAND.DEV.	0.40825			
COEFF. VAR	34.02069	5.33915	23.02204	45.01934
G1	1.59749	0.45368	0.68849	2.50650
G2	0.59289	0.90172	-1.17434	2.36061
K-S DMAX	0.48790			

BASIC STATISTICS — 0401

N= 25   0 CLASSES   TRANSFORMATION CODE =   0

	STATISTIC	STAND.ERROR	CONFIDENCE LIMITS (95.00 PER CENT)	
MEAN	1.16000	0.07483	1.00584	1.31416
MEDIAN	1.00000	0.09379	0.80680	1.19320
VARIANCE	0.14000			
STAND.DEV.	0.37417			
COEFF. VAR	32.25567	5.01363	21.92717	42.58415
G1	1.97541	0.45368	1.06641	2.88441
G2	2.06098	0.90172	0.29325	3.82871
K-S DMAX	0.50554			

BASIC STATISTICS — 0402

N= 25   0 CLASSES   TRANSFORMATION CODE =   0

	STATISTIC	STAND.ERROR	CONFIDENCE LIMITS (95.00 PER CENT)	
MEAN	0.92000	0.05538	0.80592	1.03408
MEDIAN	1.00000	0.06940	0.85703	1.14297
VARIANCE	0.07667			
STAND.DEV.	0.27689			
COEFF. VAR	30.09646	4.62578	20.56735	39.62556
G1	-3.29753	0.45368	-4.20653	-2.38852
G2	9.64083	0.90172	7.87310	11.40856
K-S DMAX	0.49368			

BASIC STATISTICS — 0403

N= 25   0 CLASSES   TRANSFORMATION CODE =   0

	STATISTIC	STAND.ERROR	CONFIDENCE LIMITS (95.00 PER CENT)	
MEAN	0.92000	0.05538	0.80592	1.03408
MEDIAN	1.00000	0.06940	0.85703	1.14297
VARIANCE	0.07667			
STAND.DEV.	0.27689			
COEFF. VAR	30.09646	4.62578	20.56735	39.62556
G1	-3.29753	0.45368	-4.20653	-2.38852
G2	9.64083	0.90172	7.87310	11.40856
K-S DMAX	0.49368			

BASIC STATISTICS — 0404

| N= | 25 | 0 CLASSES | TRANSFORMATION CODE = | 0 |

	STATISTIC	STAND.ERROR	CONFIDENCE LIMITS (95.00.PER CENT)	
MEAN	1.00000	0.05774	0.88117	1.11893
MEDIAN	1.00000	0.07236	0.85094	1.14906
VARIANCE	0.08333			
STAND.DEV.	0.28868			
COEFF. VAR	28.86751	4.40959	19.79377	37.95126
G1	0.	0.46368	-0.90900	0.90900
G2	12.00000	0.90172	10.23227	13.76773
K-S DMAX	0.46000			