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Front Cover: View to the SSE on White Cay in Grahams Harbour off the north coast of San Salvador, Bahamas. At this spectacularly scenic site one can see that marine erosion has removed the entire windward portion of these early Holocene eolianites (North Point Member, with an alochem age of ~5000 radiocarbon years B.P.) that were deposited when sea level was at least 2 meters below its present position.

Back Cover: Stephen Jay Gould, keynote speaker for this symposium, holds a *Cerion rodregoi* at the Chicago Herald Tribune's 1891 monument to the landfall of Christopher Colombus, which is located on the windward coast of Crab Cay on the eastern side of San Salvador Island, Bahamas. The monument consists of an obelisk constructed from local limestone which houses a carved rock sphere depicting the globe with the continents. The inscription carved in a marble slab, reads: "On this spot, Christopher Columbus first set foot upon the soil of the New World."

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MORPHOLOGY OF FOSSIL AND MODERN *CERION* FROM SAN SALVADOR ISLAND, BAHAMAS

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ABSTRACT

The terrestrial gastropod *Cerion* sp. has been used as a paleontological criterion for distinguishing between deposits of differing ages on San Salvador and New Providence islands in the Bahamas. The various morphotypes of *Cerion* are thought to be the result of rapid evolution; and thus, are useful for distinguishing depositional events that occurred during different high stands of sea level associated with oxygen isotope stages and substages of the Quaternary.

Adult *Cerion* shells were collected from twenty-seven fossil and modern populations on San Salvador Island. Twenty-five shells were randomly selected from each population. Their shapes were digitized using a computer scanner, and were then enlarged and enhanced to make the shell characteristics more visible. Care was taken to insure a distortion-free computer image. Measurments including shell height and width, height and width of specific whorls, and aperture height and width were measured directly from the computer image. The number of whorls and number of ribs on specific whorls were counted on the specimens themselves.

Cluster analysis of the average measured values from each location indicate that the *Cerion* populations make poor biostratigraphic indicators. The variation of the average measured values between geographic locations is as great as the variation between fossil and modern populations. Generally, larger shells are found on the eastern, windward, side of the island, while smaller shells are found in the island interior and on the western, leeward, side.

INTRODUCTION

Garrett and Gould (1984) and Hearty et al. (1993) have used *Cerion* sp. for distinguishing between deposits of differing ages on San Salvador and New Providence islands in the Bahamas. The various morphotypes of *Cerion* are thought to be the result of rapid evolution; and thus, are useful for distinguishing depositional events that occurred during different high stands of sea level associated with oxygen isotope stages and substages of the Quaternary.

The occurrence of *Cerion* sp. is well documented in the Bahama islands (e.g., Clench, 1957; Garrett and Gould, 1984; Gould, 1984, 1993; Gould and Woodruff, 1978; Mayr and Rosen, 1956). Gould et al. (1974) described a morphometric method of characterizing the *Cerion* shell shape using nineteen measures for samples that they had collected on Great Abaco, Bahamas. These measurements were analyzed using R-mode factor analysis in an effort to determine the patterns of variation among the *Cerion* samples they had collected. While this morphometric method is excellent for small populations, we found that for larger sample populations it proved to be impractical because of the time necessary to complete all of the nineteen measures.

In this paper, we are reporting a new methodology using computer scanning techniques to determine seven morphometric characteristics of the *Cerion* shell. Further, we will demonstrate that the variation of the *Cerion* shell morphology on San Salvador Island is a function of environmental parameters rather than age, suggesting that, at least for the San Salvador *Cerion* population, this taxon in not a reliable stratigraphic indicator.

San Salvador Island, Bahamas is located at approximately 24° 00' N and 74° 30' W (Figure 1). As one of the most windward islands, San Salvador is different than other Bahamian islands in the archipelago. It does not occur on an extensive bank as do many other Bahamian islands, and it is surrounded by deep water with only a small shallow bank on the northern end of the island. For this reason, it has been geographically isolated even during Quaternary sea level lowstands, and thus the *Cerion* probably have been genetically isolated.

METHODS

Living, Holocene subfossil, and Pleistocene fossil populations of *Cerion* were collected from 27 locations on San Salvador Island (Figure 2 and Table 1). Of these collecting localities, 19 yielded Holocene *Cerion* shells, and nine yielded fossil *Cerion* shells. At each locality, 25 to 100 shells were collected. The shells were subsequently washed and curated, and 25 adult shells exhibiting the final thickened apertural "Phase 3" lip as defined by Gould (1984) were randomly selected for biometric analysis. Thus, 675 adult shells were initially used in this study.

Morphometric Measurements

The 25 shells from each sample location were glued onto stiff paper, with the aperture facing up and parallel to the paper, and then scanned into a computer file. The image was enlarged and enhanced to make the

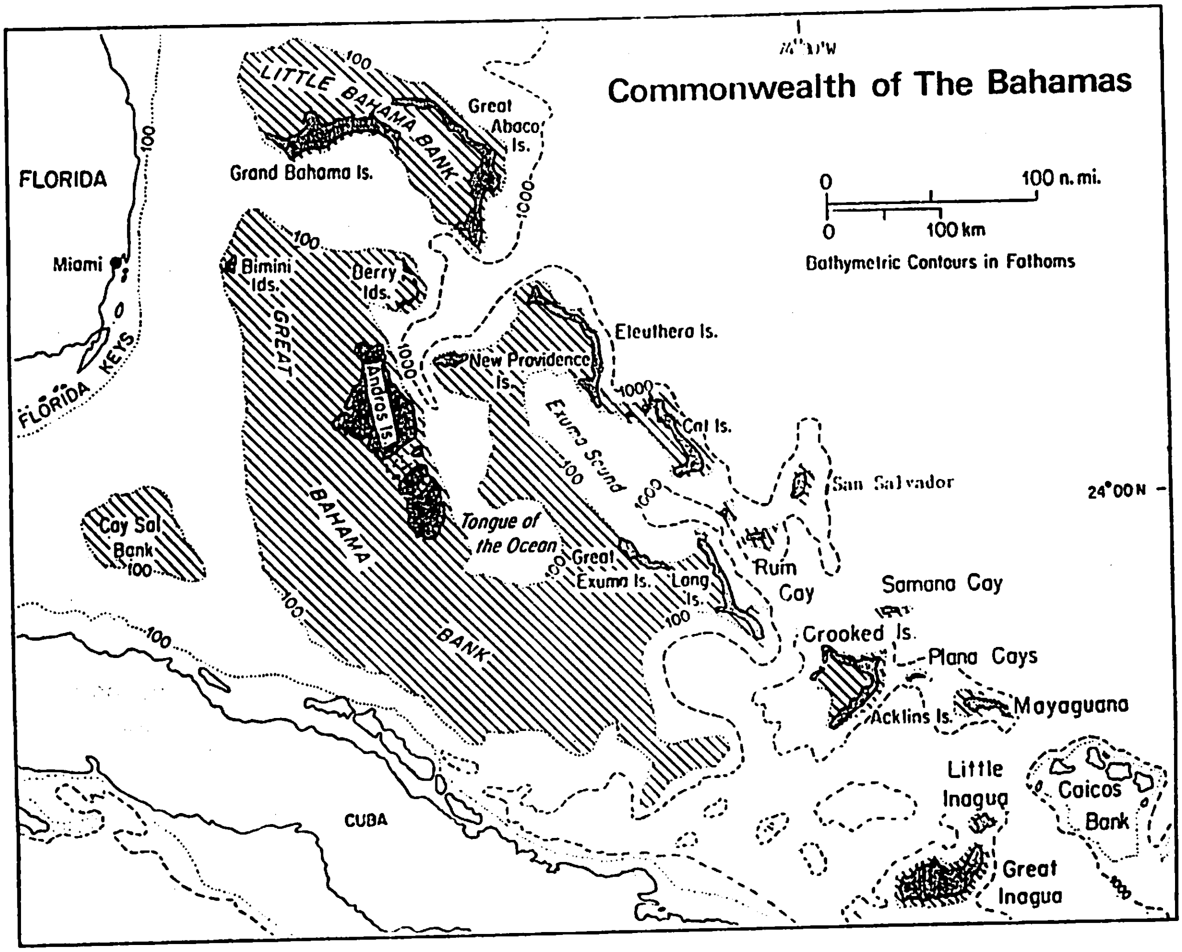

Figure 1. Map of the Bahamian archipelago.

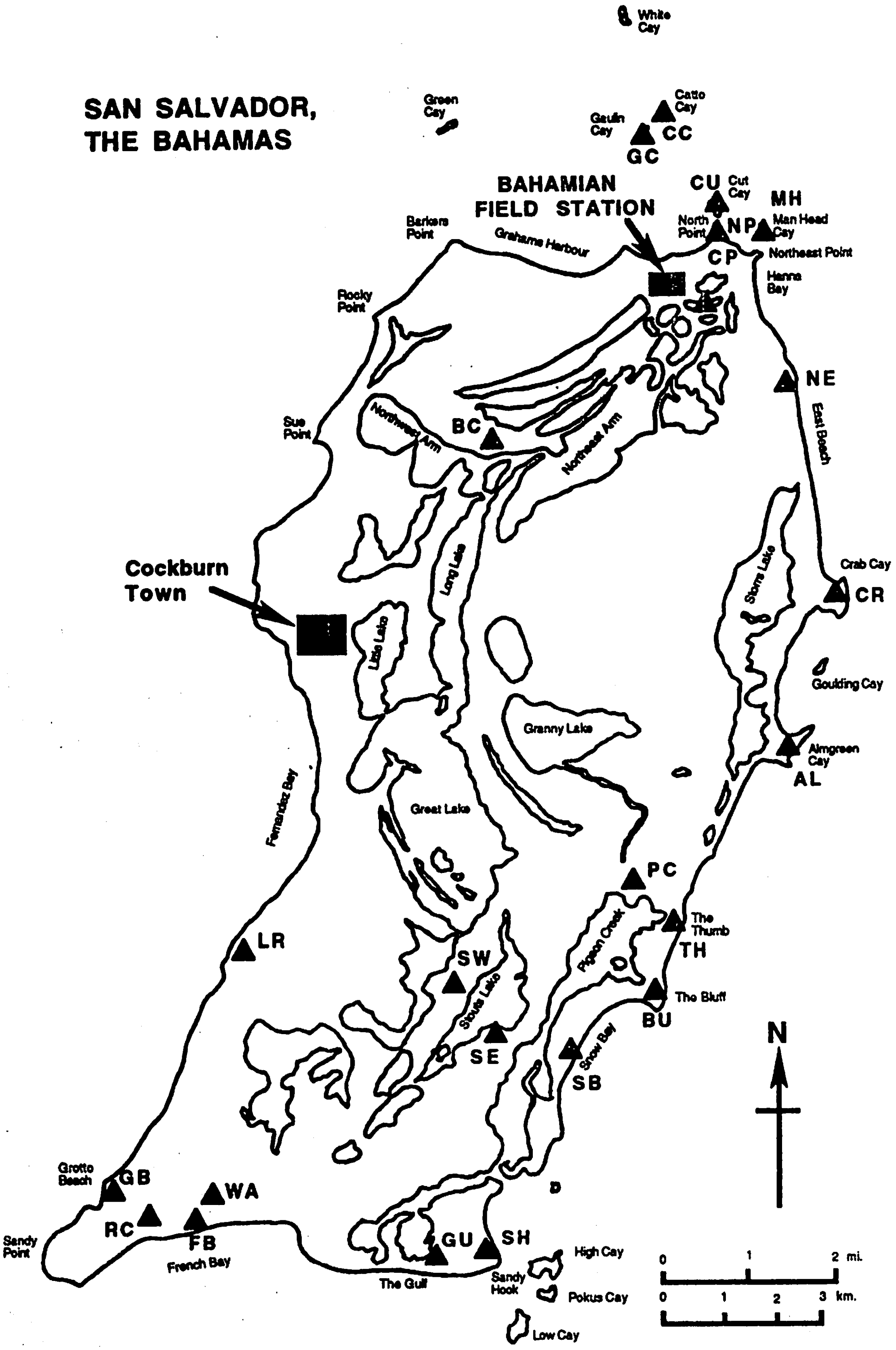

Figure 2. Map of collection localities on San Salvador Island.

Table 1. Key to sample location abbreviations used in this report.

Abbreviation	Location	Holocene or Pleistocene
AL	Almgreen Cay	Pleistocene/Holocene
BC	Barn Cay Ridge	Holocene
BU	The Bluff	Pleistocene/Pleistocene/Holocene*
CC	Catto Cay	Holocene
CP	Crescent Pond	Holocene
CR	Crab Cay	Holocene
CU	Cut Cay	Holocene
FB	French Bay	Pleistocene
GB	Grotto Beach	Holocene
GC	Gaulin Cay	Holocene
GU	TheGulf	Pleistocene
LR	Linsey Reef	Holocene
MH	Man Head Cay	Pleistocene/Holocene
NE	North End East Beach	Holocene
NP	North Point	Holocene
PC	Pigeon Creen	Holocene
RC	Road Cut	Pleistocene
SB	Snow Bay	Holocene
SE	Stouts Lake East	Holocene
SH	Sandy Hook	Holocene
SW	Stouts Lake West	Holocene
TH	The Thumb	Holocene
WA	Watling's Quarry	Pleistcene

*The Bluff contains two Pleistocene age fossil populations and one modern population.

measurement of the shell characteristics easier. Care was taken to insure that a distortion-free image was obtained.

The height to depth ratio of the ribs on *Cerion* shells is an obvious morphologic variable that also appears to be dependent on location, but the "ribbiness" of the cannot be reliably measured, and some shells have such shallow ribs that they cannot be accurately determined. Shell coloration, or mottling is another morphologic variable that we have not used because shell bleaching occurs rapidly after deach, and virtually all fossil and subfossil shells lack coloration.

Of the following measurements, 1 through 6 were measured from the scanned images (see Figure 3), and measurements 7 through 9 were measured directly on the shell.

1. Total Height - Measured parallel to the axis of coiling, from the apex to the lower end of the apertural tip.

2. Total Width - Measured at the widest portion of the shell, perpendicular to the axis of coiling.

3. Apertural Height - Measured parallel to the axis of coiling, from the highest point on the outer edge of the apertural lip to the lowest point on the outer edge of the apertural lip.

4. Apertural Width - Measured perpendicular to the axis of coiling, from the left most point to the right most point on the outer edges of the apertural lip.

5. Height of the Fourth Whorl - Measured at its widest value, parallel to the axis of coiling, on the scanned side, on the fourth whorl up from the aperture.

6. Width of the Fourth Whorl - Measured at its widest value, perpendicular to the axis of coiling, on the scanned side, on the fourth whorl up from the aperture.

7. Total Whorls - Measured to the nearest whorl from the end of the protochonch to the aperture on the side of the scanned image.

8. Ribs on the Fifth Whorl - Total number of ribs on a half whorl on the fifth whorl down from the protochonch.

9. Ribs on the Last Whorl - Total number of ribs on a half whorl on the last whorl above the aperture.

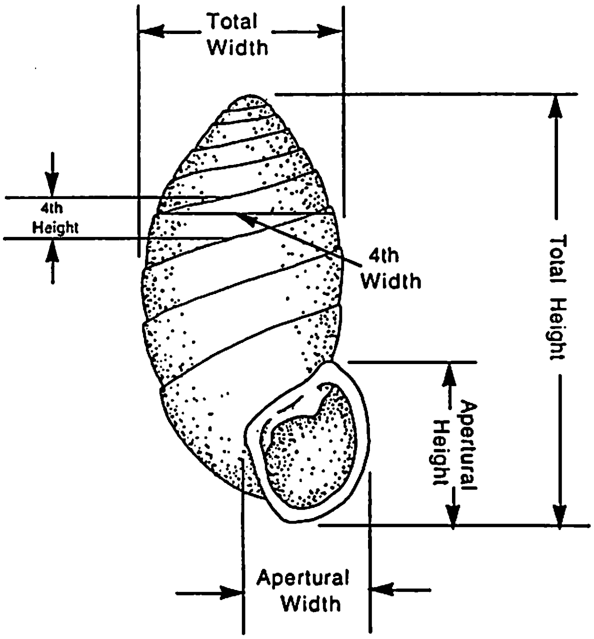

Figure 3. Morphometric measurements used in this study.

Use of measurements of the number of ribs on the 5th and last whorls was abandoned from this study because the ribs on some of the shells are so shallow that it is impossible to reliably count them either directly, or from the computer image. The morphometric measurements used in this study are different from the ones originally defined by Gould et al. (1974) because of the difference in orientation of the shell during measurement. Gould et al. (1974) oriented the shell on the basis of the transitional line separating the protoconch and the immature shell. We have oriented our shells to look directly down on the aperture, without regard to the positioning of the line separating the protoconch and the immature shell. Thus, unlike Gould et al. (1974), we have measured the number of whorls to the nearest whole value. Despite the obvious fact that our morphometic measurements do not reflect the separation of protochonch, immature, and mature shell phases, it is a valid morphometric system of measurement because it accurately defines the populations and permits rapid measurement of large numbers of shells.

Statistical Analysis

All statistical analyses were completed using the SYSTAT computer package (Wilkinson, 1987) on a Macintosh platform. Initial inspection of the total data set, including both modern and fossil shells, indicates that *Cerion* shell morphology on San Salvador Island (Figures 4 and 5) exhibits a strongly bimodal distribution. One population is larger with a mean shell height of ~ 25 mm, and the other population is small with a mean shell height of ~ 20 mm. The range of morphometric measurements of these two populations overlap. This bimodality may be dependent on geologic age, on geography, or both (Figure 5).

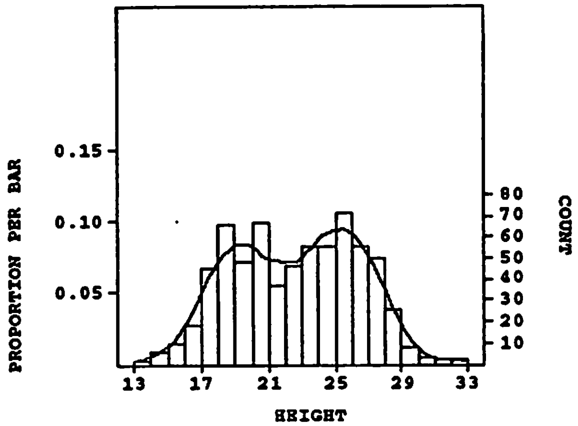

Figure 4. Histogram of the Cerion shell height for all shells measured in this study. The histogram indicates that there is a strongly bimodal distribution to the population on San Salvador Island.

Because the data set matrix is so large, 675 individuals by 7 measures, yielding 4,725 values, we reduced the data set prior to clustering by using the average value of each measurement for each sample locality. Two smaller data sets were generated from the total data using this method. First, the mean values of each measured variable from each location

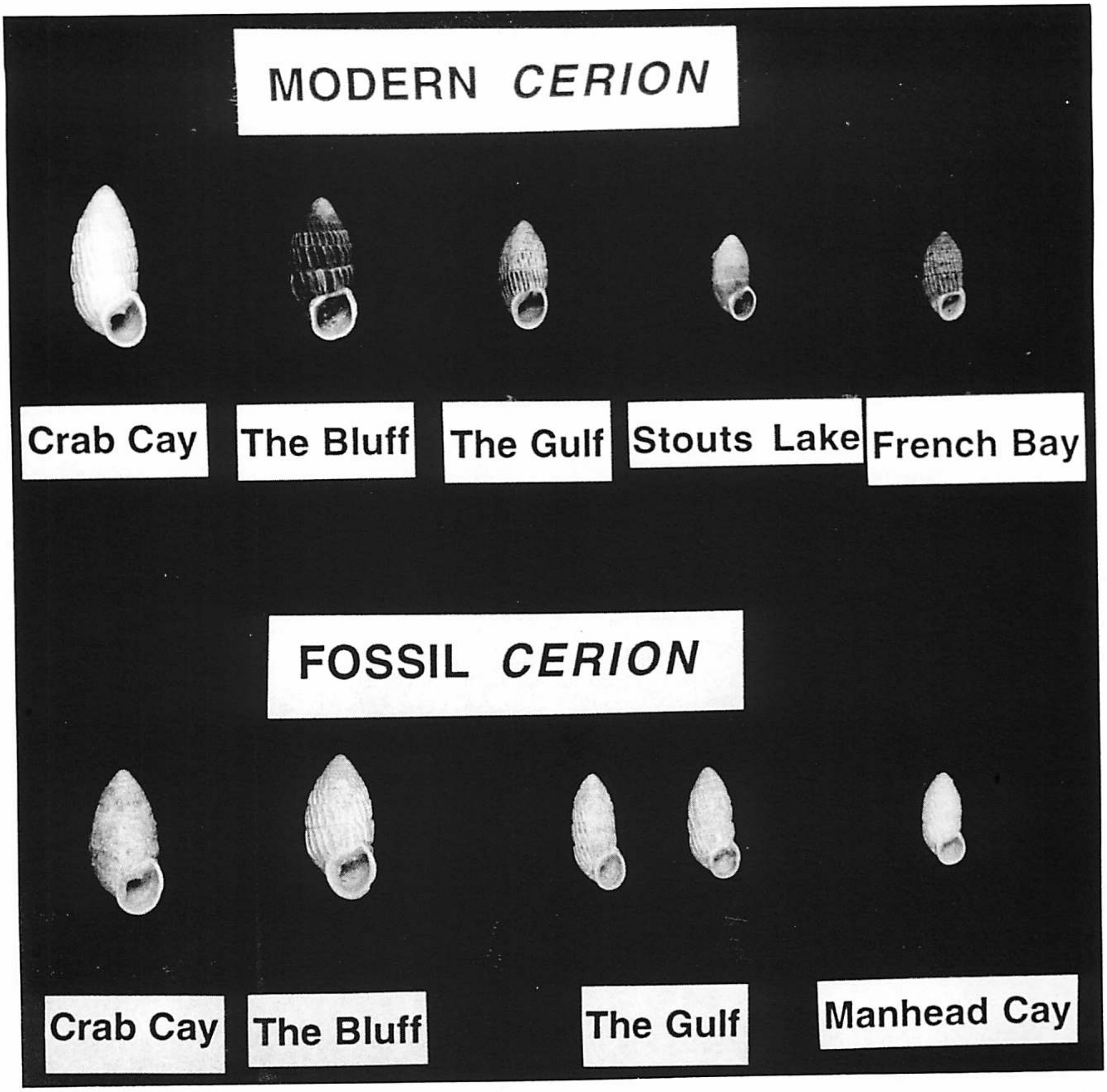

Figure 5. Representative shells from San Salvador Island showing the range in morphometric variation among modern and fossil populations.

was calculated, combining both fossil and modern populations (Table 2, Appendix). Next, the mean values of each measured variable from each location was calculated, keeping the fossil and modern populations separate (Table 3, Appendix).

We used Q-mode cluster analysis on the resulting two data sets, using a 1-gamma Goodman-Kruskal distance metric and complete linkage, to determine whether the variation in the data are either temporally or geographically associated. The use of a Goodman-Kruskal distance metric is often recommended for rank order or ordinal scales such as are encountered in some of the measures in this data set, and it produces "lumpy" clusters with initially high degrees of associativity. The phenon line is an arbitrary line drawn on the resulting dendogram to separate the samples into subclusters at some degree of associativity. Our phenon lines were arbitrarily selected to provide two subclusters of related locations for both data sets.

RESULTS

Figure 6 illustrates the resulting dendogram from Q-mode cluster analysis of mean values from each location, without regard to geologic age of the *Cerion*. The

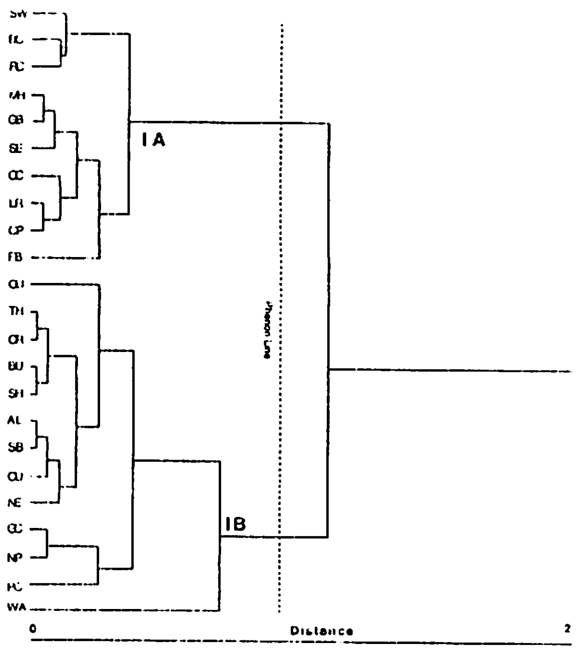

Figure 6. Q-mode cluster analysis dendogram of mean values from each location without regard to geologic age ofCerion. Distance metric is 1-gamma with a complete linkage. The populations are divided into two distinct subpopulations separated by the dashed phenon line.

populations are divided into two distinct subpopulations (IA and IB) separated by the dashed phenon line on the dendogram. The geographic distribution of clusters IA and IB is shown in Figure 7, and two examples of *Cerion* shells that are representive of the two populations are shown in Figure 8. Cluster IA consists of shells collected primarily from the interior and western half of the island while cluster IB consists of shells collected from the east coast. Morphologically, cluster IA consists of smaller, more delicate shells (Figure 9 and Table 4a), while cluster IB consists of shells that are generally larger and more robust (Figure 9 and Table 4b). Once clusters IA and IB were established from the dendogram (Figure 6), we performed a t-test on each measure between clusters IA and IB to test the null hypothesis that these differences could occur by chance. Table 5 (Appendix) illustrates those results which indicate that for every morphometric measurement between clusters IA and IB, the variation has a zero probability of occurring by random chance. Thus, clusters IA and IB are statistically independent.

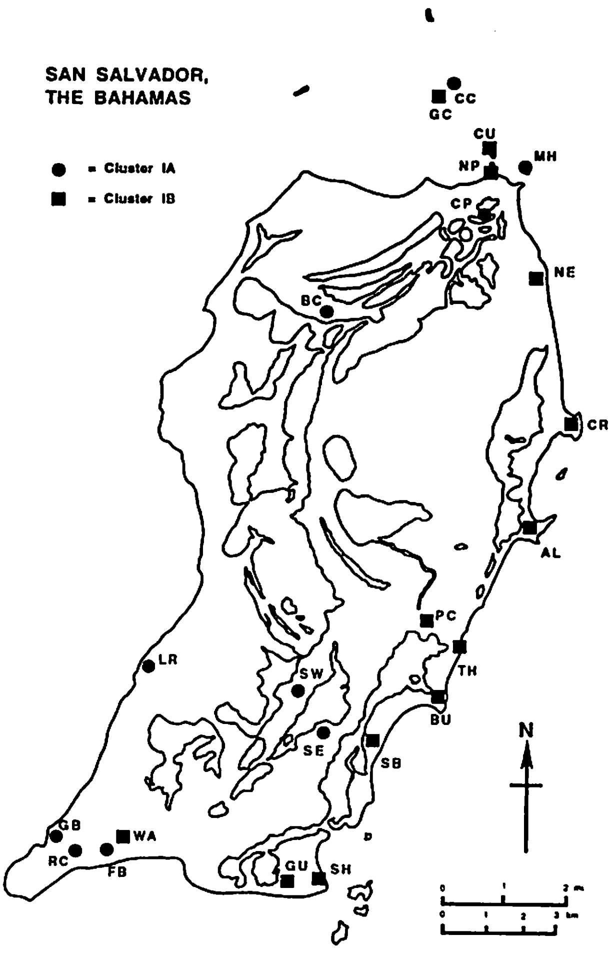

Figure 7. Map of San Salvador Island showing the geographic distribution of the two subpopulations, clusters IA and IB that were determined from the dendogram illustrated in Figure 6.

Figure 10 illustrates the resulting dendogram from Q-mode cluster analysis of mean values from each location with fossil and modern populations treated separately. Again, the populations are divided into two distinct subpopulations (IIA and IIB) separated by the dashed phenon line on the dendogram. The geographic distributions of clusters IIA and IIB are shown in Figure 11. The clusters do not separate on the basis of geologic age, but do

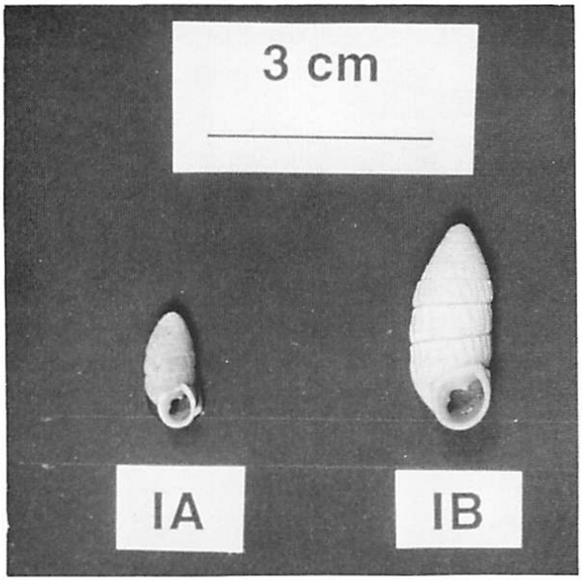

Figure 8. Representative shells from clusters IA and IB that were determined from the dendogram in Figure 6.

maintain some geographic separation. For this reason, the null hypothesis that the morphology of *Cerion* on San Salvador is a function of time (i.e., that the change in shell morphology is temporally related) fails.

Three sample localities have both modern and fossil populations, Man Head Cay (MH), Almgreen Cay (AL), and the Bluff (BU). T-tests were performed for each of these locations to test the null hypothesis that the differences in morphometric measurments between modern and fossil populations at each locality could occur by chance. Only the modern and fossil populations on Man Head Cay (MH) (Table 6) have a zero probability that the measured variations occur by chance. Man Head Cay is located just to the northeast of San Salvador Island (Figure 2) and is unprotected from the trade winds. It is possible that Man Head Cay was somehow protected from the trade winds when the smaller, more delicate fossil population inhabited this site. This variation is of the same magnitude and order as observed between Clusters IA and IB. Thus, the variation of morphology with geographic location is identical to, or greater than, the variatin of morphology with geologic time for the *Cerion* shells on San Salvador Island. Again, the result is that the variation in *Cerion* morphology on San Salvador Island is more sensitive to changes in environment than to time. So, *Cerion* on San Salvador do not make good biostratigraphic indicators.

CONCLUSIONS

The new morphometric method used in this study has the advantage of being rapid, and of being able to distinguish between different *Cerion* populations. It is not as precise in determining the growth history as is the method described by Gould et al. (1974), but it is excellent in defining morphologically distinct subpopulations of *Cerion*.

While shell rib height is a potentially useful morphologic variable, we have, as yet been unable to determine a valid objective and quantitative measure for this parameter. Shell coloration is not used because subfossil and fossil shells have lost this ornamentation by post-mortem bleaching. These two morphologic variables are important in distinguishing the two species that have been recognized by Gould (1997, this volume). *Cerion rodrigoi sp. nov.* Gould (1997) is characterized, in part, by a "smooth and thick white shell" (Gould, 1997) while *C. watlingense* Dall (1905) is a more ribby and often mottled morphotype. Gould's (1997) identification of these two species is not equivalent to our clusters IA and IB because we did not use the determining factors of coloration and ribbiness in our analyses. Thus, our analyses have separated the *Cerion* populations primarily on the basis of size. Future research in the biometry of *Cerion* should include a method of quantifying shell coloration and rib depth.

Statistical analysis indicates that the variation of *Cerion* shell morphology on San Salvador Island is largely dependent on geography, suggesting that environment affects the shell shape. The variation seen between modern and fossil populations is the same as the variation seen in the geographic distribution. Small, more delicate shells are generally found in the interior and on the west coast, while larger, more robust shells are found on the east coast of San Salvador.

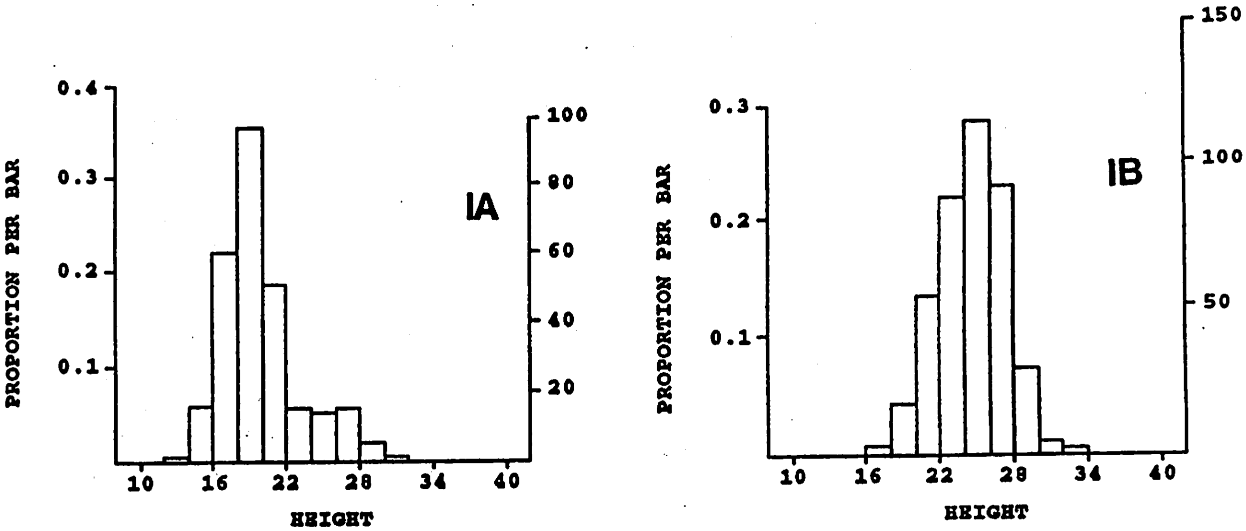

Figure 9. Histogram of the Cerion shell hieght for clusters IA and IB that there determined from the dendograp in Figure 6.

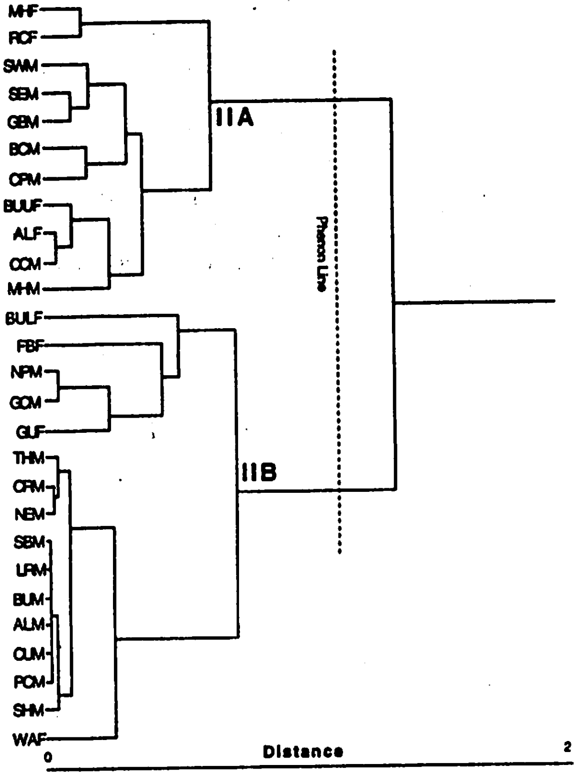

Figure 10. Q-mode cluster analysis dendogram of mean values from each location with the fossil and Holocene populations of Cerion being treated separately. Distance metric is 1-gamma with a complete linkage. The populations are divided into two distinct subpopulations, clusters IIA and IIB separated by the dashed phenon line.

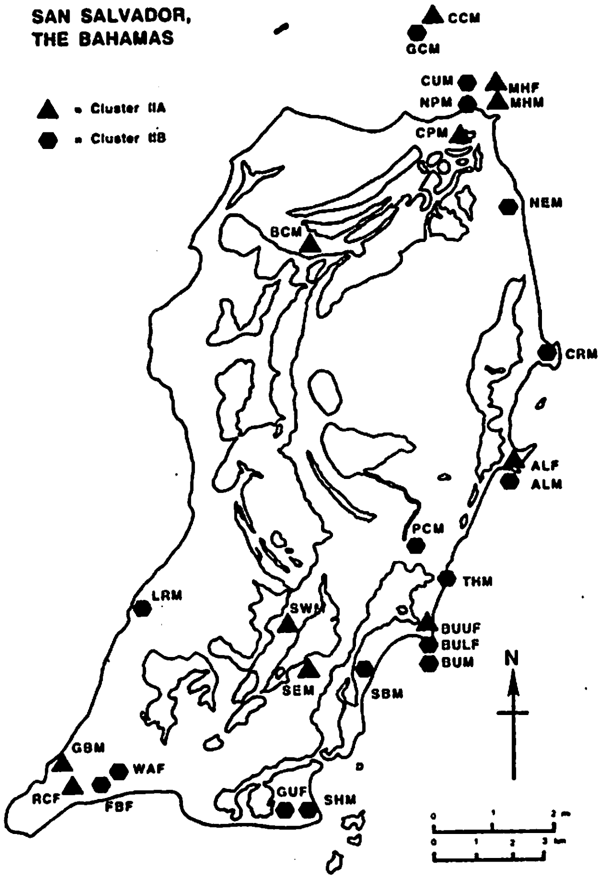

Figure 11. Map of San Salvador Island showing the geographic distribution of the two clusters IIA and IIB that were determined from the dendogram illustrated in Figure 8.

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APPENDIX
(TABLES 2-6)

Table 2. Mean values of measurements used in determining the cluster analysis dendogram of Figure 6.

*Location	Shell Height (mm)	Shell Width (mm)	Aperture Height (mm)	Aperture Width (mm)	Height of 4th Whorl (mm)	Width of 4th Whorl (mm)	Total Whorls
AL	25.00	10.84	8.35	7.03	2.00	8.13	7.22
BC	17.81	7.71	6.49	5.46	1.38	5.54	5.80
BU	25.98	11.28	8.67	7.52	2.29	8.22	6.86
CC	20.76	9.22	7.01	6.14	1.61	6.75	6.56
CP	22.56	8.81	7.25	6.41	1.69	7.35	6.56
CR	26.44	11.42	8.84	7.84	2.03	8.42	7.13
CU	23.07	9.76	7.75	7.01	1.84	7.89	7.12
FB	18.72	9.12	6.46	6.20	1.43	6.93	6.36
GB	19.61	9.37	6.98	6.05	1.43	6.75	6.52
GC	23.73	10.08	7.89	6.75	1.83	7.45	6.88
GU	21.69	9.17	6.88	5.90	1.74	7.20	6.96
LR	19.85	8.62	7.16	5.92	1.47	6.61	6.44
MH	21.50	9.32	7.51	6.55	1.60	7.25	6.60
NE	27.32	11.85	8.81	7.95	2.16	9.32	7.40
NP	25.13	10.74	8.34	7.35	2.00	8.46	6.92
PC	24.61	9.87	8.32	6.92	1.94	8.01	7.44
RC	17.96	8.44	5.76	5.29	1.21	5.25	5.64
SB	25.51	11.04	8.91	7.72	1.91	8.69	7.24
SE	18.85	7.89	6.93	5.75	1.66	6.30	6.44
SH	22.51	10.09	7.83	6.54	1.67	7.62	6.96
SW	18.69	8.24	7.00	5.92	1.60	6.30	6.24
TH	25.53	10.57	8.46	6.97	2.46	7.39	7.32
WA	19.40	9.14	6.55	6.35	1.53	7.13	6.64

* See Table 1 of an explaination of the abbreviations used to describe the location.

Table 3. Mean values of measurements used in determining the cluster analysis dendogram of Figure 8.

*Location	Shell Height (mm)	Shell Width (mm)	Aperture Height (mm)	Aperture Width (mm)	Height of 4th Whorl (mm)	Width of 4th Whorl (mm)	Total Whorls
ALF	22.80	10.67	8.19	6.81	1.80	7.58	7.04
ALM	27.14	11.02	8.52	7.25	2.20	8.67	7.40
BCM	17.81	7.71	6.49	5.46	1.38	5.54	5.80
BUM	27.62	11.32	9.20	7.82	2.20	9.30	7.40
BUUF	25.87	11.12	8.29	7.08	2.26	8.47	6.80
BULF	24.44	11.39	8.54	7.65	2.43	6.75	6.32
CCM	20.76	9.22	7.01	6.14	1.61	6.75	6.56
CPM	22.56	8.81	7.25	6.41	1.69	7.35	6.56
CRM	26.44	11.42	8.84	7.84	2.03	8.42	7.13
CUM	23.07	9.76	7.75	7.01	1.84	7.89	7.12
FBF	18.72	9.12	6.46	6.20	1.43	6.93	6.36
GBM	19.61	9.37	6.98	6.05	1.43	6.75	6.52
GCM	23.73	10.08	7.89	6.75	1.83	7.45	6.88
GUF	21.69	9.17	6.88	5.90	1.74	7.20	6.96
LRM	19.85	8.62	7.16	5.92	1.47	6.61	6.44
MHM	27.04	11.06	9.14	7.76	2.15	8.96	7.32
MHF	15.96	7.57	5.88	5.33	1.06	5.53	5.88
NEM	27.32	11.85	8.81	7.95	2.16	9.32	7.40
NPM	25.13	10.74	8.34	7.35	2.00	8.46	6.92
PCM	24.61	9.87	8.32	6.92	1.94	8.01	7.44
RCF	17.96	8.44	5.76	5.29	1.21	5.25	5.64
SBM	25.51	11.04	8.91	7.72	1.91	8.69	7.24
SEM	18.85	7.89	6.93	5.75	1.66	6.30	6.44
SHM	22.51	10.09	7.83	6.54	1.67	7.62	6.96
SWM	18.69	8.24	7.00	5.92	1.60	6.30	6.24
THM	25.53	10.57	8.46	6.97	2.46	7.39	7.32
WAF	19.40	9.14	6.55	6.35	1.53	7.13	6.64

* See Table 1 of an explaination of the abbreviations used to describe the location. F suffix indicates fossil and M suffix indicates modern.

Table 4. Mean and Standard Deviation of the measurements for the two subpopulations that were derived from the dendogram in Figure 6. Table 4a contains the statistical summary for cluster IA and Table 4b contains the statistical summary for cluster IB.

Table 4a. Mean and Standard Deviation of the measurements for Cluster IA.

	Total Height (mm)	Total Width (mm)	Apertural Height (mm)	AperturalWidth (mm)	Height of 4th Whorl (mm)	Width of 4th Whorl (mm)	Total Number of Whorls
n	275	275	275	275	275	275	275
Mean	19.8	8.8	6.9	6.0	1.5	6.6	6.3
Std. Dev.	3.2	1.1	1.0	0.8	0.4	1.1	0.6

Table 4b. Mean and Standard Deviation of the measurements for Cluster IB.

	Total Height (mm)	Total Width (mm)	Apertural Height (mm)	AperturalWidth (mm)	Height of 4th Whorl (mm)	Width of 4th Whorl (mm)	Total Number of Whorls
n	400	400	400	400	398	398	396
Mean	24.6	10.6	8.2	7.1	2.0	8.0	7.6
Std. Dev.	2.7	1.0	0.9	0.7	0.4	1.0	0.6

Table 5. T-test of each morphometric measure by grouped clusters IA and IB.

Independent samples t-test on shell height grouped by cluster.

GROUP	N	MEAN	SD
IA	275	19.802	3.170
IB	400	24.550	2.693

Separate variancest = 20.306 df = 524.6 prob = 0.000
Pooled variances t = 20.925 df = 673 prob = 0.000

Independent samples t-test on shell width grouped by cluster.

GROUP	N	MEAN	SD
IA	275	8.824	1.120
IB	400	10.579	0.979

Separate variances t = 21.034 df = 535.7 prob = 0.000
Pooled variancest = 21.565 df = 673 prob = 0.000

Independent samples t-test on aperture height grouped by cluster.

GROUP	N	MEAN	SD
IA	275	6.914	1.024
IB	400	8.207	0.895

Separate variancest = 16.951 df = 535.9 prob = 0.000
Pooled variancest = 17.377 df = 673 prob = 0.000

Independent samples t-test on aperture width grouped by cluster.

GROUP	N	MEAN	SD
IA	275	6.021	0.772
IB	400	7.120	0.741

Separate variances t = 18.467 df = 572.7 prob = 0.000
Pooled variances t = 18.611 df = 673 prob = 0.000

Independent samples t-test on height of 4th whorl grouped by cluster.

GROUP	N	MEAN	SD
IA	275	1.517	0.357
IB	398	1.997	0.370

Separate variancest = 16.933 df = 602.4 prob = 0.000
Pooled variances t = 16.824 df = 671 prob = 0.000

Independent samples t-test on width of 4th whorl grouped by cluster.

GROUP	N	MEAN	SD
IA	275	6.571	1.136
IB	398	8.029	1.007

Separate variances t = 17.134 df = 541.8 prob = 0.000
Pooled variances t = 17.516 df = 671 prob = 0.000

Independent samples t-test on total whorls grouped by cluster.

GROUP	N	MEAN	SD
IA	275	6.342	0.661
IB	396	7.066	0.596

Separate variances t = 14.512 df = 549.0 prob = 0.000
Pooled variances t = 14.787 df = 669 prob = 0.000

Table 6. T-test of each morphometric measure by modern and fossil populations collected from Man Head Cay.

```
                      Independent samples t-test on total height grouped by age.
GROUP          N          MEAN             SD
M              25         27.044           1.304
F              25         15.964           1.549
                    Separate variances t = 27.357 df = 46.6 prob = 0.000
                     Pooled variances t = 27.357 df = 48 prob = 0.000

                      Independent samples t-test on total width grouped by age.
GROUP          N          MEAN             SD
M              25         11.064           0.325
F              25         7.572            0.438
                    Separate variances t = 31.993 df = 44.3 prob = 0.000
                     Pooled variances t = 31.993 df = 48 prob =  0.000

                    Independent samples t-test on aperture height grouped by age.
GROUP          N          MEAN             SD
M              25         9.140            0.782
F              25         5.876            0.532
                    Separate variances t = 17.257 df = 42.3 prob = 0.000
                     Pooled variances t = 17.257 df = 48 prob = 0.000

                    Independent samples t-test on aperture width grouped by age.
GROUP          N          MEAN             SD
M              25         7.760            0.468
F              25         5.332            0.344
                    Separate variances t = 20.904 df = 44.0 prob = 0.000
                     Pooled variances t = 20.904 df = 48 prob = 0.000

                 Independent samples t-test on height of 4th whorl grouped by age.
GROUP          N          MEAN             SD
M              25         2.148            0.200
F              25         1.056            0.250
                    Separate variances t = 17.040 df = 45.8 prob = 0.000
                     Pooled variances t = 17.040 df = 48 prob = 0.000

                 Independent samples t-test on width of 4th whorl grouped by age.
GROUP          N          MEAN             SD
M              25         8.960            0.421
F              25         5.532            0.697
                    Separate variances t = 21.035 df = 39.5 prob = 0.000
                     Pooled variances t = 21.035 df = 48 prob = 0.000

                    Independent samples t-test on total whorls grouped by age.
GROUP          N          MEAN             SD
M              25         7.320            0.476
F              25         5.880            0.526
                    Separate variances t = 10.149 df = 47.5 prob = 0.000
                     Pooled variances t = 10.149 df = 48 prob = 0.000
```