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BEEM, Kenneth Alan, 1942-
BENTHONIC FORAMINIFERAL PALEOECOLOGY OF THE CHOCTAWHATCHEE DEPOSITS (NEOGENE) OF NORTHWEST FLORIDA.

University of Cincinnati, Ph.D., 1973
Paleontology

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BENTHONIC FORAMINIFERAL PALEOECOLOGY OF THE CHOCTAWHATCHEE DEPOSITS (NEOGENE) OF NORTHWEST FLORIDA

A dissertation submitted to the

Division of Graduate Studies
of the University of Cincinnati

in partial fulfillment of the
requirements of the degree of

DOCTOR OF PHILOSOPHY

in the Department of Geology
of the Graduate School of Arts and Sciences

1973

BY

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M.S. Tulane University, 1967

UNIVERSITY OF CINCINNATI

May 17 *19* 73

I hereby recommend that the thesis prepared under my supervision by Kenneth Alan Beem

entitled Benthonic Foraminiferal Paleoecology of the Choctawhatchee Deposits (Neogene) of Northwest Florida

be accepted as fulfilling this part of the requirements for the degree of Doctor of Philosophy

Approved by:

W. A. Dreyer

Richard Cifelli

Wayne A. Pryor

Form 668—Grad. School—1M—3-69

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ABSTRACT

The Choctawhatchee deposits are represented in northwest Florida by a narrow band of disjunct outcrops of gray to buff clays, sands, marls, and limestones. The ages of these outcrops vary from Mid-Miocene to Pliocene. One hundred twenty-eight species of benthonic foraminifera are described, one of which, Bolivina bulbosa, is new. Paleoecologic analysis of these deposits is based on a combination of present-day species distributions and several statistical parameters: these include planktonic-benthonic ratios, and population diversity measurements based on the Shannon-Weiner Information Function. For the Choctawhatchee deposits, the modern species distribution approach is more diagnostic than the various statistical parameters utilized. The faunas are shown to be indicative of water depths less than 100 meters, and affected by abnormal concentrations of organic carbon. Analogous modern environments are shallow embayments along the northern coast of Venezuela, and near-shore, high nutrient areas off the coast of southern California.

INTRODUCTION

Sediments that have been attributed by previous authors to the Choctawhatchee Formation (Neogene) are exposed in a narrow band extending from 20 miles west of Tallahassee, Leon County, Florida, west-northwest to DeFuniak Springs, Walton County, Florida, a distance of approximately 80 miles. The exposed sediments are buff, brown, gray, or gray-green clays, clayey sands, marls, and sandy limestones. The outcrops are widely spaced, often poorly exposed, and usually of small vertical extent. Subsurface control is relatively poor, and stratigraphic relationships between the various levels are poorly understood.

Several authors have speculated about the paleoecology of the Choctawhatchee deposits. It is the purpose of this study to reexamine the benthonic foraminiferal fauna, and to use data derived from it to suggest the probable depositional environments of the sampled horizons. In conjunction with stratigraphic studies of the Gulf Coast Neogene now in progress, this investigation should aid in reconstructing the paleogeography of northwest Florida.

ACKNOWLEDGMENTS

The author gratefully acknowledges the help and suggestions of members of the Department of Geology at the University of Cincinnati, under whose direction the present manuscript was prepared in partial completion of the requirements for the degree of Doctor of Philosophy.

Special thanks are extended to the following faculty members of the Department of Geology at the University of Cincinnati, who provided helpful criticism at various stages in the preparation of the manuscript: Dr. Wayne A. Pryor, and the chairman of the committee, Dr. Kenneth E. Caster. Special thanks are also extended to Dr. John S. Warren, of Thomas Jefferson College, who provided much-needed editing during the final stages of manuscript preparation. The aid and encouragement of Dr. Richard Cifelli, of the United States Museum of Natural History, Smithsonian Institution, has been essential throughout the various stages of research and preparation. The author also wishes to thank Mr. Walter Brown, of the United States Museum of Natural History, who provided the scanning electron photomicrographs.

SAMPLE COLLECTION AND PREPARATION

A total of 62 samples from 25 localities were collected in October, 1969, from outcrops of sediments that have been attributed to the Choctawhatchee Formation. Of these samples, 44 contained usable foraminiferal faunas. Most of the unusable samples exhibited evidence of extensive weathering.

In addition to the samples I collected, material was provided by the Department of Geology at Tulane University, by Dr. Druid Wilson of the United States Geological Survey, and by Mr. Paul Huddlestun while he was at Florida State University.

The locations of the outcrops sampled for this study are shown in figure 1. The samples collected at each outcrop are listed by faunizone in figure 2. The localities utilized in this study are further described on pages 146 to 151 .

Fig. 1. Locality map.

Fig. 2. Correlation of sample and locality numbers.

All samples were washed on a No. 200 U.S. Standard seive (opening: 74 microns). No flotation or other separation process was used. All

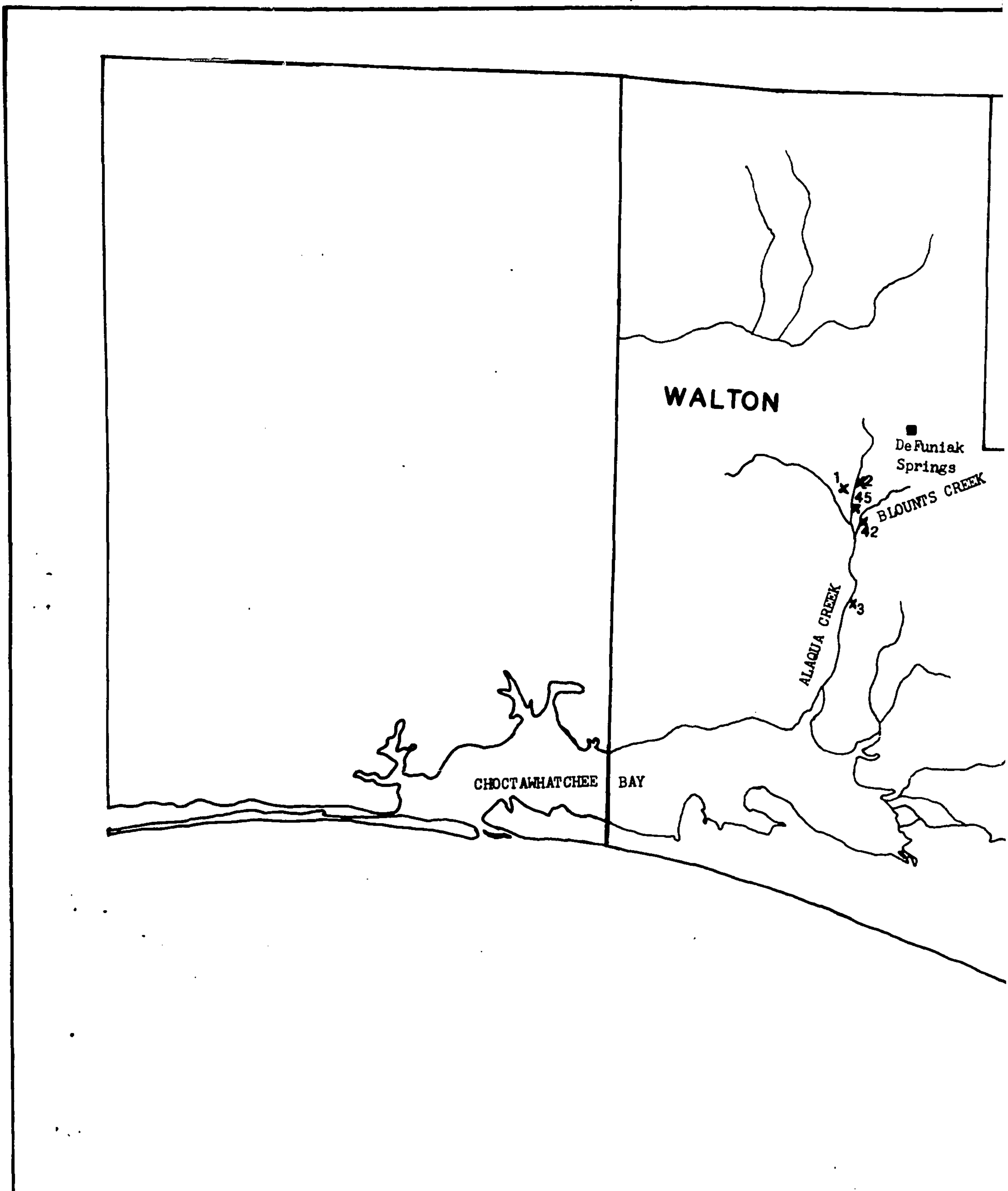
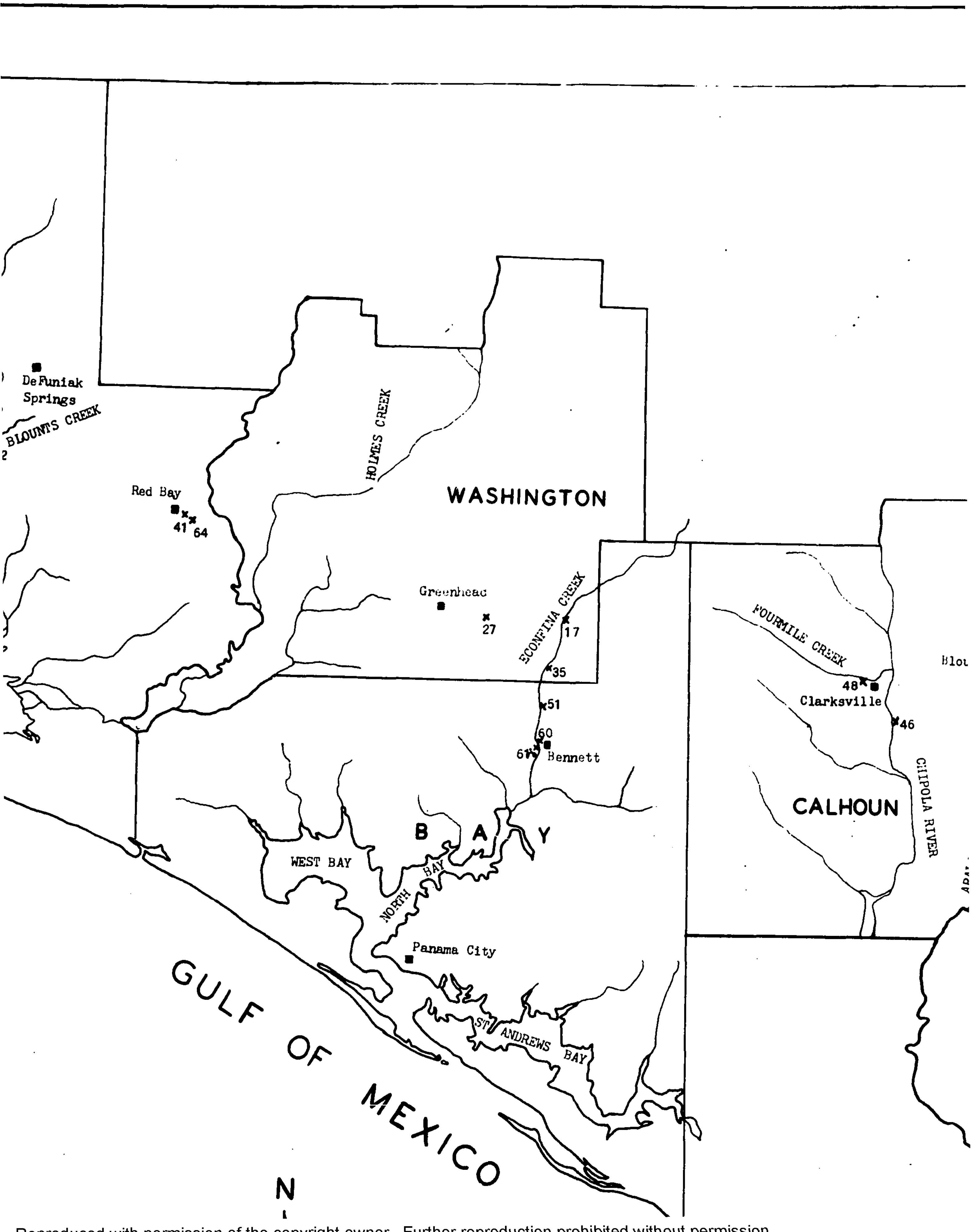


FIGURE 1.

LOCALITY MAP



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ECONFINA CREEK
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Bennett
FOURMILE CREEK
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Clarksville
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CHIPOLA RIVER
CALHOUN
WEST BAY
B A Y
NORTH BAY
Panama City
ST ANDREWS BAY
GULF OF MEXICO
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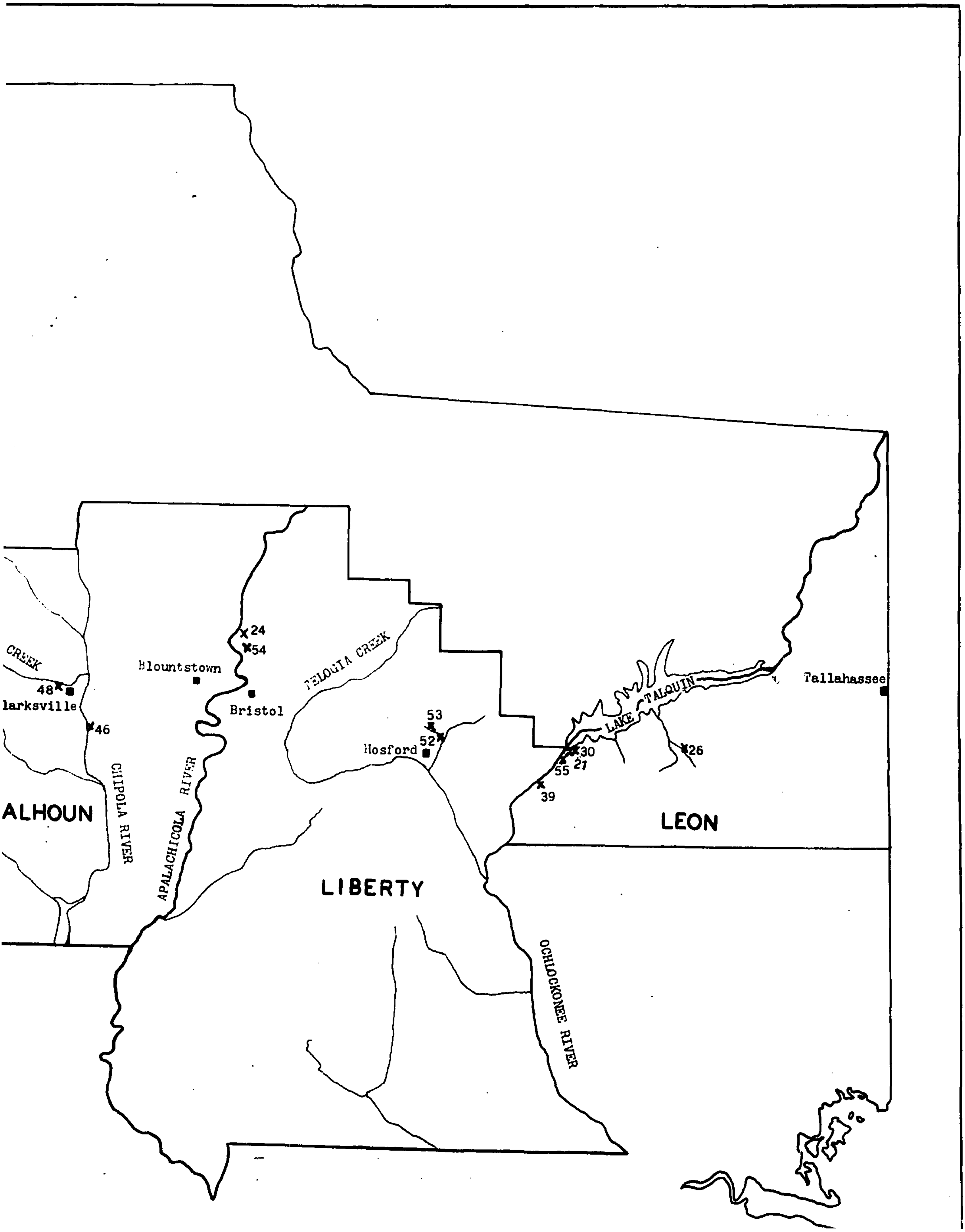
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Blountstown
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APALACHICOLA RIVER
TELOGIA CREEK
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Hosford
LIBERTY
LAKE TALQUIN
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Tallahassee
LEON
OCHLOCKONEE RIVER

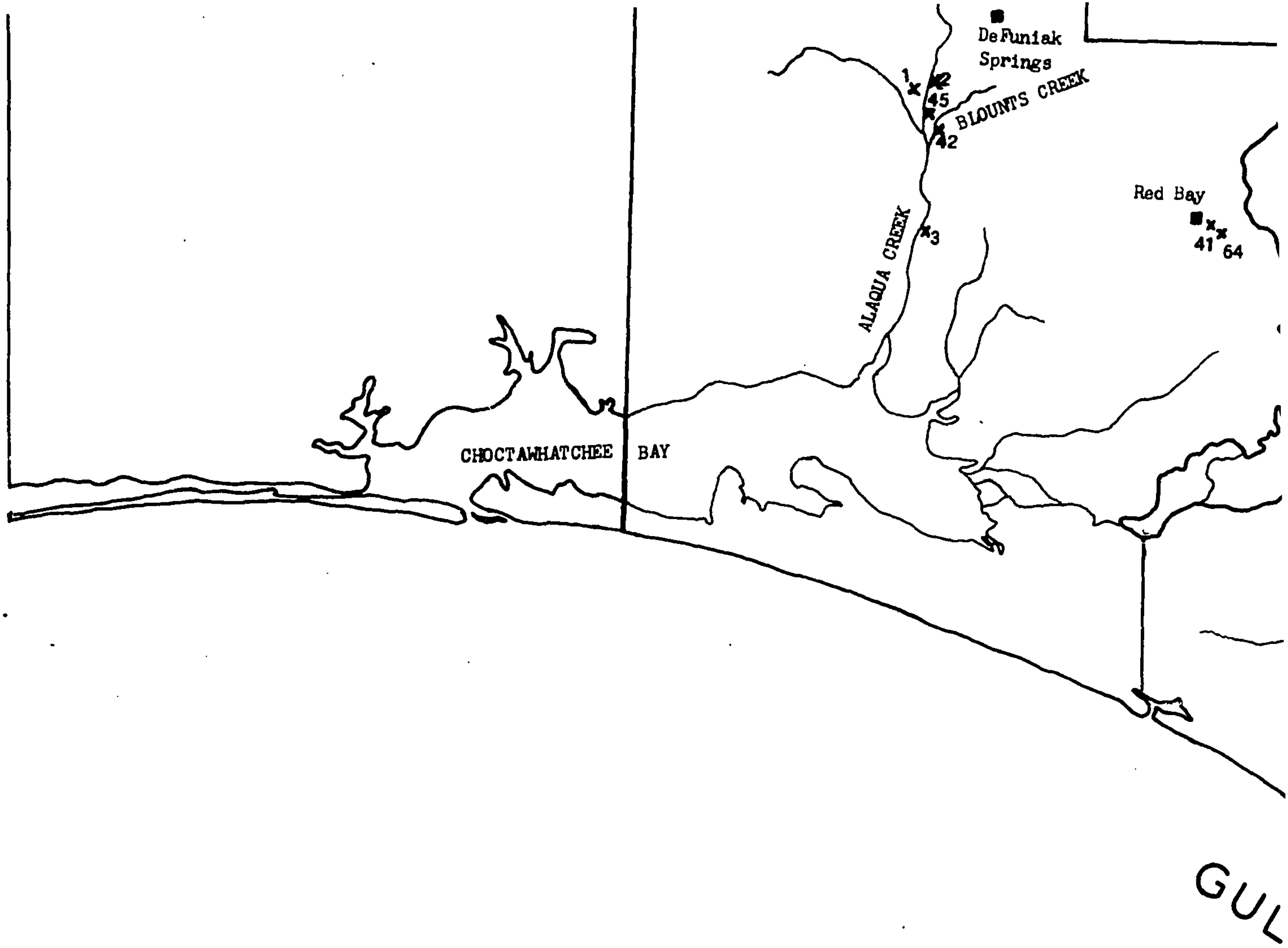
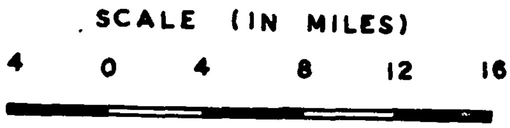


FIGURE 1.

LOCALITY MAP

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Panama City
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GULF OF MEXICO
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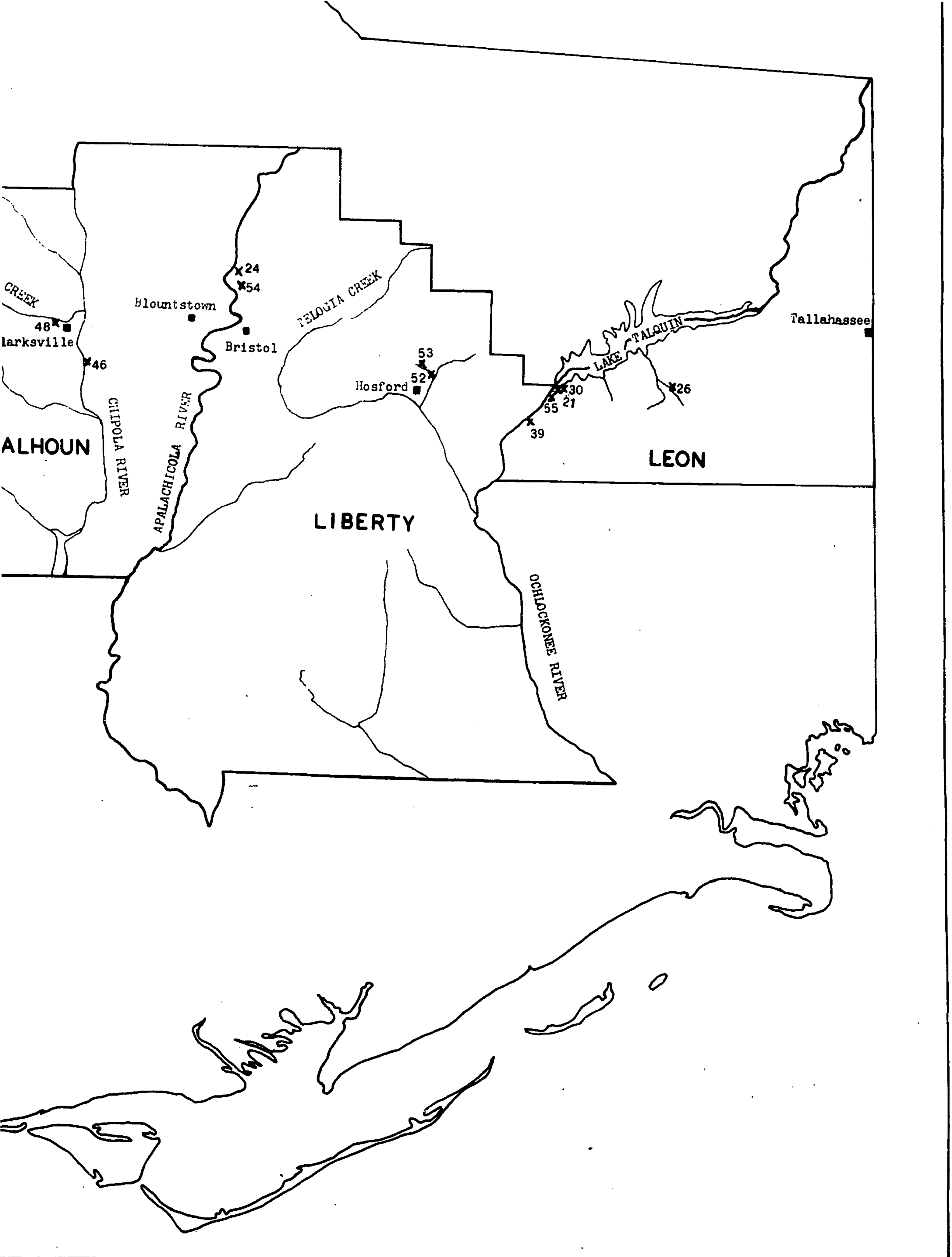
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APALACHICOLA RIVER
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54
Blountstown
Bristol
TELOGIA CREEK
53
52
Hosford
LAKE TALQUIN
30
21
55
39
26
Tallahassee
LEON
LIBERTY
OCHLOCKONEE RIVER

Locality number.	Sample numbers.
Yoldia faunizone	
1	Y-2, 3, 4
2	Y-1
Arca faunizone	
3	A-12
41	A-2, 3, 4, 5, 6
42	A-10, 11
45	A-7, 8, 9
64	A-1
Ecphora faunizone	
17	E-1
21	E-15, 16, 17, 18, 19
24	E-2, 3, 4, 5, 6
26	E-20
46	E-8, 9, 10, 11, 12
48	E-13, 14
54	E-7
Cancellaria faunizone	
27	C-8, 9, 10
30	C-3
35	C-11, 12, 13
39	C-6, 7
51	C-14, 15
52	C-1
53	C-2
55	C-4, 5
60	C-16
61	C-17, 18

Fig. 2. Correlation of sample and locality numbers.

samples were split to a size allowing retrieval of a minimum of approximately 300 specimens of benthonic foraminifera. The actual numbers of specimens studied per sample varied from 297 in sample A-11 to 823 in sample C-1. The number of benthonic specimens collected from each sample is shown in figure 3.

Fig. 3. Statistical parameters.

STRATIGRAPHY

Historical Review

The first published report of sediments falling within the scope of this study was by Langdon (1889), who described an outcrop of sands, clays and marls at Alum Bluff, Liberty County. Langdon measured the section and recorded the molluscan fauna of the fossiliferous marl, which he equated with the Miocene strata of the Carolinas, and which he called the "Alum Bluff series." A correlation chart showing the opinions of Langdon and subsequent authors concerning the stratigraphy of the Choctawhatchee beds is given in figure 4.

Fig. 4. Correlation of Choctawhatchee deposits.

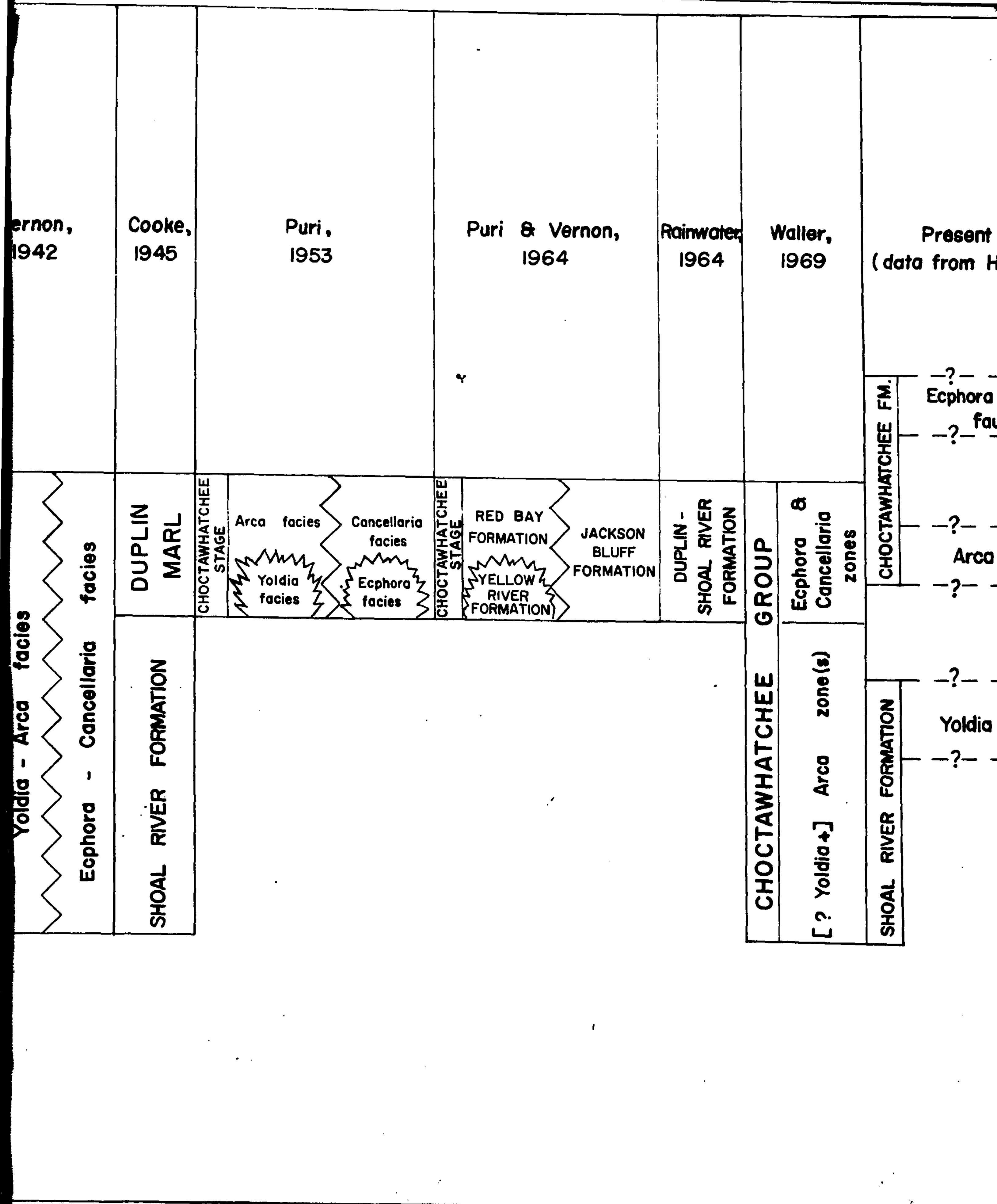
Sample	% dominant species	Benthonic specimens	Benthonic species	H(S)	$e^{H(S)}/S$	Planktonic specimens	P/P+B
Y-1	84	343	13	0.82	0.174	19	.052
Y-2	82	318	10	0.76	0.213	17	.051
Y-3	46	318	15	1.83	0.416	32	.091
Y-4	56	314	19	1.64	0.270	12	.037
A-1	21	311	28	2.67	0.331	12	.037
A-2	28	340	29	2.59	0.444	16	.045
A-3	21	339	33	2.81	0.505	21	.058
A-4	28	312	32	2.74	0.482	19	.057
A-5	42	331	27	2.18	0.327	9	.027
A-6	54	312	19	1.71	0.290	3	.010
A-7	23	318	28	2.66	0.513	21	.062
A-8	22	370	25	2.34	0.413	13	.034
A-9	49	313	25	2.05	0.310	5	.016
A-10	15	320	33	2.81	0.503	24	.070
A-11	17	297	25	2.69	0.593	17	.054
A-12	51	302	19	1.84	0.331	13	.041
E-1	38	303	29	2.38	0.372	30	.089
E-2	35	392	32	2.49	0.376	89	.185
E-3	51	574	33	1.95	0.214	32	.053
E-4	37	551	31	2.28	0.314	70	.127
E-5	56	513	24	1.75	0.239	51	.091
E-5	74	315	9	0.81	0.249	0	.000
E-7	74	322	16	1.03	0.174	7	.021
E-8	48	421	28	2.00	0.265	46	.098
E-9	53	440	27	1.86	0.237	42	.087
E-10	60	439	25	1.66	0.210	34	.072
E-11	50	343	24	1.94	0.289	58	.145
E-12	39	314	23	2.17	0.361	85	.230
E-13	44	313	26	2.18	0.339	47	.130
E-14	43	314	24	2.18	0.369	42	.118
E-15	15	320	34	2.93	0.548	47	.129
E-16	15	325	39	3.03	0.533	56	.147
E-17	13	354	46	3.26	0.542	44	.111
E-18	44	520	25	1.73	0.225	0	.000
E-19	33	312	27	2.17	0.324	3	.010
E-20	54	396	24	1.70	0.228	3	.008
C-1	46	458	17	1.77	0.347	9	.019
C-2	51	823	28	1.78	0.213	22	.026
C-3	25	343	28	2.38	0.388	11	.031
C-4	26	338	25	2.27	0.387	12	.034
C-5	39	331	20	2.04	0.385	11	.032
C-6	32	410	23	2.03	0.330	25	.060
C-7	42	305	19	1.93	0.364	11	.035
C-8	24	601	35	2.33	0.303	28	.045
C-9	24	507	29	2.31	0.348	30	.056
C-10	32	331	22	2.05	0.354	6	.018
C-11	24	361	26	2.31	0.388	32	.081
C-12	24	405	24	2.28	0.409	41	.092
C-13	31	682	23	2.11	0.350	45	.062
C-14	32	380	30	2.33	0.341	18	.045
C-15	31	474	34	2.41	0.329	39	.076
C-16	33	344	28	2.15	0.305	33	.088
C-17	29	423	25	2.18	0.340	34	.074
C-18	37	300	26	2.10	0.314	28	.085

Figure 3. Foraminiferal data and diversity indices.

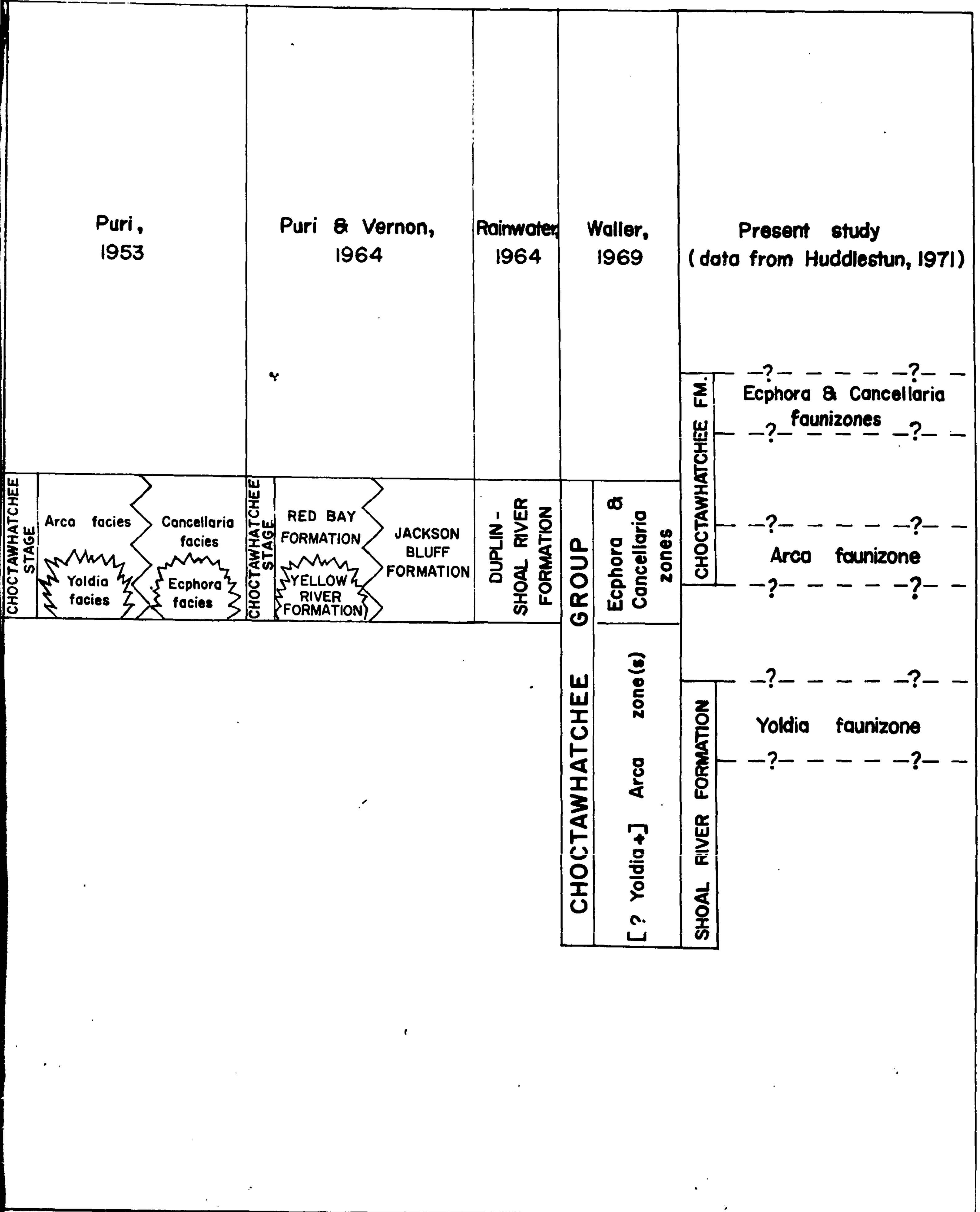
MIOCENE: LOWER	MIOCENE: MIDDLE	MIOCENE: UPPER	PLIOCENE	
4, 5, 6, 7, 8	9, 10, 11, 12, 13, 14, 15	16, 17	18, 19, 20, 21	Planktonic Foraminiferal Zones of Blow, 1969.

Units	Reference
ALUM BLUFF SERIES	Langdon, 1889
CHESAPEAKE GROUP; "Ecphora bed" & "aluminous clay"	Dall & Stanley-Brown, 1894
CHOCTAWHATCHEE MARL	Matson & Clapp, 1909
CHOCTAWHATCHEE FORMATION: Arca zone; Ecphora zone; Cancellaria zone	Cooke & Mossom, 1929
CHOCTAWHATCHEE FORMATION: Yoldia zone; Arca zone; Ecphora zone; Cancellaria zone	Mansfield & Ponton, 1932
CHOCTAWHATCHEE FORMATION: Yoldia zone; Arca zone; Permenter's Farm beds; Ecphora zone; Cancellaria zone	Smith, 1941
CHOCTAWHATCHEE FORMATION: Yoldia - Arca facies / Ecphora - Cancellaria facies	Vernon, 1942
SHOAL RIVER FORMATION; DUPLIN MARL	Cooke, 1945

FIGURE 4. CORRELATION



ELATION OF CHOCTAWHATCHEE DEPOSITS.



OF CHOCTAWHATCHEE DEPOSITS.

Dall and Stanley-Brown (1894) redescribed the section at Alum Bluff, applying the name "Alum Bluff formation" to the lower fossiliferous sands, which were under water at the time that Langdon visited the outcrop. They named the upper fossiliferous marl the "*Ecphora* bed" after a rare gastropod, *Ecphora quadricostata umbilicata*, which they considered characteristic of the horizon. Above the marl lay an "aluminous clay," a compact gray clay containing a few poorly-preserved shell and plant molds, and tasting of alum. They referred the marl and clay section to the "Chesapeake group" of Miocene age. The "*Ecphora* bed" and "aluminous clay" were also recognized at two localities on the Chipola River in Calhoun County. The "*Ecphora* bed" alone was observed at Jackson Bluff on the Ochlockonee River in Leon County.

Matson and Clapp (1909) first used the term "Choctawhatchee marl," which included the "*Ecphora* bed" and "aluminous clay" of Dall and Stanley-Brown. The name was derived from the Choctawhatchee River, in the banks of which are exposures of fossiliferous clayey marl in the vicinity of Red Bay, Walton County. They considered these beds equivalent to the "*Ecphora* bed" at Alum Bluff.

Cooke and Mossom (1929) referred the "Choctawhatchee marl" of Matson and Clapp to the "Choctawhatchee formation," because "the marl beds that contain the characteristic fossils of the Choctawhatchee make up only a part of the formation and are less persistent than the clay" (p. 138). On the basis of study of the molluscan faunas, Mansfield (*in* Cooke and Mossom) recognized three faunal zones within the "Choctawhatchee formation." The oldest, or *Arca* zone, he found only in the vicinity of Red Bay, Walton County. This zone was named for *Arca staminea rubisiana* Mansfield. Mansfield considered this zone equivalent "in age with part of the Chesapeake group of Virginia" (p. 140). The second zone was the *Ecphora* zone ("*Ecphora* bed" of Dall and Stanley-Brown), which he correlated with part of the Yorktown Formation of Virginia. The third and youngest zone was named the *Cancellaria* zone for *Cancellaria propevenusta* Mansfield. Typical exposures of this zone were found along Harveys Creek, Leon County, near Jackson Bluff. This zone was equated with the Duplin marl of the Carolinas. The "aluminous clay" of Dall and Stanley-Brown he considered younger than the *Ecphora* zone and older than the *Cancellaria* zone.

Mansfield and Ponton (1932) reported the existence of a fourth and older faunal zone of the "Choctawhatchee formation" exposed in the Alaqua Creek valley south of DeFuniak Springs, Walton County. They named this zone the *Yoldia* zone, for "its abundant content of large *Yoldia* shells, a genus which usually indicates that the temperature of the water in which it lived was rather cold" (p. 86). Mansfield and Ponton considered the *Yoldia* and *Arca* zones to be Mid-Miocene, and the *Ecphora* zone, the "aluminous clay," and the *Cancellaria* zone to be Late Miocene.

Smith (1941) proposed the name "Permenter's Farm beds" for a horizon which outcrops on the old Permenter farm south of DeFuniak Springs. These beds he considered older than the *Ecphora* zone, but younger than the typical *Arca* zone at Red Bay, Walton County. Mansfield and Ponton had assigned these beds to the *Ecphora* zone, but on the basis of the microfossil faunas, Smith considered them to be latest Mid-Miocene in age.

Vernon (1942), in his study of the geology of Holmes and Washington Counties, decided that the *Yoldia* and *Arca* zones were of approximately the same age as the *Ecphora* and *Cancellaria* zones, being different facies within the "Choctawhatchee formation." He postulated this time equivalence on the basis of field relationships and hypothetical subsurface structure.

Cooke (1945) discarded the name "Choctawhatchee formation," placing the *Yoldia* and *Arca* zones in the Middle Miocene "Shoal River formation" and the *Ecphora* and *Cancellaria* zones in the "Duplin marl" of Late Miocene age. He postulated a major unconformity between the two formations, representing a regression of the sea throughout the entire Atlantic Coastal Province.

Puri (1953) rejected normal stratigraphic procedures in his analysis of the Miocene stratigraphy of the Florida panhandle by dividing the "Miocene series" into three stages, the uppermost of which was the "Choctawhatchee Stage." This "Choctawhatchee Stage" contained four "biofacies": *Yoldia*, *Arca*, *Ecphora*, *Cancellaria*. Following Vernon (1942), he considered the *Yoldia* and *Arca* biofacies to be down-dip time-equivalents of the *Ecphora* and *Cancellaria* biofacies. Puri included the "Permenter's Farm beds" of Smith in the *Arca* biofacies. No rock unit nomenclature was included.

Puri and Vernon (1964), following the "stage" concept of Puri, applied rock unit names to the various "contemporaneous biofacies" within the "Choctawhatchee Stage." They referred the *Arca* biofacies to the "Red Bay formation," in reference to its typical exposure at Red Bay, Walton County. The *Yoldia* biofacies they named the "Yellow River formation," although it is not exposed in the vicinity of Yellow River. The *Ecphora* and *Cancellaria* biofacies were combined into the "Jackson Bluff formation," because both biofacies are exposed at Jackson Bluff in Leon County. This is the only exposure at which more than one biofacies has been observed.

Rainwater (1964) proposed that all the "Upper Miocene" sediments of northwest Florida be combined into the "Duplin-Shoal River formation." The Upper Miocene of the Florida panhandle, as he defined it, "is equivalent to the Choctawhatchee Stage and part of the Alum Bluff Stage of Puri. His Shoal River Facies and the Hawthorn Facies are regarded as approximate time equivalents of the *Yoldia*, *Arca*, *Cancellaria*, and *Ecphora* Facies."

Waller (1969) discussed the stratigraphic problems within the "Choctawhatchee group," and suggested that the *Ecphora* and *Cancellaria* zones were younger than the *Arca* zone, based on the stages of evolution of the species of *Argopecten* present in the various zones. The *Yoldia* zone was not considered in his study because no specimens of *Argopecten* have been found within it.

Akers (unpublished Ph.D. dissertation, Tulane University, 1970) and Huddlestun (pers. comm., 1970) have studied the planktonic foraminiferal faunas in attempts to establish a zonation of the "Miocene" of the northeast Gulf Coast in accordance with the biostratigraphic zones of Blow (1969). Their studies assign the *Yoldia* zone to the Middle Miocene, the *Arca* zone to the Upper Miocene, and the *Ecphora* and *Cancellaria* zones to the Pliocene, as defined by Blow (1969). These age assignments appear to be the most reliable that have yet been given, and are in agreement with the limited evidence afforded by the benthonic species found in the present study.

Synthesis

It is obvious from the foregoing discussion that the stratigraphic problems of the "Choctawhatchee formation" are many, and have attracted the attention of many workers. Of particular importance to this study is the usage of the four molluscan "zones" of Mansfield (*in* Cook and Mossom, 1929), and Mansfield and Ponton (1932). These "zones" have been viewed previously in two distinct ways. The first is that typified by Mansfield, who considered the various "zones" to be representative of noncontemporaneous time-stratigraphic units. The second concept, proposed by Vernon (1942), considered the various "zones" to be roughly contemporaneous facies.

Recent studies suggest that neither concept is wholly correct. Waller (1969), on the basis of stages of evolution within the *Argopecten gibbus* stock, has suggested that the *Arca* "zone" is significantly older than the *Ecphora* and *Cancellaria* "zones," which he considered contemporaneous. Akers (unpublished Ph.D. dissertation, Tulane

University, 1970), and Huddlestun (pers. comm., 1970) have concluded, on the basis of the planktonic foraminifera, that the *Yoldia* "zone" is of Mid-Miocene age, the *Arca* "zone" is Late Miocene, and the *Ecphora* and *Cancellaria* "zones" are Pliocene.

Benthonic foraminiferal distributions, while not conclusive, suggest that the *Yoldia* and *Arca* "zones" are older than the *Ecphora* and *Cancellaria* "zones," although most obvious faunal dissimilarities are undoubtedly the result of ecologic rather than chronologic differences. The only stratigraphically significant species in this study is *Caucasina elongata* (d'Orbigny), one of the most abundant species in the *Arca* "zone," to which it is restricted. *C. elongata* is considered by Loeblich and Tappan (1964b) to be an important marker of the Tortonian Stage (Upper Miocene) in Europe, which agrees with the Late Miocene age suggested for the *Arca* "zone" by Akers and by Huddlestun.

Bolivina californica and *B. floridana* have been found in the present study in only the *Yoldia* and *Arca* "zones." *B. californica* is otherwise known only from the Monterey Shale of California. Neither species has been reported from beds younger than Late Miocene.

Alliatina glabrella has been found in only the *Ecphora* and *Cancellaria* "zones" in the current study, which agrees with the range of Pliocene to Recent reported for the genus by Loeblich and Tappan (1964a). However, this species also occurs in some outcrops of the Mid-Miocene Shoal River Formation (Cushman and Ponton, 1932b; Cushman, 1939), suggesting that the restricted stratigraphic distribution of this species in the Choctawhatchee deposits is ecologically controlled, and that the range of this genus should include the Miocene.

The species *Buliminella subfusiformis* and *Fursenkoina fusiformis* are of limited and nearly mutually exclusive ranges in the Choctawhatchee deposits, occurring together only in the beds exposed at Permenter's Farm, which is thought to be the youngest part of the *Arca* "zone." *Fursenkoina fusiformis* is otherwise limited to the *Ecphora* and *Cancellaria* "zones," while *Buliminella subfusiformis* has been found in only the *Yoldia* and *Arca* "zones" in the present study. However, both species have been reported in Miocene to Recent strata in other areas, and are therefore of questionable value as biostratigraphic indices.

Since a comprehensive stratigraphic study is beyond the scope of this study, separation of the various horizons into meaningful lithologic units will not be undertaken at this time. However, a few tentative conclusions about the stratigraphic relationships of the various horizons are in order.

The beds of the *Yoldia* "zone" are gray and brown clay, quite similar in lithology to the beds of the typical Shoal River Formation. In addition, the foraminiferal faunas are quite similar, and the ages indicated by the planktonic foraminifera are identical. Typical Shoal River sediments are reported by Cushman and Ponton (1932b) to occur below the *Yoldia* outcrop at the Spence Farm (Loc. 2), separated by only a thin "oxidized seam." The faunas on both sides of the "oxidized seam" are quite similar, although Cushman and Ponton separated the "zones" on faunal bases. A thin, irregular, brown clay layer was observed at the typical *Yoldia* outcrop (Sample Y-3) in the present study. This brown clay layer may be equivalent to the "oxidized seam" reported by Cushman and Ponton at the Spence Farm. There seems to be no valid basis for separation of the *Yoldia* beds from the Shoal River Formation.

The beds referrable to the *Arca* "zone" are gray marls, as are some beds of the *Ecphora* "zone" and *Cancellaria* "zone." Until adequate subsurface control is established, no separation of the marls from these three "zones" can be justified on lithologic bases.

The *Ecphora* beds at Jackson Bluff and the light gray and brownish calcareous sands and sandy limestones characteristic of much of the *Cancellaria* "zone" represent a different facies from the contemporaneous greenish-gray marls of the typical *Ecphora* "zone" and the *Cancellaria* beds in the Hosford area and at Gully Pond Sink. The "Jackson Bluff formation" of Puri and Vernon (1964) unites these dissimilar facies, but obscures their lithologic relationships with the beds characteristic of the *Arca* "zone" ("Red Bay formation" of Puri and Vernon). Considering the present state of knowledge of the subsurface relationships of these beds, the biostratigraphic separation inherent in the approach of Puri and Vernon seems less satisfactory than does retention of the "Choctawhatchee Formation" for the beds of the *Arca*, *Ecphora*, and *Cancellaria* "zones."

In summary, the "zones" proposed by Mansfield (1929), and by Mansfield and Ponton (1932), are not true biostratigraphic units, nor do they represent contemporaneous "biofacies" as stated by Vernon (1942). Because neither term is applicable in this case, the term "faunizone" is used for the purposes of this study. The beds of the *Yoldia* faunizone are Mid-Miocene, the *Arca* faunizone beds are Late Miocene, and the *Ecphora* and *Cancellaria* faunizone beds are Pliocene. The *Yoldia* faunizone should be included in the Shoal River Formation, while the *Arca*, *Ecphora*, and *Cancellaria* faunizones are herein considered to represent the Choctawhatchee Formation. The "Permenter's Farm beds" of Smith (1941) are included within the *Arca* faunizone as suggested by Puri (1953), although they are somewhat younger that the typical *Arca* horizon (Huddlestun, pers. comm., 1971). These stratigraphic relationships are shown in figure 4.

PALEOECOLOGY

Historical Review

The first important paleoecological study of the Choctawhatchee deposits was that of Puri (1953). On the basis of his study of the Ostracoda, and of the foraminiferal studies of Cushman (1930b) and Cushman and Ponton (1932b), he postulated the following paleobathymetric conditions for each faunizone: 1) the *Yoldia* faunizone represents deposition at depths of less than 50 meters ("inner neritic"); 2) the *Arca*, *Ecphora*, and lower part of the *Cancellaria* faunizones represent deposition at depths between 30 and 100 meters; 3) the upper part of the *Cancellaria* faunizone represents deposition "under more shallow conditions during a transgressive sea" (p. 51).

Bandy (1956), using the list of foraminifera given by Cushman and Ponton (1932b), suggested that the "late Miocene" of northern Florida was deposited in water 75 to 175 meters deep, with the exception of the *Cancellaria* faunizone, which represented a gradually shoaling environment. Bandy based these depth determinations on the presence of the genera *Valvulineria* and *Uvigerina* in the *Yoldia*, *Arca*, and *Ecphora* faunizones. The "late Miocene" included all four of the Choctawhatchee faunizones.

On the basis of the foraminiferal and molluscan faunas at Alum Bluff, Calhoun County, DuBar and Beardsley (1961) postulated that the "*Ecphora* Facies" at Alum Bluff was deposited in a turbulent, open ocean, normal salinity environment, at depths no greater than 15 meters. They believed that the "aluminous clay" was deposited in a shallow stagnant lagoon.

From an analysis of the foraminifera and mollusks at Jackson Bluff, Leon County, DuBar and Taylor (1962) suggested that the depositional environment of all sediments at Jackson Bluff was open marine with normal salinity, never deeper than 39 meters. Because of this constancy of conditions, they rejected the subdivision of the beds there into *Ecphora* and *Cancellaria* "Facies." They presented evidence for two periods of transgression, the older one with water depths up to 39 meters, the younger one with water depths no more than 15 meters, separated by a regression when water depths were less than 9 meters. They suggested that the upper transgression was equivalent to the "aluminous clay" at Alum Bluff.

Diversity

The diversity of a population, a measure of taxonomic variety, is independent of faunal composition, and is thus particularly useful in cases where some species are extinct or may have inhabited different niches from their modern counterparts (Walton, 1964; Gibson and Buzas, 1973).

Several authors (Walton, 1964; Sanders, 1968; Buzas and Gibson, 1969, etc.) have observed a correspondence of diversity with water depth. Shallow water, in which the environment is strongly affected by daily and seasonal changes in the water and atmosphere, will support a relatively small number of species -- those which can withstand these types of changes. Deep water, in which conditions are apparently less variable, will support more species. Buzas and Gibson (1969) demonstrated an increase in the numbers of benthonic species from shallow to deep water in the North Atlantic. Latitude should also affect the population diversity, since seasonal variations in temperature and salinity are greater at high latitudes than in the tropics (Pianka, 1966; Sanders, 1968; Buzas and Gibson, 1969).

Other abiotic factors may also be important in affecting diversity (Gibson, 1968). High or low levels of temperature, Eh, pH, free oxygen, sedimentation rate, etc., or a combination of these, may result in such a restricted environment that few species are able to live there.

A number of methods have been devised to measure population diversity. Several of these methods are reviewed by Pianka (1966), and by Buzas (1972). The most easily measured diversity-related parameter is the number of species in a population. Various authors (e.g., Walton, 1964; Buzas and Gibson, 1969) have shown that the number of species is directly proportional to water depth. However, this parameter is dependent on both sample size and chance occurrence of rare individuals. The number of species of benthonic foraminifera counted for each sample in the present study is given in figure 3. Because many factors, such as the ones mentioned above, affect this parameter, it cannot be regarded as a definitive measure of water depth.

A more elegant measure of diversity is given by the Shannon-Weiner Information Function:

$$H(S)=-\sum_{i=1}^{S} p(i) \ln p(i),$$

where p(i) is the proportion of the total population represented by the species i, S is the number of species in the population, and H(S) is a measure of the information required to define the statistical characteristics of the population. The value of H(S) increases proportionally to both the number of species being considered and the relative abundance of each species within the population. The values of H(S) for the various samples are given in figure 3.

The ranges and means of the H(S) values for the various faunizones are as follows:

Faunizone	Range	Mean
Yoldia	0.76 - 1.83	1.26

Arca	1.71 - 2.81	2.42
Ecphora	0.81 - 3.26	2.07
Cancellaria	1.77 - 2.41	2.15

There are significant differences between the mean values of H(S) for the four faunizones. In particular, the *Yoldia* faunizone exhibits very low diversity, with the greatest H(S) value falling well below the means of the other faunizones. This suggests that the *Yoldia* faunizone represents shallower water conditions than the other three faunizones.

The *Ecphora* faunizone exhibits the greatest range of H(S) values, suggesting that it may represent a variety of environments. The highest H(S) values in this faunizone are probably misleading, because they reflect addition of numerous miliolids to the perforate calcareous fauna found in other samples from this faunizone; this is especially true of Sample E-17, with the highest H(S) value, 3.26. Miliolids are a highly variable group whose taxonomy is poorly understood; their presence inordinately increases the apparent diversity, since there are undoubtedly fewer true (biologic) species than have been reported (see Arnold, 1964). Large miliolid populations generally occur in shallow water (Seiglie, 1966; Murray, 1969; Schnitker, 1971), and addition of these organisms to a shallow water perforate calcareous fauna does not necessarily require an increase in depth.

Because H(S) is dependent upon both the number of species and the relative abundance of the various species within the population, the maximum value of H(S) for a given number of species will occur when all species within that population are equally abundant (Sanders, 1968; Buzas and Gibson, 1969; Buzas, 1972). In such cases, p(i) = 1/s, and $e^{H(S)} = S$, where S is the number of species, and e is the base of the natural logarithms. The second equation can be written as $e^{H(S)} = 1$. If the species within a population are unequally proportionate, $e^{H(S)} = 1$, and can be used as a measure of equitability within that population. Species equitability has been related to environmental stability by various authors. According to Walton (1964) and to Buzas and Gibson (1969), variable (i.e., shallow) environments tend to be strongly dominated by a few broadly tolerant species, and should exhibit low $e^{H(S)}/S$ values, while environmental stability results in species equitability and high $e^{H(S)}/S$ values. As is shown in figure 3, the value of $e^{H(S)}/S$ fluctuates much more than the value of H(S). For further discussion of the application of Information Function theory to paleoecology, see Buzas and Gibson (1969), Beerbower and Jordan (1969), and Gibson and Buzas (1973).

Walton (1964) discussed the distribution of benthonic foraminifera in the northeastern Gulf of Mexico, and derived some bathymetric generalities using the number of species as a measure of population diversity. He reached the following conclusions concerning the relationship of the number of species to water depth:

1. 100% of all faunas with fewer than 20 species occur in water shallower than 18 meters.

2. 100% of all faunas with fewer than 30 species occur in water shallower than 37 meters.

3. 85% of all faunas with 31 to 40 species occur in water shallower than 37 meters.

4. 53% of all faunas with 41 to 50 species occur in water shallower than 37 meters (82% in water shallower than 92 meters).

Another parameter measured by Walton was the frequency of the dominant species. Comparing this parameter with water depth, he concluded the following:

1. 100% of all faunas whose dominant species constitutes more than 35% of the entire fauna occur in water shallower than 18 meters.

2. 67% of all faunas whose dominant species constitutes 21% to 30% occur in water shallower than 37 meters.

3. 43% of all faunas whose dominant species constitutes 11% to 20% occur in water shallower than 92 meters (4% shallower than 18 meters, 22% shallower than 37 meters).

The number of benthonic foraminiferal species and the percent of dominant foraminiferal species for each sample in the present study are shown in figure 3. One problem with strict application of Walton's findings to paleoecologic studies is that he analyzed only a part of a single body of water (the northeastern Gulf of Mexico). It is improbable that his specific values would be applicable to faunas from other regions.

A second, related problem in his correlation of diversity and dominance with environmental variability, and environmental variability with bathymetry, is that he ignores the importance of other environmental factors previously mentioned (p. 19). According to Darwinian evolutionary theory and the present knowledge of adaptation, an imbalance of one or more of these factors will result in the tendency of the best-adapted species to become dominant at the expense of less well-adapted species, resulting in decreased diversity, regardless of water depth. Thus it seems unwarranted to take Walton's statistics as indicators of absolute water depth for the Choctawhatchee deposits.

Planktonic-Benthonic Ratios

Grimsdale and van Morkhoven (1955) compared the ratios of planktonic to total foraminiferal populations with increasing depth in the northwestern Gulf of Mexico. They found that although the percentage of planktonic species generally increases with depth, the ratios are insufficiently precise to draw a close correspondence between these parameters. They found, however, that planktonic faunas comprising more than 20% of the total foraminiferal fauna did not occur in water shallower than 50 meters in any of their samples, and planktonic/total fauna ratios greater than 10% did not occur in water shallower than 40 meters. Data compiled by Parker (1954) for the northwestern Gulf of Mexico show close correspondence to Grimsdale and van Morkhoven's findings. Planktonic/total foraminiferal fauna ratios (P/P+B) for samples from the Choctawhatchee deposits are shown in figure 3.

Planktonic-benthonic ratios should be used with caution, and only in conjunction with other parameters (Gibson, 1968).

The ranges and means of the planktonic/total fauna values for the various faunizones are as follows:

Faunizone	Range	Mean
Yoldia	.037 - .091	.058
Arca	.010 - .070	.042
Ecphora	.000 - .230	.097
Cancellaria	.018 - .092	.053

The wide range of values in the Ecphora faunizone suggests that a variety of environments are represented. The mean values of the Yoldia and Ecphora faunizones are higher than those of the Arca and Cancellaria faunizones, in contrast to the mean H(S) values. It seems logical that if the values of both parameters increase with depth, their distributions should show the same general patterns. Apparently this is not the case in the Choctawhatchee deposits.

In general, it may be seen from figure 3 that the planktonic/total fauna ratios are indicative of depths less than 50 meters with the exception of Sample E-12, for which the value is .230. This relatively high value seems anomalous, because no other evidence suggests a relatively deep environment of deposition for this sample.

High Nutrient Environments

Seiglie (1968), in his discussion of the occurrence of organic carbon in shallow water environments, stated:

> "Species included in the following genera, where abundant, are related to high or relatively high percentages of organic carbon in sediments or to abundance of nutrients: *Bulimina*, *Buliminella*, *Fursenkoina*, *Florilus*, *Nonionella*, and probably *Uvigerina*" (p. 2239).

It may be seen in figures 5-7 that these genera are abundant in many samples from all four faunizones. In 26 of the 54 samples of this study, at least 50% of the benthonic foraminiferal fauna is composed of species of these 6 genera. These data suggest that many of the Choctawhatchee beds represent high organic carbon-low oxygen environments.

Fig. 5. Genera indicative of high organic carbon sediments: *Yoldia* and *Arca* faunizones.

Fig. 6. Genera indicative of high organic carbon sediments: *Ecphora* faunizone.

Fig. 7. Genera indicative of high organic carbon sediments: *Cancellaria* faunizone.

Boltovskoy (1963) reported the occurrence of symbiotic green algae in the protoplasm of species of *Buccella*, *Buliminella*, *Elphidium*, and *Florilus*, all abundant genera in the Choctawhatchee deposits. There is no reason to assume that symbiotic algae are restricted to only certain species of these four genera, nor, of course, that they are found in all species of these genera. Seiglie (1968) suggested that these algae allow foraminifera to exist in low oxygen environments by supplying them with oxygen as a product of their photosynthetic processes. If this can be applied to the present case, the hosts must have been limited to an epifaunal existence within the photic zone.

Additional indication of probable low-oxygen conditions is the presence of abundant pyrite in Sample A-12 and in the "aluminous clay" which overlies parts of the *Ecphora* faunizone. The "aluminous

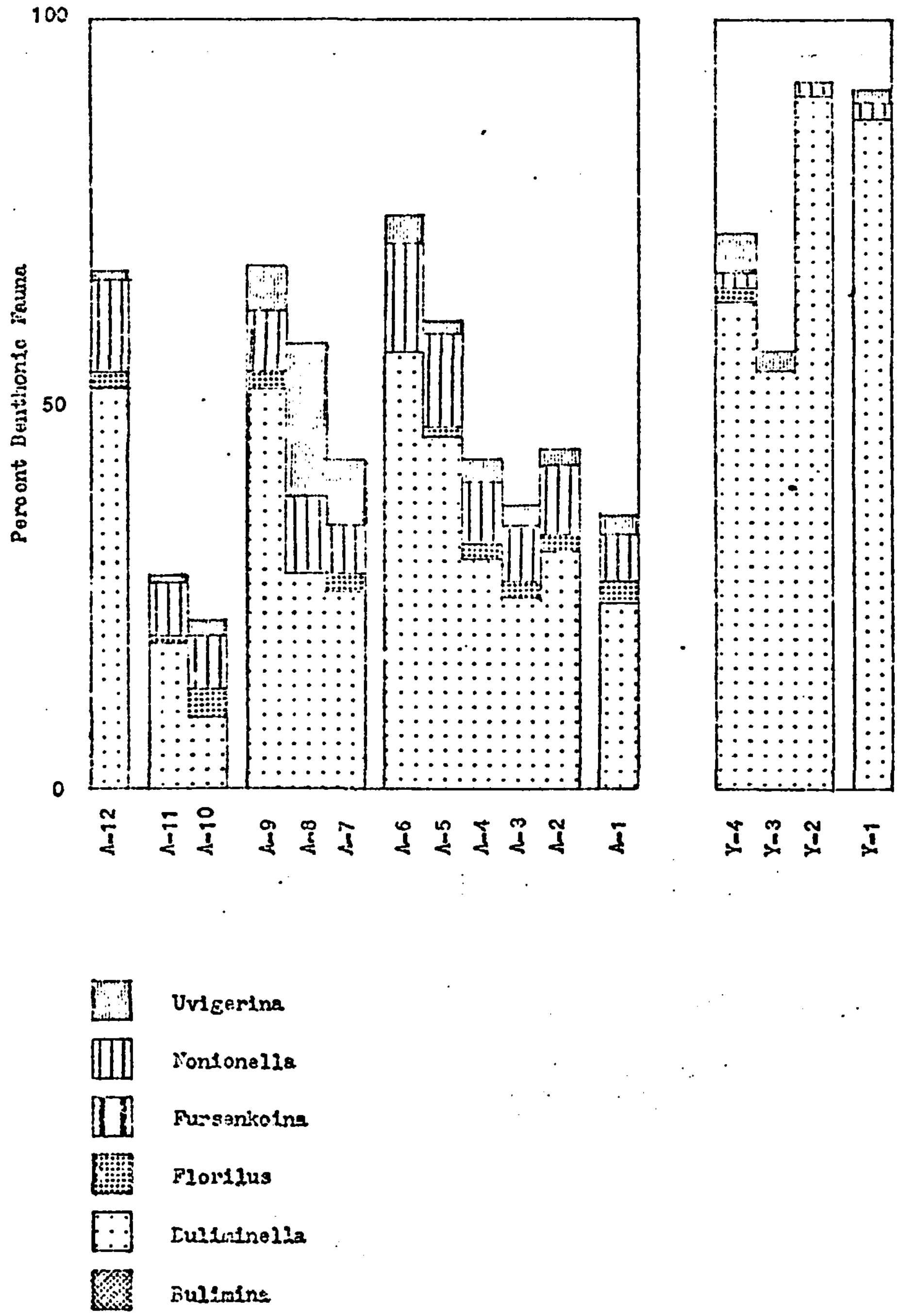


Figure 5. Genera indicative of high organic carbon sediments: Yoldia and Arca faunizones.

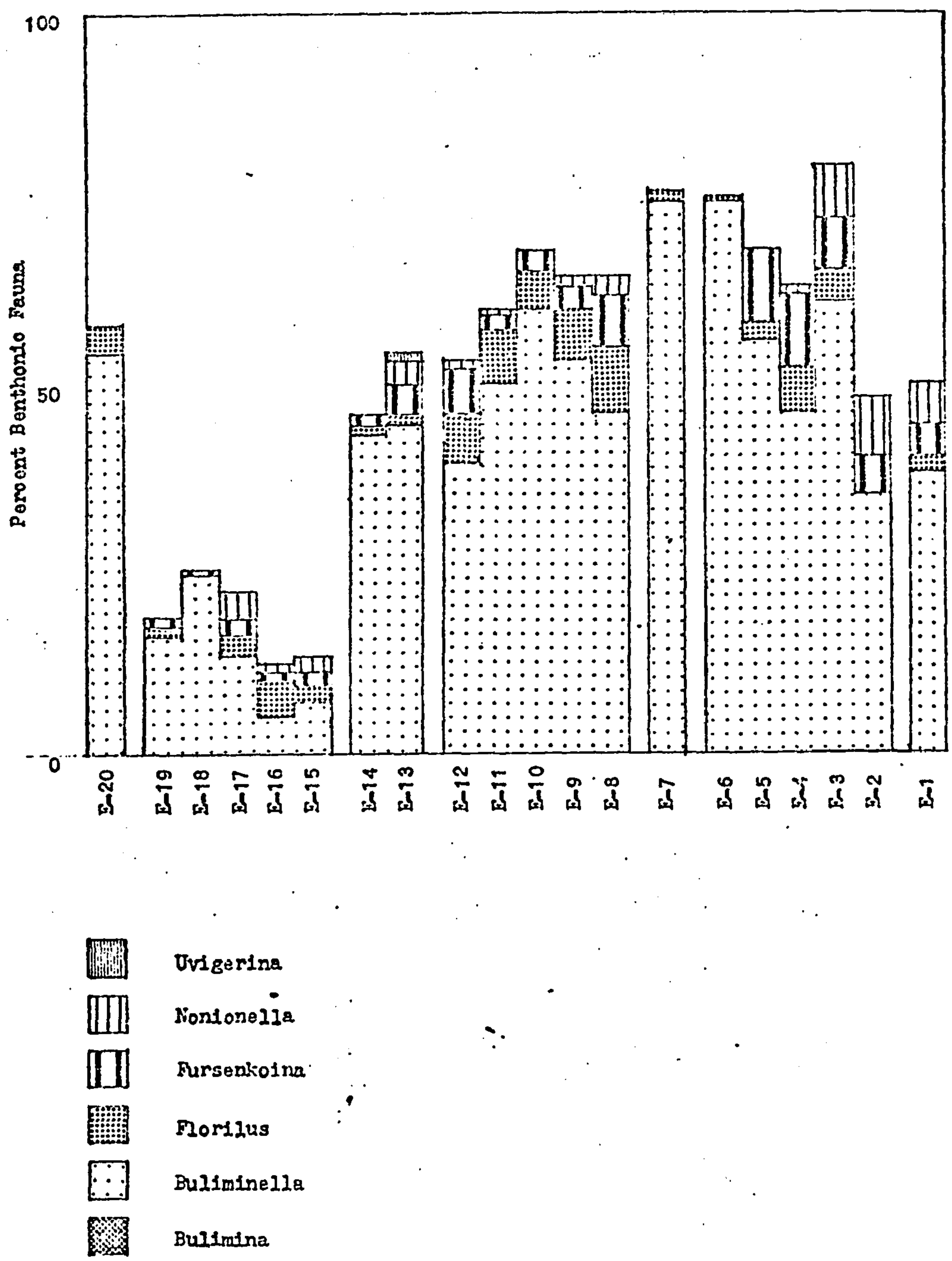


Figure 6. Genera indicative of high organic carbon sediments: *Ecphora* faunizone.

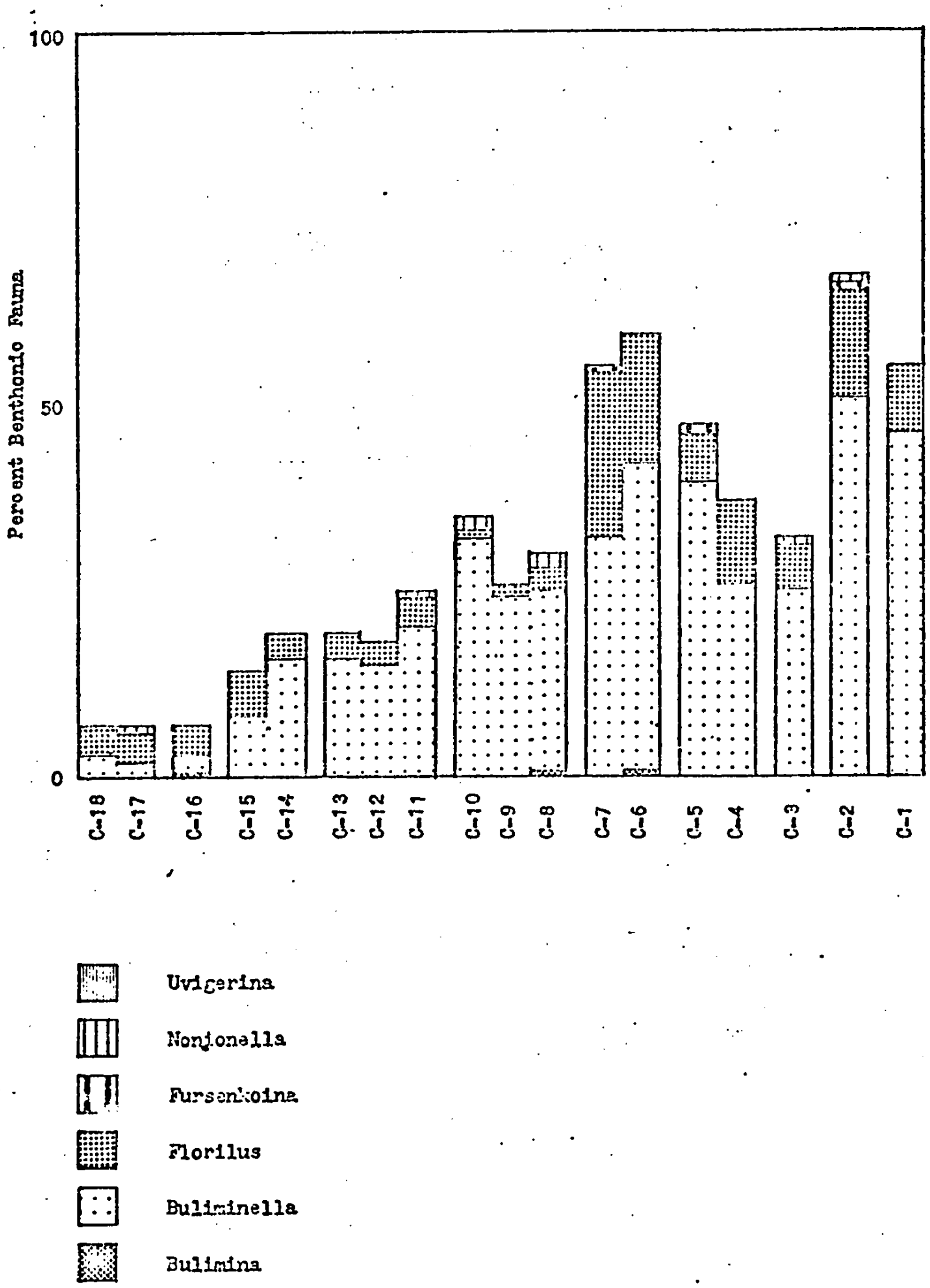


Figure 7. Genera indicative of high organic carbon sediments: Cancellaria faunizone.

species of these genera. Seiglie (1968) suggested that these algae allow foraminifera to exist in low oxygen environments by supplying them with oxygen as a product of their photosynthetic processes. If this can be applied to the present case, the hosts must have been limited to an epifaunal existence within the photic zone.

Additional indication of probable low-oxygen conditions is the presence of abundant pyrite in Sample A-12, and in the "aluminous clay" which overlies parts of the *Ecphora* faunizone. The "aluminous clay" received its name from the efflorescence of ferrous sulfate, a weathering product of pyrite (Langdon, 1889).

Predation

Sliter (1971) has discussed boring of foraminiferal tests by nematodes and possibly by other minute organisms. Several of the specimens illustrated in the present study exhibit probable evidence of boring. These include:

Guttulina rectiornata, pl. 2, figs. 15, 16;

Guttulina elegans, pl. 2, fig. 17;

Lenticulina cf. *L. vaughani*, pl. 3, fig. 4;

Fissurina flintii, pl. 4, figs. 5, 6;

Buliminella subfusiformis, pl. 5, fig. 8;

Bolivina bulbosa, pl. 5, figs. 15-18;

Pseudoparrella pontoni, pl. 7, figs. 7-9;

Elphidium sagrum, pl. 8, figs. 7, 8;

clay" received its name from the efflorescence of ferrous sulfate, a weathering product of pyrite (Langdon, 1889).

Abundant Species

If relative abundance within a population can be correlated with adaptation to an environment, as the theory of natural selection implies, distributional data of the most abundant species should serve as important guidelines in paleoecologic interpretations. In the present study, those species occurring in any sample with a frequency of 10% or greater have been considered abundant. The distributions of the

16 species so considered have been plotted in figures 8-10. Of these species, *Ammonia beccarii*, *Buliminella elegantissima*, *Cibicides lobatulus*, and *Hanzawaia americana* comprise more than 25% of at least one sample. The 16 abundant species are discussed below in alphabetical order.

Fig. 8. Distribution of abundant species: *Yoldia* and *Arca* faunizones.

Fig. 9. Distribution of abundant species: *Ecphora* faunizone.

Fig. 10. Distribution of abundant species: *Cancellaria* faunizone.

Ammonia beccarii (Linné) is a widely distributed species, occurring in abundance in very shallow water. It is reported by Phleger and Parker (1951) and Parker (1954) to occur in frequencies greater than 10% no deeper than 40 meters in the Gulf of Mexico. Seiglie (1966) has reported a fauna rich in *Ammonia* at 2-5 meters, with a maximum depth for the genus at about 55 meters on the Araya-Los Testigos Shelf of northern Venezuela. *A. beccarii* occurs in the following samples in frequencies greater than 10% E-18 (44%), E-19 (33%), C-1 (12%), C-3 (16%), and C-4 (11%).

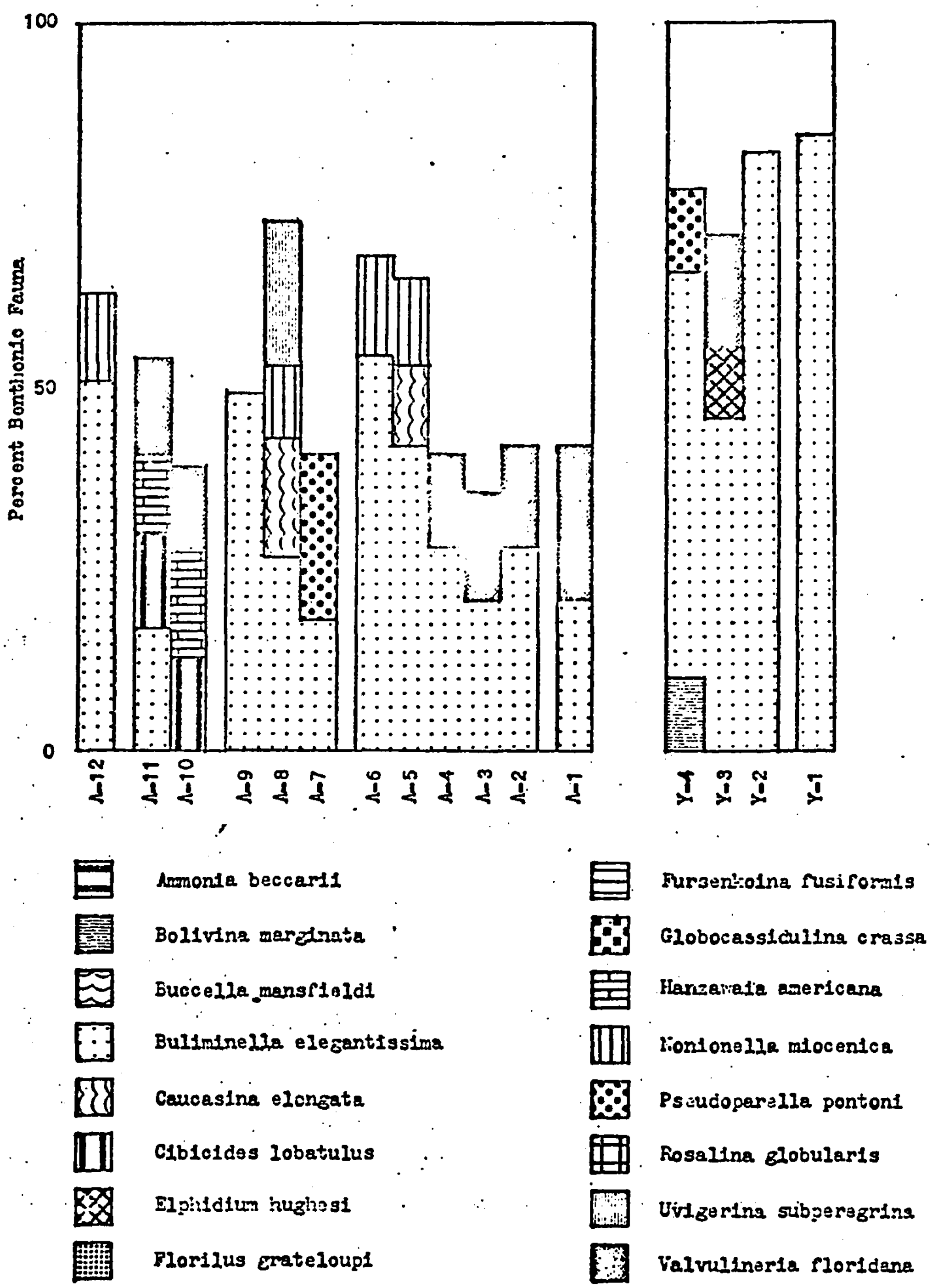


Figure 8. Distribution of abundant species: Yoldia and Arca faunizones.

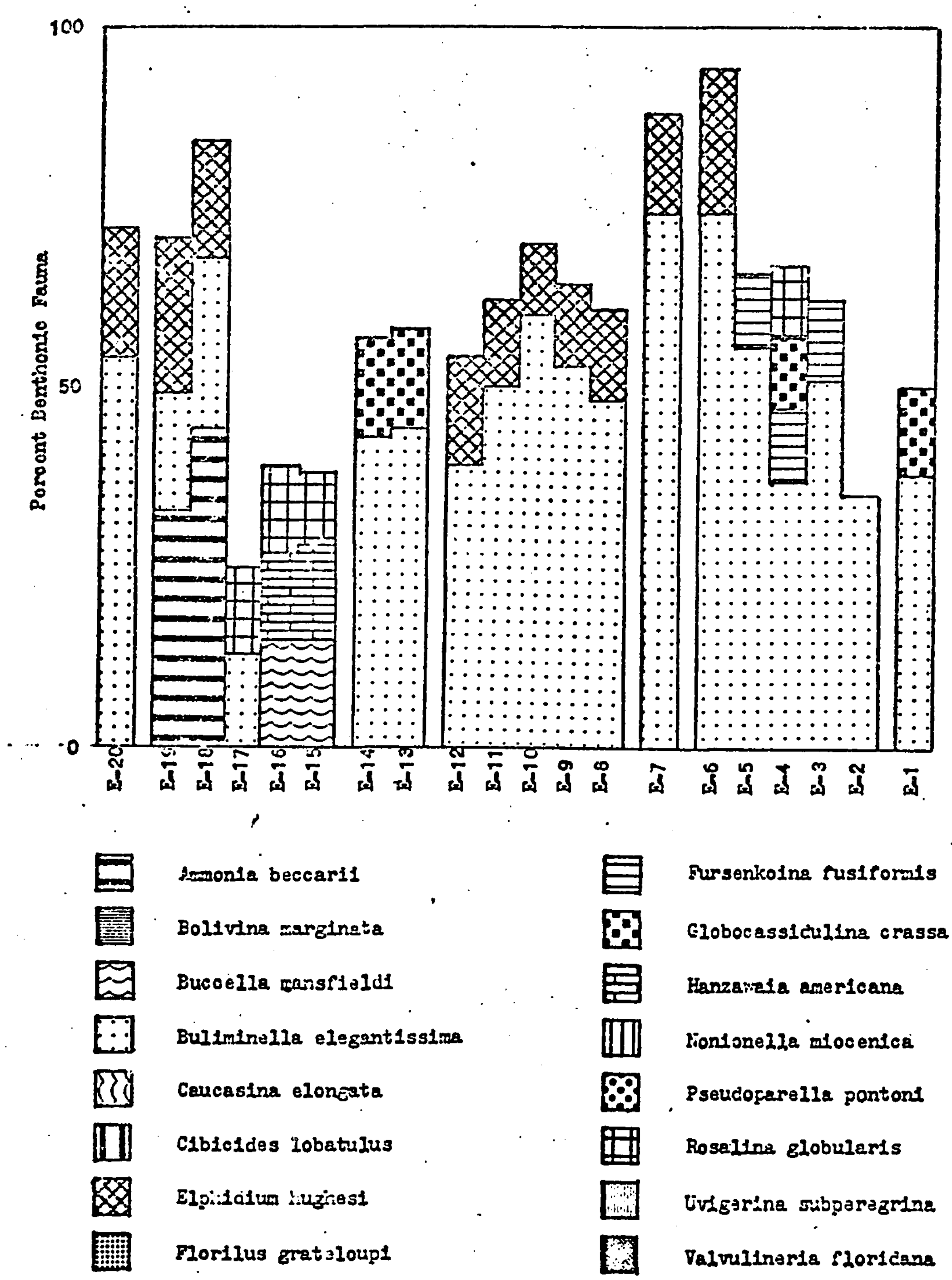


Figure 9. Distribution of abundant species: Ecphora faunizone.

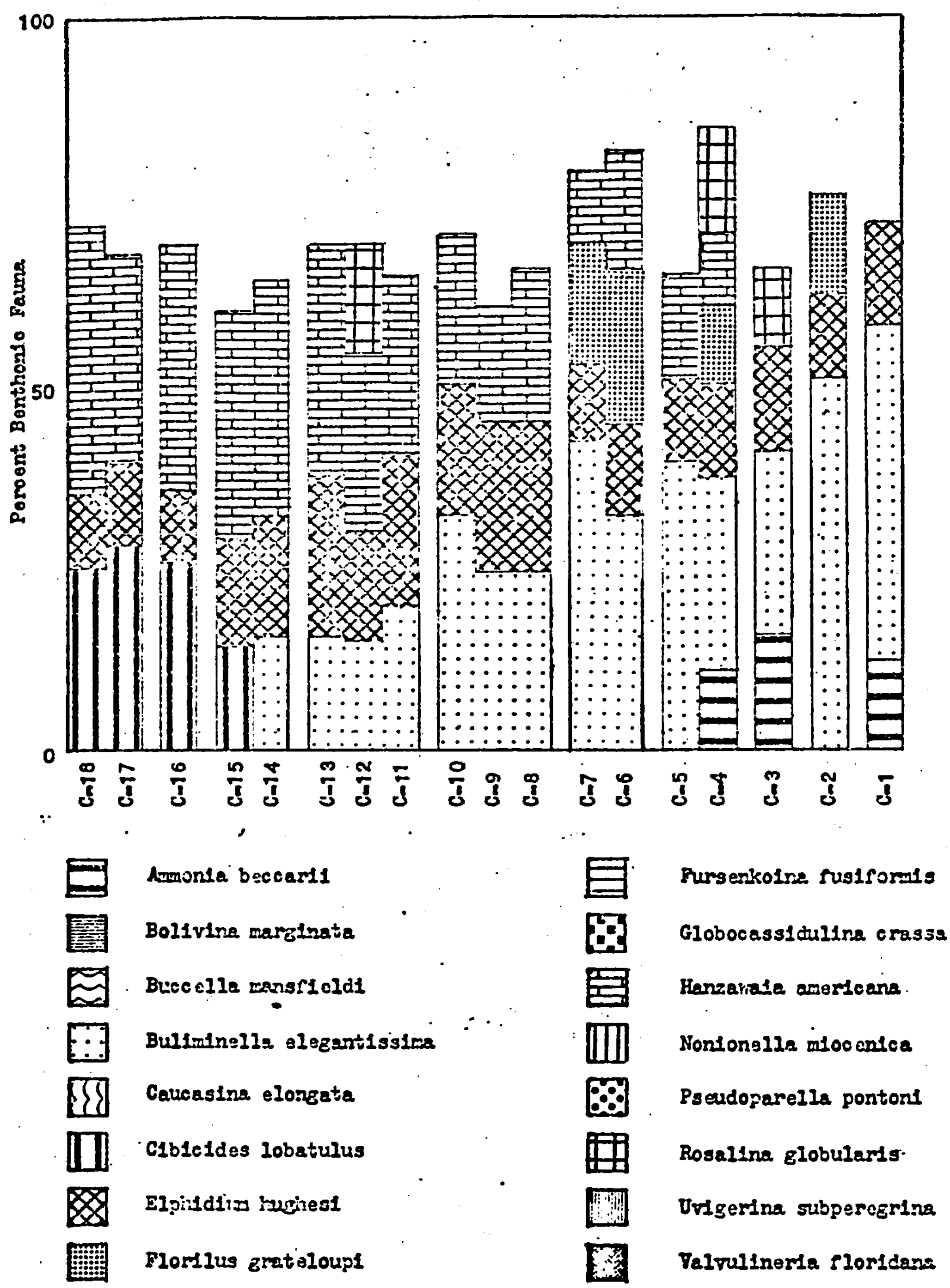


Figure 10. Distribution of abundant species: Cancellaria faunizone.

Bolivina marginata Cushman is a species originally described from the Choctawhatchee Formation. Although it has been reported from the continental shelf off northern Venezuela by Drooger and Kaaschieter (1958) and by Bermudez and Seiglie (1963), both identifications appear incorrect. Cooper (1961) listed this species from a beach sample from southern California, although he did not figure his species. This species comprises 10% of sample Y-4.

Buccella mansfieldi (Cushman) was also originally described from the Choctawhatchee deposits. Bandy (1961, 1963) reported this species to be characteristic of water less than 37 meters deep in the Gulf of California. The closely-related species *B. hannai* was reported by Phleger (1960) to be "relatively important in the open-ocean nearshore fauna (less than 20 m.)" along the Gulf and Atlantic coasts of the United States. Fifteen percent of the total benthonic faunas of samples E-15 and E-16 are composed of *Buccella mansfieldi*.

Buliminella elegantissima (d'Orbigny) has not been reported to occur in abundance in the Gulf of Mexico. However, it is reportedly abundant in the Skagerak north of Denmark (Hoeglund, 1947), the Gulf of Cariaco, Venezuela (Seiglie and Bermudez, 1963), the eastern Gulf of Paria (Todd and Bronniman, 1957), the Araya - Los Testigos Shelf, Venezuela (Seiglie, 1966), and the inner shelf off southern California and Baja California (Natland, 1933; Bandy, 1953, 1963; Walton, 1955; Watkins, 1961; Bandy, Ingle, and Resig, 1964a, 1964b, 1964c, 1965a, 1965b). Seiglie (1968) correlates abundant occurrence of *Buliminella* spp. to high organic carbon environments. High organic carbon and/or large amounts of nutrients are characteristic of all areas of abundance of *B. elegantissima*, with the possible exception of the Skagerak, for which there is insufficient data. The areas of most *B. elegantissima* today are the outfalls of the southern California sewage systems, where percentages approach the highest found in the current study. *Buliminella elegantissima* is the most abundant species in 39 of the 54 samples of the present study. This is the only species common to all samples, with a frequency varying from 2% to 84%. In 13 samples, more than 50% of the benthonic fauna is *Buliminella elegantissima*. In only 7 samples does this species occur in frequencies less than 10%.

Caucasina elongata (d'Orbigny) (*s.s.*) is known with certainty only from the fossil record, although it has been reported from Recent sediments by numerous authors. According to Loeblich and Tappan (1964b), this species is an index to the Tortonian Stage in Europe. *C. elongata* is limited to the *Arca* faunizone in the present study, and is abundant in samples A-5 (11%) and A-8 (16%).

Cibicides lobatulus (Walker and Jacob) is a wide-spread attached species that is generally restricted to firm substrates. Although most often found in shallow water, it has been reported both from beaches (Bhatia, 1956) and abyssal depths (Phleger, Parker and Peirson, 1953). This species is abundant in the following samples: A-10 (13%), A-11 (11%), C-15 (14%), C-16 (26%), C-17 (28%), and C-18 (25%).

Elphidium hughesi Cushman and Grant is apparently restricted to Neogene sediments, but it is quite similar in morphology to several shallow water Recent species (e.g., *E. incertum* (Williamson), *E. clavatum* (Cushman), "*E.*" *poeyanum* (d'Orbigny)). *E. hughesi* occurs in all samples from the *Cancellaria* faunizone in frequencies ranging from 10% to 21%. In addition, it occurs in abundance in sample Y-3 (10%) from the *Yoldia* faunizone, and in the following samples from the *Ecphora* faunizone: E-6 (20%), E-7 (14%), E-8 (13%), E-9 (11%), E-10 (10%), E-11 (12%), E-12 (15%), E-18 (16%), E-19 (22%), and E-20 (18%).

Florilus grateloupi (d'Orbigny) was reported by Phleger and Parker (1951) to be characteristic of depths less than 100 meters (their shallowest depth boundary), although occasional specimens occur in deeper water. Seiglie (1966) reported high percentages of this species at depths less than 35 meters on the Araya - Los Testigos Shelf of northern Venezuela. Seiglie (1968) related abundant occurrence of this species in the eastern Caribbean Sea to the presence of sewage outfalls, and suggested that this foraminifer may be an indicator of high organic content in sediments. *F. grateloupi* is abundant in the following samples: C-2 (14%), C-4 (11%), C-6 (22%), C-7 (16%).

Fursenkoina fusiformis (Williamson) was reported by Hoeglund (1947) to be very abundant in Gullmar Fjord, Norway, at depths between 20 and 50 meters, and also on the southern slope of the Skagerak, north of Denmark, where it may be found at depths greater than 600 meters, with greatest abundance between 200 and 300 meters. Parker (1948, 1952), Buzas (1965), and others have reported low frequencies of this species from the neritic zone on both sides of the Atlantic. *F. fusiformis* is found in abundance in the following samples: E-4 (11%), E-5 (10%), E-6 (10%).

Globocassidulina crassa (d'Orbigny) is reportedly limited in the Gulf of Mexico to depths greater than 50 meters (Phleger and Parker, 1951). However, this species is not well-defined, and specimens similar to those in the present samples have been reported under several different names. The reference collection of the U. S. Museum of Natural History contains numerous specimens from depths less than 40 meters off the Atlantic coast of the southern United States labeled "*Cassidulina subglobosa*", but identical to the present specimens. *G. crassa* occurs abundantly in the following samples: E-1 (12%), E-4 (10%), E-13 (14%), E-14 (14%).

Hanzawaia americana (Cushman) has been reported by Phleger and Parker (1951) and Parker (1954) to be abundant in the Gulf of Mexico at depths less than 100 meters. Bandy (1954, 1956) suggested that this species was limited to depths less than 70 meters, with greatest frequencies at less than 50 meters. Seiglie (1966) reported a "*Hanzawaia concentrica*" assemblage on the Araya - Los Testigos Shelf off Venezuela from 40 to 90 meters, which he related to low sedimentation rates and sandy substrate. *H. americana* occurs in abundance in the following samples: A-10 (15%), A-11 (11%), E-15 (13%), E-16 (12%), and *Cancellaria* faunizone samples C-4 through C-18, in which frequencies vary from 10% to 37%.

Nonionella miocenica Cushman was originally described from the Neogene of California, and is apparently not widespread in the Recent. Cushman (1939) reported this species off the west coast of Mexico, and Brenner (1959) found it in water less than 40 meters deep in the northern Gulf of California. This species is abundant in the following *Arca* faunizone samples: A-5 (12%), A-6 (14%), A-8 (10%), and A-12 (12%).

Pseudoparella pontoni (Cushman) was originally described from the Choctawhatchee Formation, and has not been found in Recent sediments. Species of this genus have been reported from nearly all benthonic environments. *P. pontoni* is abundant in samples Y-4 (11%) and A-7 (23%).

Rosalina globularis d'Orbigny is a widely-distributed species that has been given a variety of names (*see* Douglas and Sliter, 1965). The form commonly called "*Tretomphalus bulloides*" has a planktonic stage, and may therefore be found in environments where the attached "typical" form would be unlikely to exist. Although this species has been reported from abyssal depths, it is abundant only in water shallower than 100 meters in the Gulf of Mexico (Parker, 1954). Phleger and Parker (1951) considered "*Discorbis floridana*" (which is synonymous with *R. globularis*) characteristic of depths less than 60 meters. This species occurs in high frequencies in the following samples: E-4 (10%), E-15 (10%), E-16 (12%), C-3 (11%), C-4 (14%), and C-12 (15%).

Uvigerina subperegrina Cushman and Kleinpell has been reported as "*Uvigerina peregrina*, var. *parvula*" from the eastern Gulf of Paria by Todd and Bronniman (1957), where it is abundant at depths less than

35 meters. Lankford (1959) reported this species as *"Uvigerina parvula"* from water shallower than 35 meters off the Mississippi River delta. This species is present in all samples from the *Yoldia* and *Arca* faunizones, but is abundant in only sample A-8 (20%).

Valvulineria floridana Cushman was originally described from the Choctawhatchee Formation, and is apparently limited to Neogene deposits of the Atlantic and Gulf coastal plains. No extant species seems closely related. Bandy (1956), on the basis of occurrence of species of *Uvigerina* and *Valvulineria*, suggested that the *Yoldia*, *Arca*, and *Ecphora* faunizones were deposited in water 77 to 183 meters in depth. *Valvulineria floridana* is abundant in the following samples: Y-3 (15%), A-1 (21%), A-2 (14%), A-3 (15%), A-4 (13%), A-10 (11%), and A-11 (13%).

Synthesis

Analysis of the benthonic foraminiferal faunas from the Choctawhatchee deposits suggests that sediment deposition took place in an area of high nutrient supply. The presence of abundant *Buliminella elegantissima* in most horizons leads to this conclusion, since this species occurs in abundance only in soft, organic-rich muds. Beds lacking high concentrations of *B. elegantissima* contain large numbers of attached forms that frequent firm substrates, and other associated species that occur in nutrient-rich areas. All faunas considered in this study are characteristic of depths shallower than 100 meters. No horizon sampled contained a fauna indicating a depth greater than 50 meters.

The *Arca* faunizone, as a whole, probably represents the deepest depositional environment, as is suggested by abundance of *Valvulineria floridana* and *Uvigerina subperegrina*. In addition, occurrences of *Chilostomella oolina* and *Pullenia* sp., which indicate depths greater than about 70 to 100 meters, have been reported from subsurface samples of this faunizone. Neither of these forms was found in this study.

Samples from the lower *Ecphora* bed at Jackson Bluff, Leon County, have high faunal diversities and relatively large planktonic/total fauna ratios, which tend to suggest relatively deep water. However, the high diversities are partially caused by addition of miliolids to a shallow water benthonic fauna characteristic of depths of 50 meters or less.

Relatively large numbers of planktonic foraminifera occur in some *Ecphora* horizons. This increase in relative numbers of planktonic specimens can be interpreted as a general indication of increasing depth (Grimsdale and van Morkhoven, 1955). More likely, this indicates close proximity to an open-ocean environment; the plankton being transported into the shallow environment by storms or currents (Murray, 1965; Wilcoxon, 1964). In addition, selective dissolution may be a factor in this type of environment (Berger and Soutar, 1970; Parker and Berger, 1971).

SUMMARY OF STRATIGRAPHY AND PALEOECOLOGY

1. The deposits attributed by many authors (e. g., Cooke and Mossom, 1929; Mansfield and Ponton, 1932; Smith, 1941; Vernon, 1942) to the "Choctawhatchee Formation" comprise four "Faunizones", each named for a characteristic molluscan species. The oldest, the *Yoldia*, is of Mid-Miocene age. The *Arca* faunizone is Late Miocene. The *Ecphora* and *Cancellaria* faunizones are virtually contemporaneous, and are Pliocene in age. The name "Choctawhatchee Formation" is retained for the *Arca*, *Ecphora*, and *Cancellaria* faunizones, but the *Yoldia* faunizone is placed in the Shoal River Formation. The formation names proposed for the various faunizones by Puri and Vernon (1964) are rejected because they are faunally, rather than lithologically, defined.

2. All horizons within the four faunizones of the Choctawhatchee deposits exhibit evidence of deposition in high nutrient environments. Maximum water depth seldom exceeded 50 meters. The benthonic foraminifera appear similar to those living at depths of 50 meters or less in high nutrient environments off the coasts of southern California and northern Venezuela. This interpretation is based primarily on modern species distributions. Population density analysis, based primarily on the Shannon-Weiner Information Function, tends to support the species distribution data, and provides a basis for relative depth determinations within this environment. Planktonic-benthonic ratios suggest a shallow-water environment, although this parameter seems less dependable than the other parameters (see Grimsdale and van Morkhoven, 1955).

SYSTEMATIC PALEONTOLOGY

Previous work

Cushman (1918, 1930b), Cushman and Ponton (1932a, 1932b), and Cushman and Cahill (1933) described the foraminiferal fauna of the "Choctawhatchee formation" in considerable detail. In his 1918 publication, Cushman identified 38 species and varieties from three outcrops of the Choctawhatchee. In the 1930 study, he listed 105 species and varieties. Cushman and Ponton identified 144 forms in 1932. Cushman and Cahill redescribed and refigured some forms from the Choctawhatchee, but added no new taxa.

Smith (1941) studied the foraminifera and ostracodes from a well drilled at Niceville, Oklaloosa County, Florida. He based his faunal determinations on the work of Cushman (1930b), and Cushman and Ponton (1932b).

Vernon (1942), in his study of the geology of Washington and Holmes Counties, provided a checklist of the foraminifera present in Choctawhatchee samples from Washington County. A total of 125 species and varieties were identified for this publication by Dr. H. V. Howell.

Puri (1953) revised the taxonomy of the faunas described by Cushman (1930b), and by Cushman and Ponton (1932b), and re-issued their illustrations of the species that he considered dominant or diagnostic.

DuBar and Beardsley (1961) and DuBar and Taylor (1962) published lists of the foraminiferal faunas they found in samples from Alum Bluff and Jackson Bluff, respectively. DuBar and Beardsley reported 44 species present at Alum Bluff, while DuBar and Taylor found 39 species at Jackson Bluff.

Organization of taxa in this study

The problem of systematically classifying the Order Foraminiferida is one of great magnitude. The various schemes that have been presented attempt to group species on the basis of both observable test characteristics and probable phylogeny. However, so little is presently understood of intraspecific variation and of the influences of external stimuli upon test morphology that no existing classification can be considered definitive. Therefore, I have used no suprageneric classification, but rather have arranged genera and species alphabetically. The grouping of photographs is merely a convenient comparison of morphologically similar forms, and is not intended to suggest any relationships.

The generic definitions of Loeblich and Tappan (1964a) have not been used in this study, because in some instances older genera have been so finely split that they have become monotypic. Also, the wall structure criteria used by them are not taxonomically usable (Towe and Cifelli, 1967; Buzas, 1968; Hansen and Riess, 1971). A third problem with Loeblich and Tappan's taxonomic scheme is inconsistency in definitions at various levels of the taxonomic hierarchy. For these reasons, the generic definitions of Cushman (1948) have been used for older genera. This is the most usable source for most of the genera that had been defined at that time. For subsequent genera, the original definitions have been used.

Some modifications of definitions have been made to broaden the concepts of the genera to allow inclusion of species that are clearly closely related to typical species of those genera. Also, several of the genera have subsequently proven invalid, and name changes have been required. These changes are noted in the discussion of the genera concerned.

Genus : ALLIATINA Troelsen, 1954.

Alliatina glabrella (Cushman), new combination.

Pl. 8, figs. 13, 14.

Nonion glabrella Cushman, J. A., 1930, Florida Geol. Sur., Bull. 4, p. 38, pl. 6, fig. 6. - Cushman and Ponton, G. M., 1932, Florida Geol. Sur., Bull. 9, p. 69. - Cushman and Cahill, E. D., 1933, United States Geol. Sur., Prof. Paper 175-A, p. 20, pl. 7, fig. 3.

Nonion glabrellum Cushman: Cushman, J. A., 1939, United States Geol. Sur., Prof. Paper 191, p. 14, pl. 3, fig. 14.

Astrononion glabrellum (Cushman): Puri, H. S., 1953, Florida Geol. Sur., Bull. 36, p. 145, pl. 26, figs. 4, 5.

Discussion: The characteristics of this species clearly place it in the genus *Alliatina*. All of the present specimens exhibit a comma-shaped supplementary aperture on the apertural face of the final chamber which is connected to the supplementary aperture of the penultimate chamber by an "inverted V-shaped partition," a diagnostic characteristic of this genus. The holotype of the species also possesses this supplementary aperture, although it is not mentioned in the original description, nor is it shown in the type illustration. The supplementary aperture is shown in pl. 8, fig. 14.

Occurrence: *Ecphora* and *Cancellaria* faunizones.

Genus : AMMONIA Bruennich, 1772.

Discussion: Although placed in synonomy with *Rotalia* Lamarck by Cushman (1948), *Ammonia* is clearly differentiated from that genus on the basis of wall structure (see Cifelli, 1962), and because it possesses a partially to completely open umbilicus. This genus differs from *Discorbis* Lamarck in possessing much thicker, partially double septa, by having irregular granules and calcite wedges along the sutures and on the chamber flaps on the umbilical side of the test, and in having an internal axial plate.

Ammonia beccarii (Linné).

Pl. 11, figs. 7-9.

Nautilus beccarii Linné, K., 1758, *Systema Naturae*, Edit. 10, Stockholm, p. 710.

Streblus beccarii (Linné): Fischer de Waldheim, G., 1817, Soc. Imp. Natur. Moscou, Mem. 5 (Nouv. Mem. 1), p. 449.

Rotalia beccarii (Linné): d'Orbigny, A., 1826, Ann. Sci. Natur., Ser. 1, vol. 7, p. 275, no. 40. - Brady, H. B., 1884, Rep. Voyage Challenger, Zool., vol. 9, p. 704, pl. 107, figs. 2, 3. - Cushman, J. A., 1928, Cushman Lab. Foram. Res., Contrib., vol. 4, pt. 4, p. 104, pl. 15, figs. 1-7. - Cushman, 1931, United States Nat. Mus., Bull. 104, pt. 8, p. 58, pl. 12, figs. 1-7; pl. 13, figs. 1, 2.

Ammonia beccarii (Linné): Frizzell, D. L., and Keen, A. M., 1949, J. Paleontol., vol. 23, no. 1, p. 106. - Cifelli, R., 1962, Cushman Found. Foram. Res., Contrib., vol. 13, pt. 4, p. 119-126. - Belford, D. J., 1966, Bur. Mineral Resources, Geol., Geophys., Australia, Bull. 79, p. 108, pl. 19, figs. 2-8.

Rosalina parkinsonia d'Orbigny, A., (*in* de la Sagra) 1839, *Histoire physique, politique, et naturelle de l'Ile de Cuba, Foraminiferes,* Paris, p. 99, pl. 4, figs. 25-27.

Rotalia beccarii (Linné), var. *parkinsonia* (d'Orbigny): Cushman, J. A., 1930, Florida Geol. Sur., Bull. 4, p. 56, pl. 11, fig. 3. - Cushman and Ponton, G. M., 1932, Florida Geol. Sur., Bull. 9, p. 93. - Cushman and Cahill, E. D., 1933, United States Geol. Sur., Prof. Paper 175-A, p. 31, pl. 11, fig. 3.

Rotalia beccarii (Linné), var. *tepida* Cushman, J. A., 1926, Carnegie Inst. Washington, Pub. 344, p. 79. - Dorsey, A., 1948, Maryland Dept. Mines, Geol. Water Resources, Bull. 2, p. 312, pl. 37, fig. 9.

Streblus beccarii tepida (Cushman): Puri, H. S., 1953, Florida Geol. Sur., Bull. 36, p. 136.

Rotalia beccarii tepida Cushman: McLean, J. D., 1966, Virginia Div. Mineral Resources, Rep. Invest. 9, p. 50, pl. 15, figs. 7, 8; pl. 16, figs. 1, 3.

Discussion: Under *Ammonia beccarii* are included both "varieties" *tepida* and *parkinsonia*, neither of which seems to be of subspecific rank. Both "varieties" have been reported from Choctawhatchee deposits by previous authors. As Cifelli (1962) demonstrated, specimens of *A. beccarii* from the type locality exhibit considerable variability. The present specimens fall within the range of characteristics shown by specimens from Rimini.

Ammonia beccarii is able to tolerate a wide range of salinities, and may be found in large numbers in brackish environments as well as in open-sea waters. High percentages of this species occur in very shallow water.

Occurrence: *Arca*, *Ecphora*, and *Cancellaria* faunizones.

Genus : AMPHISTEGINA d'Orbigny, 1826.

Amphistigina gibbosa d'Orbigny.

Pl. 11, figs. 10-12.

Amphistegina gibbosa d'Orbigny, A., (*in* de la Sagra) 1839, *Histoire physique, politique, et naturelle de l'Ile de Cuba, Foraminiferes*, Paris, p. 120, pl. 8, figs. 1, 3. - Barker, R. W., 1960, Soc. Econ. Paleontol. and Mineral., Spec. Pub. 9, p. 228, pl. 111, figs. 2, 4, 7. - Bermudez, P. J., and Seiglie, G. A., 1963, Inst. Oceanogr. Univ. Oriente, Bol., vol. 2, no. 2, p. 8, pl. 27, fig. 5. - Bermudez and Fuenmayor, A. N., 1966, Bol. Geol., Venezuela, vol. 7, no. 14, p. 420.

"Amphistegina lessonii d'Orbigny": Cushman, J. A., and Ponton, G. M. (*not A. lessonii* d'Orbigny, 1826), 1932, Florida Geol. Sur., Bull. 9, p. 95, pl. 14, fig. 5. - Cushman and Cahill, E. D., 1933, United States Geol. Sur., Prof. Paper 175-A, p. 32, pl. 11, fig. 6. - Puri, H. S., 1953, Florida Geol. Sur., Bull. 36, p. 142, pl. 19, figs. 9-11. - Akers, W. H., and Dorman, J. H., 1964, Tulane Stud. Geol., vol. 3, no. 1, p. 21, pl. 11, figs. 32, 33.

Discussion: *Amphistegina gibbosa* has often been confused with an Indian Ocean species, *A. lessonii*, which was inadequately described by d'Orbigny in 1826. The original illustrations often cited for *A. lessonii* actually appear to be those of *A. quoii*, an Australian species. Indeed, d'Orbigny compares *A. gibbosa* with only *A. "quoyi"*, stating that this is the only species to which it is similar. The "modele" constructed by d'Orbigny to illustrate the characteristics of *A. lessonii* differs from the illustration of *A. gibbosa* in possessing a much thicker test with fewer chambers in each whorl. Considering these circumstances, it seems probable that *A. gibbosa* is the name that should be applied to these specimens.

Occurrence: *Arca*, *Ecphora*, and *Cancellaria* faunizones. Large numbers of worn, glauconitized fragments occur in some horizons of the *Arca* faunizone. Such specimens do not appear to have been indigenous to the environment of deposition.

Genus : ANOMALINOIDES Brotzen, 1942.

Anomalinoides riveroae Bermudez and Fuenmayor.

Pl. 10, figs. 13-15.

Anomalinoides riveroae Bermudez, P. J., and Fuenmayor, A. N., 1966, Bol. Geol. Venezuela, vol. 7, no. 14, p. 423, pl. 2, figs. 4-6.

Discussion: The original description of *Anomalinoides riveroae* is as follows (translated from the original Spanish):

> "Test comparatively small, compressed, slightly trochoid, periphery rounded, somewhat lobate, chambers differentiated, slightly inflated: the spire has two whorls, with 8 or 9 subglobose chambers in the final whorl, which increase gradually in size as formed; sutures slightly depressed; ventral side occupied by an umbonal nodule of glassy material, not very large; wall finely perforate; aperture in the form of a groove at the base of the septal face of the final chamber, extending toward the umbilical region. Diameter 0.03mm; height 0.30mm."

A slide labeled "HOLOTIPO" containing four specimens of *A. riveroae* is in the U. S. Natural History Museum collection (USNM 687279). The specimen illustrated in the type reference does not appear to be any of the specimens on this slide. Specimens on this slide exhibit a large variation in external morphology, but appear conspecific. Specimens from the present material fall within the variation shown on the type slide.

Occurrence: *Ecphora* and *Cancellaria* faunizones.

Genus : ASTERIGERINA d'Orbigny, 1839.

Asterigerina sp.

Discussion: Two broken and worn specimens of *Asterigerina* sp. occur in the present material. Because of the poor state of preservation of the specimens, no specific identification was attempted.

Occurrence: *Ecphora* and *Cancellaria* faunizones.

Genus : ASTRONONION Cushman and Edwards, 1937.

Astrononion stelligerum (d'Orbigny).

Pl. 7, figs. 18, 19.

Nonionina stelligera d'Orbigny, A. (*in* Barker-Webb and Berthelot), 1839, *Histoire Naturelle des Iles Canaries*, vol. 2, pt. 2, Zool., Paris, p. 128, pl. 3, figs. 1, 2.

Astrononion (Astrononion) stelligerum (d'Orbigny): Hornibrook, N. B., 1964, Micropaleontol., vol. 10, no. 3, p. 334, pl. 1, figs. 5-9, 14, 15.

Astrononion stelligera (d'Orbigny): Loeblich, A. R., and Tappan, H., 1964, Treatise Invert. Paleontol., pt. C, vol. 2, no. 2, fig. 612, 8.

Discussion: D'Orbigny (1839) illustrated a strongly compressed specimen from the Canary Islands as the holotype of *Nonionina stelligera*. Hornibrook (1964) examined d'Orbigny's type material, but found all the specimens broken beyond recognition. Therefore, he designated as neotype for *Astrononion stelligerum* a specimen from the Canary Islands. Specimens from the Choctawhatchee deposits compare favorably with the ontogenetic series illustrated by Hornibrook.

The specimen illustrated on pl. 7 is a juvenile of this species, whose final chamber has been lost. The large "aperture" shown in fig. 19 is a hole broken in the apertural face of the penultimate chamber. The true aperture of this species is a slit along the base of the final chamber.

Occurrence: *Ecphora* faunizone.

Genus : BIGENERINA d'Orbigny, 1826.

Bigenerina sp.

Discussion: A single fragment of *Bigenerina* was found in Choctawhatchee material. This specimen was insufficiently diagnostic for specific identification.

Occurrence: *Cancellaria* faunizone.

Genus : BOLIVINA d'Orbigny, 1839.

Bolivina advena Cushman.

Pl. 6, fig. 3.

Bolivina advena Cushman, J. A., 1925, Cushman Lab. Foram. Res., Contrib., vol. 1, pt. 2, p. 29, pl. 5, fig. 1. - Cushman and Ponton, G. M., 1932, Florida Geol. Sur., Bull. 9, p. 83, pl. 12, fig. 3. - Cushman, 1937, Cushman Lab. Foram. Res., Spec. Pub. 9, p. 95, pl. 10, fig. 16. - Puri, H. S., 1953, Florida Geol. Sur., Bull. 36, p. 120.

Discussion: Early development of the test of *Bolivina advena* is quite similar to that of many species of *Bolivina*, with short, wide compressed chambers, limbate, curved, flush sutures, and an acute periphery. However, as development of the individual continues, the chambers become inflated, their height increases relative to their width, the sutures become depressed, and slightly lobate, and the periphery becomes subacute to rounded.

Occurrence: *Arca*, *Ecphora*, and *Cancellaria* faunizones.

Bolivina cf. *B. brevior* Cushman.

Discussion: Two small specimens of *Bolivina* are comparable to *Bolivina brevior* Cushman (1925, p. 31, pl. 5, fig. 8), a species previously reported from only the Monterey Shale of California. Neither specimen is sufficiently well preserved to permit positive identification. The test of each is elongate, two to three times longer than wide, and twisted in early development, with 8-9 pairs of moderately inflated chambers, smooth, slightly curved, depressed sutures, a subquadrate periphery, and a narrow vertical aperture on the apertural face of the final chamber which is bordered by a slight raised collar.

Occurrence: *Yoldia* and *Arca* faunizones.

Bolivina bulbosa Beem, new species.

Pl. 5, figs. 15-18.

"*Bolivina inflata* Heron-Allen and Earland": Todd, R., and Bronnimann, P. (*not B. inflata* Heron-Allen and Earland, 1913), 1957, Cushman Found. Foram. Res., Spec. Pub. 3, p. 33, pl. 8, figs. 32-34. - Smith, P. B., 1963, United States Geol. Sur., Prof. Paper 429-A, p. 22, pl. 30, figs. 22, 23.

Description: Test small, finely punctate, transparent, about twice as long as wide; 7-10 chambers in adult; early chambers compressed, short, wide, later chambers strongly inflated, globular; sutures curved, depressed, limbate; aperture broadly rounded, extending about half-way up apertural face of final chamber.

Holotype (USNM ______)	height: 0.24mm;	width: 0.12mm.
Paratype (USNM ______)	height: 0.21mm;	width: 0.10mm.
Paratype (USNM ______)	height: 0.18mm;	width: 0.11mm.
Paratype (USNM ______)	height: 0.26mm;	width: 0.13mm.

Discussion: The juvenile stage of this species is virtually indistinguishable from that of several other species of *Bolivina*, most notably *B. paula* Cushman and Cahill, which is a common constituent of most samples in this study. However, the globose swelling of the mature chambers of *B. bulbosa* serves to distinguish this species. *Bolivina inflata*, with which this species has been confused by previous workers, differs in having a less elongate, wedge-shaped test with roughened, coarsely punctate walls. Also, the sutures of *B. inflata* are crenulate, and the aperture is much narrower than that of *B. bulbosa*.

Occurrence: *Arca* and *Ecphora* faunizones. The holotype is from Locality E-4 at Alum Bluff, Calhoun County.

Bolivina californica Cushman.

Pl. 6, fig. 5.

"*Bolivina kaerreriana* Brady": Cushman, J. A. (*not B. karreriana* Brady, 1884), 1918, United States Geol. Sur., Bull. 676, p. 8, pl. 2, fig. 5.

Bolivina californica Cushman, J. A., 1925, Cushman Lab. Foram. Res., Contrib., vol. 1, pt. 2, p. 32, pl. 5, fig. 10. - Cushman, 1937, Cushman Lab. Foram. Res., Spec. Pub. 9, p. 100, pl. 11, figs. 1, 2. - Smith, P. B., 1960, United States Geol. Sur., Prof. Paper 294-M, p. 483.

Loxostomum gunteri Cushman, J. A., 1930, Florida Geol. Sur., Bull. 4, p. 47, pl. 8, fig. 11. - Cushman and Ponton, G. M., 1932, Florida Geol. Sur., Bull. 9, p. 84. - Cushman and Cahill, E. D., 1933, United States Geol. Sur., Prof. Paper 175-A, p. 26, pl. 8, fig. 15.

Loxostoma gunteri Cushman: Cushman, J. A., 1937, Cushman Lab. Foram Res., Spec. Pub. 9, p. 182, pl. 21, fig. 9. - Puri, H. S., 1953, Florida Geol. Sur., Bull. 36, p. 123, pl. 16, figs. 9, 10.

Discussion: As is the case with several of the species of *Bolivina* that are found in the Choctawhatchee deposits, *B. californica* is otherwise known only from the Monterey Shale of California.

Occurrence: *Arca* faunizone.

Bolivina floridana Cushman.

Pl. 6, fig. 6.

Bolivina floridana Cushman, J. A., 1918, United States Geol. Sur., Bull. 676, p. 49, pl. 10, fig. 4. - Cushman, 1930, Florida Geol. Sur., Bull. 4, p. 46, pl. 8, fig. 15. - Cushman and Ponton, G. M., 1932, Florida Geol. Sur., Bull. 9, p. 82. - Cushman and Cahill, E. D., 1933, United States Geol. Sur., Prof. Paper 175-A, p. 26, pl. 11, fig. 11. - Cushman, 1937, Cushman Lab. Foram. Res., Spec. Pub. 9, p. 85, pl. 10, figs. 2, 3. - Dorsey, A., 1948, Maryland Dept. Mines, Geol., Water

Resources, Bull. 2, p. 306, pl. 36, fig. 15. - Puri, H. S., 1953, Florida Geol. Sur., Bull. 36, p. 120, pl. 22, figs. 9, 10.

"*Bolivina decussata* Brady": Cushman, J. A. (*not B. decussata* Brady, 1884), 1925, Cushman Lab. Foram. Res., Contrib., vol. 1, pt. 2, p. 31, pl. 5, fig. 6.

Discussion: This species is reported from Miocene strata of the Atlantic and Gulf coastal plains, California, and Venezuela.

Occurrence: *Yoldia* and *Arca* faunizones.

Bolivina limbata Brady.

Bolivina limbata Brady, H. B., 1881, Quart. J. Microscop. Sci., N. S., vol. 21, p. 27 (nomen nudem). - Brady, 1884, Rep. Voy. Challenger, Zool., vol. 9, p. 419, pl. 52, figs. 26-28. - Cushman, J. A., 1922, United States Nat. Mus., Bull. 104, pt. 3, p. 36, pl. 7, fig. 3.

Loxostoma limbatum (Brady): Cushman, J. A., 1937, Cushman Lab. Foram. Res., Spec. Pub. 9, p. 186, pl. 21, figs. 26-29.

Occurrence: *Arca*, *Ecphora*, and *Cancellaria* faunizones.

Bolivina marginata Cushman.

Pl. 6, fig. 1.

Bolivina marginata Cushman, J. A., 1918, United States Geol. Sur., Bull. 676, p. 48, pl. 10, fig. 1. - Cushman, 1930, Florida Geol. Sur., Bull. 4, p. 45, pl. 8, fig. 9. - Cushman and Ponton, G. M., 1932, Florida Geol. Sur., Bull. 9, p. 81. - Cushman and Cahill, E. D., 1933, United States Geol. Sur., Prof. Paper 175-A, p. 25, pl. 8, fig. 9. - Cushman, 1937, Cushman Lab. Foram. Res., Spec. Pub. 9, p. 86, pl. 10, figs. 4-6. - Puri, H. S., 1953, Florida Geol. Sur., Bull. 36, p. 120.

Bolivina aenariensis (Costa), var. *multicostata* Cushman, J. A., 1918, United States Geol. Sur., Bull. 676, p. 48, pl. 10, fig. 2.

Bolivina marginata Cushman, var. *multicostata* Cushman: Cushman, J. A., 1930, Florida Geol. Sur., Bull. 4, p. 46, pl. 8, figs. 13, 14. - Cushman and Ponton, G. M., 1932, Florida Geol. Sur., Bull. 9, p. 82. - Cushman and Cahill, E. D., 1933, United States Geol. Sur., Prof. Paper 175-A, p. 25, pl. 8, fig. 10. - Cushman, 1937, Cushman Lab. Foram. Res., Spec. Pub. 9, p. 87, pl. 10, figs. 7-10.

Bolivina marginata multicostata Cushman: Puri, H. S., 1953, Florida Geol. Sur., Bull. 36, p. 121, pl. 22, figs. 3-6.

Discussion: Under the present species are included costate as well as noncostate forms, both of which occur in the same samples in apparent intergrading series. *B. marginata multicostata*, which is distinguishable only by the presence of costae, is considered for the purposes of this paper to be a varietal form of *B. marginata*.

Occurrence: All four faunizones.

Bolivina ornata Cushman.

Pl. 6, fig. 2.

Bolivina advena Cushman, var. *ornata* Cushman, J. A., 1925, Cushman Lab. Foram. Res., Contrib., vol. 1, pt. 2, p. 29, pl. 5, fig. 2. - Cushman, 1937, Cushman Lab. Foram. Res., Spec. Pub. 9, p. 98, pl. 10, figs. 17, 18.

Discussion: *Bolivina ornata* was originally described as a variety of *B. advena*, but differs in having a more inflated test and numerous strong longitudinal costae which tend to obscure early chamber development in mature specimens. The periphery is generally less acute than that of *B. advena*, but some specimens may bear a narrow peripheral keel. The test is more strongly compressed than that of *B. californica*, but less compressed than that of *B. marginata*. The costae are more strongly developed than those of *B. californica*.

Occurrence: *Yoldia*, *Arca*, and *Ecphora* faunizones.

Bolivina paula Cushman and Cahill.

Pl. 6, fig. 7.

Bolivina paula Cushman, J. A., and Cahill, E. D. (*in* Cushman and Ponton), 1932, Florida Geol. Sur., Bull. 9, p. 84, pl. 12, fig. 6. - Cushman and Cahill, 1933, United States Geol. Sur., Prof. Paper 175-A, p. 26, pl. 8, fig. 14. - Cushman, 1937, Cushman Lab. Foram. Res., Spec. Pub. 9, p. 91, pl. 11, fig. 9. - Dorsey, A., 1948, Maryland Dept. Mines, Geol., Water Resources, Bull. 2, p. 307, pl. 36, fig. 20. - Puri, H. S., 1953, Florida Geol. Sur., Bull. 36, p. 121.

Discussion: This species closely resembles immature specimens of *Bolivina advena* and *B. bulbosa*, and also the Recent species *B. lowmani*, which is a common inner neritic species of the Gulf Coast.

Occurrence: All four faunizones.

Bolivina plicatella Cushman

Pl. 6, fig. 4.

Bolivina plicatella Cushman, J. A., 1930, Florida Geol. Sur., Bull. 4, p. 46, pl. 8, fig. 10. - Cushman and Ponton, G. M., 1932, Florida Geol. Sur., Bull. 9, p. 82. - Cushman and Cahill, E. D., 1933, United States Geol. Sur., Prof. Paper 175-A, p. 26, pl. 8, fig. 12. - Cushman, 1937, Cushman Lab. Foram. Res., Spec. Pub. 9, p. 89, pl. 11, figs. 3, 4. - Puri, H. S., 1953, Florida Geol. Sur., Bull. 36, p. 122.

Discussion: Immature specimens of this species in which the ridge and depression pattern is only weakly developed resemble immature specimens of *Bolivina floridana*.

Occurrence: *Arca*, *Ecphora*, and *Cancellaria* faunizones.

Genus : BUCCELIA Andersen, 1952.

Buccella mansfieldi (Cushman).

Pl. 10, figs. 19-21.

Eponides mansfieldi Cushman, J. A., 1930, Florida Geol. Sur., Bull. 4, p. 54, pl. 11, fig. 1. - Cushman and Ponton, G. M., 1932, Florida Geol. Sur., Bull. 9, p. 92. - Cushman and Cahill, E. D., 1933, United States Geol. Sur., Prof. Paper 175-A, p. 31, pl. 10, fig. 8. - Dorsey, A., 1948, Maryland Dept. Mines, Geol. Water Resources, Bull. 2, p. 311, pl. 37, fig. 7.

Buccella mansfieldi (Cushman): Andersen, H. V., 1952, Washington Acad. Sci., J., vol. 42, no. 5, p. 148, figs. 12, 13. - Puri, H. S., 1953, Florida Geol. Sur., Bull. 36, p. 134, pl. 25, figs. 1-3.

Discussion: *Buccella mansfieldi* is closely related to *B. hannai*, which is a common inner neritic species in the Gulf of Mexico. Bandy has reported *B. mansfieldi* from the inner neritic zone off southern California.

Occurrence: All four faunizones.

Genus : BULIMINA d'Orbigny, 1826.

Bulimina cf. *B. alsatica* Cushman and Parker.

Pl. 5, fig. 6.

"*Bulimina inflata* Sequenza": Cushman, J. A. (*not B. inflata* Sequenza, 1862), 1930, Florida Geol. Sur., Bull. 4, p. 43, pl. 8, figs. 6, 7. - Cushman and Ponton, G. M., 1932, Florida Geol. Sur., Bull. 9, p. 77. - Cushman and Cahill, E. D., 1933, United States Geol. Sur., Prof. Paper 175-A, p. 24, pl. 8, fig. 1. - Puri, H. S., 1953, Florida Geol. Sur., Bull. 36, p. 114, pl. 22, figs. 1, 2.

Bulimina sp. Dorsey, A., 1948, Maryland Dept. Mines, Geol., Water Resources, Bull. 2, p. 304, pl. 36, fig. 4.

Discussion: Cushman and Parker, in United States Geol. Sur. Prof. Paper 210-D (1947), p. 102, questionably assign specimens from Choctawhatchee deposits to *Bulimina alsatica* Cushman and Parker (1937, p. 39, pl. 4, figs. 6, 7). Comparison with type material from the Oligocene of Alsace shows that the present specimens are quite similar, but not identical. These specimens show the hooked spines diagnostic of *B. alsatica*, but the costae are not as well developed. The costae are not continuous as in *B. inflata*. The single strong basal spine characteristic of *B. striata* is not present, nor do the costae cover as much of the chambers of the final whorl as in that species.

Occurrence: *Arca* faunizone.

Bulimina delreyensis Cushman and Galliher.

Pl. 5, fig. 5.

"*Bulimina buchiana* d'Orbigny": Cushman, J. A., and Ponton, G. M. (*not B. buchiana* d'Orbigny, 1826), 1932, Florida Geol. Sur., Bull. 9, p. 78, pl. 12, fig. 1.

Bulimina delreyensis Cushman, J. A., and Galliher, E. W., 1934, Cushman Lab. Foram. Res., Contrib., vol. 10, pt. 1, p. 25, pl. 4, fig. 8. - Cushman and Parker, F. L., 1947, United States Geol. Sur., Prof. Paper 210-D, p. 112, pl. 26, fig. 16.

Discussion: Only one broken specimen has been found in the present material, but it is sufficiently well preserved to permit comparison with the holotype of this species. The type material is from the Monterey Shale of California, which is the only other reported occurrence of this species.

Occurrence: *Yoldia* faunizone.

Bulimina marginata d'Orbigny.

Pl. 5, fig. 7.

Bulimina marginata d'Orbigny, A., 1826, Ann. Sci. Natur., Ser. 1, vol. 7, p. 269, pl. 12, figs. 10-12. - Cushman, J. A., and Ponton, G. M., 1932, Florida Geol. Sur., Bull. 9, p. 77, pl. 11, fig. 12. - Cushman and Parker, F. L., 1947, United States Geol. Sur., Prof. Paper 210-D, p. 119, pl. 28, figs. 5, 6. - Puri, H. S., 1953, Florida Geol. Sur., Bull. 36, p. 114, pl. 23, fig. 2.

Discussion: *Bulimina marginata* is a widely distributed continental shelf species in Recent seas. This is the most common species of *Bulimina* in the Choctawhatchee deposits, occasional specimens occurring throughout the *Ecphora* and *Cancellaria* faunizones.

Occurrence: *Ecphora* and *Cancellaria* faunizones.

Genus : BULIMINELLA Cushman, 1911.

Buliminella elegantissima (d'Orbigny).

Pl. 5, fig. 9.

Bulimina elegantissima d'Orbigny, A., 1839, *Voyage dans l'Amérique Meridionale*, Paris, vol. 5, pt. 5, p. 51, pl. 7, figs. 134, 135.

Buliminella elegantissima (d'Orbigny): Cushman, J. A., 1911, United States Nat. Mus., Bull. 71, pt. 2, p. 89. - Cushman, 1930, Florida Geol. Sur., Bull. 4, p. 42, pl. 8, figs. 2, 3. - Cushman and Ponton, G. M., 1932, Florida Geol. Sur., Bull. 9, p. 75. - Cushman and Cahill, E. D., 1933, United States Geol. Sur., Prof. Paper 175-A, p. 23, pl. 7, figs. 13, 14. - Cushman and Parker, F. L., 1947, United States Geol. Sur., Prof. Paper 210-D, p. 67, pl. 17, figs. 10-12. - Dorsey, A., 1948, Maryland Dept. Mines, Geol., Water Resources, Bull. 2, p. 302, pl. 36, fig. 2. - Puri, H. S., 1953, Florida Geol. Sur., Bull. 36, p. 113.

Discussion: This species is the most abundant foraminiferal species in the present material. It occurs in all samples, in percentages of the benthonic population varying from 2-82%. In the present Gulf of Mexico, this species rarely exceeds frequencies greater than 1%. *B. elegantissima* is the single dominant species along the coast of southern California in water shallower than 50 meters, and in some shallow embayments along the Caribbean coast of Venezuela. This species seems to thrive only on organic-rich mud bottoms, reaching percentages comparable to those of the Choctawhatchee deposits in the sewage outfall areas off southern California.

Occurrence: All four faunizones.

Buliminella subfusiformis Cushman.

Pl. 5, fig. 8.

Buliminella subfusiformis Cushman, J. A., 1925, Cushman Lab. Foram. Res., Contrib., vol. 1, pt. 2, p. 33, pl. 5, fig. 12. - Cushman and Parker, F. L., 1947, United States Geol. Sur., Prof. Paper 210-D, p. 64, pl. 16, fig. 21.

Buliminella curta Cushman, J. A., 1925, Cushman Lab. Foram. Res., Contrib., vol. 1, pt. 2, p. 33, pl. 5, fig. 13. - Cushman, 1930, Florida Geol. Sur., Bull. 4, p. 43, pl. 8, fig. 4. - Cushman and Ponton, G. M., 1932, Florida Geol. Sur., Bull. 9, p. 75. - Cushman and Cahill, E. D., 1933, United States Geol. Sur., Prof. Paper 175-A, p. 23, pl. 7, fig. 15. - Cushman and Parker, F. L., 1947, United States Geol. Sur., Prof. Paper 210-D, p. 64, pl. 16, fig. 22. - Dorsey, A., 1948, Maryland Dept. Mines, Geol., Water Resources, Bull. 2, p. 303, pl. 36, fig. 3. - Puri, H. S., 1953, Florida Geol. Sur., Bull. 36, p. 113, pl. 23, fig. 1.

Discussion: Cushman and Parker (1947, p. 65) suggest that because *Buliminella curta* closely resembles *B. subfusiformis*, it may be a variation of the latter species. According to the original description of Cushman (1925), *B. subfusiformis* can be distinguished from *B. curta* "by the nearly parallel sides". Intergradational series occur within suites of specimens from the present material, ranging from elongate specimens resembling the holotype of *B. subfusiformis* to squat, tapering specimens typical of *B. curta*. For the purposes of this paper, *B. curta* is considered to be a varietal form of *B. subfusiformis*.

Occurrence: *Yoldia* and *Arca* faunizones.

Genus : CANCRIS de Montfort, 1808.

Cancris communis Cushman and Todd.

Pl. 10, figs. 7-9.

"*Pulvinulina sagra* (d'Orbigny)": Cushman, J. A. (*not Rotalina sagra* d'Orbigny, 1839), 1918, United States Geol. Sur., Bull. 676, p. 65, pl. 22, fig. 3; pl. 23, fig. 1.

"*Cancris sagra* (d'Orbigny)": Cushman, J. A. (*not Rotalina sagra* d'Orbigny, 1839), 1930, Florida Geol. Sur., Bull. 4, p. 56, pl. 11, fig. 4. - Cushman and Ponton, G. M., 1932, Florida Geol. Sur., Bull. 9, p. 94, pl. 14, fig. 3. - Cushman and Cahill, E. D., 1933, United States Geol. Sur., Prof. Paper 175-A, p. 32, pl. 11, figs. 4, 5. - Puri, H. S., 1953, Florida Geol. Sur., Bull. 36, p. 135.

Cancris sagra (d'Orbigny), var. *communis* Cushman, J. A., and Todd, R., 1942, Cushman Lab. Foram. Res., Contrib., vol. 18, pt. 4, p. 79, pl. 19, figs. 8-11; pl. 20, fig. 1. - Dorsey, A., 1948, Maryland Dept. Mines, Geol., Water Resources, Bull. 2, p. 312, pl. 37, fig. 10.

Cancris communis Cushman and Todd: Copeland, C. W., 1964, Bull. American Paleontol., vol. 47, no. 215, p. 265, pl. 38, fig. 2.

Occurrence: *Ecphora* and *Cancellaria* faunizones.

Cancris planus Cushman and Todd.

Pl. 10, figs. 10-12.

Cancris baggi Cushman and Kleinpell, var. *planus* Cushman, J. A., and Todd, R., 1942, Cushman Lab. Foram. Res., Contrib., vol. 18, pt. 4, p. 84, pl. 21, fig. 11. - Cushman and Gray, H. B., 1946, Cushman Lab. Foram. Res., Spec. Pub. 19, p. 39, pl. 7, figs. 7-9.

Discussion: *Cancris planus* is quite similar to *C. communis* in growth plan, but the chambers do not show as strong a tendency to increase in height. In addition, the chambers of *C. planus* are more strongly inflated throughout the test. The umbilical flap on the final chamber is broader than that of *C. communis*, but does not extend as far over the umbilicus.

Occurrence: *Arca*, *Ecphora*, and *Cancellaria* faunizones.

Genus : CASSIDULINA d'Orbigny, 1826.

Discussion: The present concept of *Cassidulina* differs from that of Cushman (1947) by including only species having lenticular tests with acute, keelate peripheries. Globose species are placed in *Globocassidulina* Voloshina, 1960.

Cassidulina caribeana Redmond.

Pl. 7, figs. 5, 6.

"*Cassidulina laevigata* d'Orbigny, var. *carinata* Cushman": Cushman, J. A., 1930 (*not C. laevigata*, var. *carinata* Cushman, 1922), Florida Geol. Sur., Bull. 4, p. 58, pl. 11, fig. 7. - Cushman and Ponton, G. M., 1932, Florida Geol. Sur., Bull. 9, p. 97. - Cushman and Cahill, E. D., 1933, United States Geol. Sur., Prof. Paper 175-A, p. 33, pl. 12, fig. 3. - Puri, H. S., 1953, Florida Geol. Sur., Bull. 36, p. 128, pl. 23, figs. 5, 6.

Cassidulina caribeana Redmond, D. C., 1953, J. Paleontol., vol. 27, no. 5, p. 729, pl. 77, fig. 6.

Discussion: *C. caribeana* resembles *C. neocarinata* Thalmann, but is smaller, generally lacks a keel, and has a relatively large clear umbilical plug on each side of the test.

Occurrence: All four faunizones.

Genus : CASSIDULINOIDES Cushman, 1927.

Cassidulinoides compacta Cushman and Ellisor.

Pl. 7, figs. 1, 2.

"*Cassidulinoides bradyi* (Wright)": Cushman, J. A. (*not Cassidulina bradyi* Norman, 1881), 1930, Florida Geol. Sur., Bull. 4, p. 58, pl. 11, fig. 8. - Cushman and Ponton, G. M., 1932, Florida Geol. Sur., Bull. 9, p. 98. - Cushman and Cahill, E. D., 1933, United States Geol. Sur., Prof. Paper 175-A, p. 33, pl. 12, fig. 4. - Puri, H. S., Florida Geol. Sur., Bull. 36, p. 128, pl. 23, figs. 9, 10.

Cassidulinoides compacta Cushman, J. A., and Ellisor, A. C., 1945, J. Paleontol., vol. 19, no. 6, p. 570, pl. 78, fig. 3.

Discussion: This species has been confused with *C. bradyi* by several authors. However, the test of *C. compacta* is less elongate in mature specimens, and is more strongly compressed laterally. Also, the final chamber bears a distinctive depressed, trough-like apertural face.

Occurrence: *Ecphora* and *Cancellaria* faunizones.

Genus : CAUCASINA Khalilov, 1951.

Caucasina elongata (d'Orbigny).

Pl. 5, fig. 4.

Bulimina elongata d'Orbigny, A., 1846, *Foraminiferes fossiles du Bassin Tertiare de Vienne (Autriche)*, Paris, p. 187, pl. 11, figs. 19, 20. - Cushman, J. A., and Parker, F. L., 1937, Cushman Lab. Foram. Res., Contrib., vol. 13, pt. 1, p. 49, pl. 7, figs. 1-3. - Cushman and Parker, 1947, United States Geol. Sur., Prof. Paper 210-D, p. 108, pl. 25, figs. 15, 16. - Dorsey, A., 1948, Maryland Dept. Mines, Geol., Water Resources, Bull. 2, p. 303, pl. 36, figs. 5, 6. - Puri, H. S., 1953, Florida Geol. Sur., Bull. 36, p. 114, pl. 10, figs. 5, 6.

Caucasina elongata (d'Orbigny): Loeblich, A. R., and Tappan, H., 1964, Tulane Stud. Geol., vol. 2, no. 3, p. 82, pl. 2, figs. 14, 15.

Bulimina gracilis Cushman, J. A., 1930, Florida Geol. Sur., Bull. 4, p. 43, pl. 8, fig. 5. - Cushman and Ponton, G. M., 1932, Florida Geol. Sur., Bull. 9, p. 76 (pars). - Cushman and Cahill, E. D., 1933, United States Geol. Sur., Prof. Paper 175-A, p. 24, pl. 7, fig. 16.

Discussion: This species is a marker of the Tortonian Stage (Late Miocene) in Europe. In addition to the Choctawhatchee deposits, this species is also found in Miocene strata along the Atlantic Coastal Plain.

Occurrence: This species is common to abundant in the *Arca* faunizone. One broken, apparently reworked specimen has been recovered from the *Cancellaria* faunizone.

Caucasina preacanthia (McLean), new combination.

Pl. 5, fig. 3.

"*Bulimina gracilis* Cushman": Cushman, J. A., and Ponton, G. M. (*not B. gracilis* Cushman, 1930), 1932, Florida Geol. Sur., Bull. 9, p. 76 (pars).

Bulimina preacanthia McLean, J. D., 1956, Bull. American Paleontol., vol. 36, no. 160, p. 345, pl. 45, figs. 2, 3, 7.

Discussion: This species has a juvenile discorbid stage, and thus clearly belongs in the genus *Caucasina*.

Occurrence: *Yoldia*, *Ecphora*, and *Cancellaria* faunizones.

Genus : CHRYSALIDINELLA Schubert, 1908.

Chrysalidinella miocenica Cushman.

Pl. 6, figs. 8-10.

"*Chrysalidinella pulchella* Cushman": Cushman, J. A., 1930, (*not C. pulchella* Cushman, 1918), Florida Geol. Sur., Bull. 4, p. 48, pl. 8, fig. 16. - Cushman and Ponton, G. M., 1932, Florida Geol. Sur., Bull. 9, p. 85. - Cushman and Cahill, E. D., 1933, United States Geol. Sur., Prof. Paper 175-A, p. 27, pl. 9, fig. 2. - Puri, H. S., 1953, Florida Geol. Sur., Bull. 36, p. 124, pl. 23, figs. 7, 8.

Chrysalidinella miocenica Cushman, J. A., 1945, Cushman Lab. Foram. Res., Contrib., vol. 21, p. 51, pl. 8, fig. 18.

Occurrence: One broken specimen from the *Ecphora* faunizone.

Genus : CIBICIDELLA Cushman, 1927.

Cibicidella variabilis (d'Orbigny).

Pl. 12, figs. 10, 11.

Truncatulina variabilis d'Orbigny, A. (*in* Barker-Webb and Berthelot), 1839, *Histoire naturelle des Iles Canaries*, Paris, vol. 2, pt. 2, Zool., p. 135, pl. 2, fig. 29.

Cibicidella variabilis (d'Orbigny): Cushman, J. A., 1931, United States Nat. Mus., Bull. 104, pt. 8, p. 127, pl. 24, fig. 3. - Cushman and Ponton, G. M., 1932, Florida Geol. Sur., Bull. 9, p. 102, pl. 15, figs. 5-7. - Dorsey, A., 1948, Maryland Dept. Mines, Geol., Water Resources, Bull. 2, p. 316, pl. 39, fig. 8. - Puri, H. S., 1953, Florida Geol. Sur., Bull. 36, p. 140, pl. 8, figs. 4-6.

Discussion: The early development of this species closely resembles that of *Cibicides lobatulus* (Walker and Jacob). Unlike *Cibicides lobatulus* (s.s.), however, later chambers are added irregularly, not in the close coil of the juvenile stage. A supplementary aperture appears at the peripheral juncture with the previous chamber in the irregular growth stage. *C. variabilis* lacks the peripheral keel characteristic of *Dyocibicides biserialis*.

Occurrence: *Arca*, *Ecphora*, and *Cancellaria* faunizones.

Genus : CIBICIDES de Montfort, 1808.

Cibicides floridanus (Cushman).

Pl. 12, figs. 1-3.

Truncatulina floridana Cushman, J. A., 1918, United States Geol. Sur., Bull. 676, p. 62, pl. 19, fig. 2.

Cibicides floridanus (Cushman): Cushman, J. A., 1930, Florida Geol. Sur., Bull. 4, p. 61, pl. 12, fig. 3. - Cushman and Ponton, G.M., 1932, Florida Geol. Sur., Bull. 9, p. 100 (pars). - Cushman and Todd, R., 1945, Cushman Lab. Foram. Res., Spec. Pub. 15, p. 71, pl. 12, fig. 8.

Discussion: The figured specimen closely resembles a specimen of *Truncatulina floridana* in the U. S. Natural History Museum collection labeled "PARATYPE" (USNM 497565). The holotype of this species has apparently been lost. A cursory examination of the U. S. Natural History Museum reference collection has revealed that many authors have mistakenly identified other species as *C. floridanus*. Many specimens from the Choctawhatchee deposits labeled "*Cibicides floridanus*" are better referred to *C. lobatulus*.

Occurrence: *Arca*, *Ecphora*, and *Cancellaria* faunizones.

Cibicides lobatulus (Walker and Jacob).

Pl. 12, figs. 4-6.

Nautilus lobatulus Walker, G., and Jacob, E. (*in* Kanmacher), 1798, *Adams' Essays on the Microscope*, London, ed. 2, p. 642, pl. 14, fig. 36.

Truncatulina lobatula (Walker and Jacob): d'Orbigny, A. (*in* Barker-Webb and Berthelot), 1839, *Histoire naturelle des Iles Canaries*, Paris, vol. 2, pt. 2, Zool., p. 134, pl. 2, figs. 22, 24. - Cushman, J. A., 1918, United States Geol. Sur., Bull. 676, p. 60, pl. 17, figs. 1-3.

Cibicides lobatulus (Walker and Jacob): Cushman, J. A., 1927, J. Paleontol., vol. 1, no. 2, p. 170, pl. 27, figs. 12, 13. - Dorsey, A., 1948, Maryland Dept. Mines, Geol., Water Resources, Bull. 2, p. 315, pl. 39, fig. 5.

Truncatulina lobatula (Walker and Jacob), var. *ornata* Cushman, J. A., 1918, United States Geol. Sur., Bull. 676, p. 61, pl. 18, figs. 1, 2.

Cibicides lobatulus (Walker and Jacob), var. *ornatus* (Cushman): Cushman, J. A., 1930, Florida Geol. Sur., Bull. 4, p. 62.

"*Planulina depressa* (d'Orbigny)": Cushman, J. A. (*not Truncatalina depressa* d'Orbigny, 1839), 1930, Florida Geol. Sur., Bull. 4, p. 60, pl. 12, fig. 2. - Cushman and Ponton, G. M., 1932, Florida Geol. Sur., Bull. 9, p. 100. - Cushman and Cahill, E. D., United States Geol. Sur., Prof. Paper 175-A, p. 34, pl. 12, fig. 6. - Puri, H. S., 1953, Florida Geol. Sur., Bull. 36, p. 141, pl. 27, figs. 1-3.

"*Cibicides floridanus* (Cushman)": Cushman, J. A., and Ponton, G. M. (*not Truncatulina floridana* Cushman, 1918), 1932, Florida Geol. Sur., Bull. 9, p. 100 (pars). - Cushman and Cahill, E. D., 1933, United States Geol. Sur., Prof. Paper 175-A, p. 34, pl. 13, fig. 1.

Discussion: *C. lobatulus* can be distinguished from *C. floridanus* by the extremely coarse punctae on both sides, by the planar to concave spiral side, and by the strongly lobate periphery. *C. lobatulus* has a much more convex umbilical side than does *Planulina depressa*.

Cibicides lobatulus is a wide-spread species in Recent shallow-water environments. It is generally found attached by its flat spiral surface to some suitable object, the shape of the host object determining the growth pattern of the individual.

Occurrence: All four faunizones.

Genus : CYCLOGYRA Wood, 1842.

Discussion: *Cornuspira* Schultze, 1854 is a junior synonym of *Cyclogyra* Wood, 1842. The definition of *Cornuspira* given by Cushman (1947) applies to *Cyclogyra*.

Cyclogyra planorbis (Schultze).

Pl. 1, fig. 13.

Cornuspira planorbis Schultze, M. S., 1854, *Ueber den Organismus der Polythalamien (Foraminiferen)*, Leipzig, p. 40, pl. 2, fig. 21. - Phleger, F. B., and Parker, F. L., 1951, Geol. Soc. America, Mem. 46, pt. 2, p. 8, pl. 4, figs. 8, 9.

Cyclogyra planorbis (Schultze): Ayala-Castanares, A., 1963, Univ. Nac. Auto. de Mexico, Inst. Geol., Bull. 67, pt. 3, p. 53, pl. 1, figs. 6, 7.

"Cornuspira involvens (Reuss)": Cushman, J. A. (*not Operculina involvens* Reuss, 1850), 1930, Florida Geol. Sur., Bull. 4, p. 23, pl. 3, fig. 6. - Cushman and Ponton, G. M., 1932, Florida Geol. Sur., Bull. 9, p. 57. - Cushman and Cahill, E. D., 1933, United States Geol. Sur., Prof. Paper 175-A, p. 12, pl. 3, fig. 5. - Puri, H. S., 1953, Florida Geol. Sur., Bull. 36, p. 96, pl. 26, fig. 11.

Genus : DENTALINA Risso, 1826.

Dentalina communis d'Orbigny.

Pl. 3, fig. 9.

Nodosaria (Dentalina) communis d'Orbigny, A., 1826, Ann. Sci. Natur., Ser. 1, vol. 7, p. 254, no. 35. - Cushman, J. A., 1923, United States Nat. Mus., Bull. 104, pt. 4, p. 75, pl. 12, figs. 3, 4, 15-17.

Dentalina communis d'Orbigny: Cushman, J. A., 1930, Florida Geol. Sur., Bull. 4, p. 27, pl. 5, fig. 1. - Cushman and Ponton, G. M., 1932, Florida Geol. Sur., Bull. 9, p. 60. - Cushman and Cahill, E. D., 1933, United States Geol. Sur., Prof. Paper 175-A, p. 14, pl. 5, fig. 2. - Puri, H. S., 1953, Florida Geol. Sur., Bull. 36, p. 99, pl. 23, fig. 14.

Discussion: This species is widely distributed, both spatially and temporally. Cushman (1923, p. 75), in his discussion of this species says:

"It is obvious that several things have been included under this name and it is questionable whether any of them are really identical with d'Orbigny's Cretaceous species."

With this statement, Cushman has obscured the problem of identifying this species by erroneously citing for the type specimens a Cretaceous age, when in fact the species was described from Recent material collected in the Adriatic Sea. Specimens found in the Choctawhatchee deposits are comparable to figures and specimens from Recent collections.

Occurrence: Several fragments from the *Arca* faunizone.

Dentalina sp.

Pl. 3, figs. 7, 8.

Discussion: A single fragmentary specimen of *Dentalina* sp. consisting of three smooth chambers was found in material from Jackson Bluff. This is not the same species as that questionably referred to *Nodosaria calomorpha* by Cushman and Ponton (1932).

Occurrence: One fragment from the *Ecphora* faunizone.

Genus : DISCORBIS Lamarck, 1804.

Discussion: In this genus are included low trochospiral perforate calcareous species with single septa throughout, and with an umbilicus covered by chamber flaps with or without an umbilical plug. The primary aperture opens into the umbilicus under the flap, and a secondary aperture is located at the posterior of the flap on each chamber. The secondary apertures of previous chambers remain open. This genus differs from *Ammonia* in having only single septa, and in lacking secondary fillings of the sutures. It differs from *Rosalina* by possessing a covered umbilicus.

?Discorbis bassleri (Cushman and Cahill), new combination.
Pl. 8, figs. 17, 18.

Rotalia bassleri Cushman, J. A., and Cahill, E. D., 1933, United States Geol. Sur., Prof. Paper 175-A, p. 30, pl. 10, fig. 7. - Dorsey, A., 1948, Maryland Dept. Mines, Geol., Water Resources, Bull. 2, p. 312, pl. 37, fig. 8.

Discussion: The morphology of this species suggests inclusion in the genus *Discorbis*.

Occurrence: *Ecphora* faunizone at Jackson Bluff.

Discorbis farishi Cushman and Ellisor.

"*Discorbis valvulata* (d'Orbigny)": Cushman, J. A. (*not Rosalina valvulata* d'Orbigny, 1826), 1930, Florida Geol. Sur., Bull. 4, p. 53, pl. 10, fig. 5. - Cushman and Ponton, G. M., 1932, Florida Geol. Sur., Bull. 9, p. 90. - Puri, H. S., 1953, Florida Geol. Sur., Bull. 36, p. 132.

Discorbis farishi Cushman, J. A., and Ellisor, A. C., 1932, Cushman Lab. Foram. Res., Contrib., vol. 8, pt. 2, p. 43, pl. 6, fig. 6.

"*Discorbis candeiana* (d'Orbigny) : Dorsey, A. (*not Rosalina candeiana* d'Orbigny, 1839), 1948, Maryland Dept. Mines, Geol., Water Resources, Bull. 2, p. 310, pl. 37, fig. 4.

Discussion: *Discorbis farishi* was originally described from Eocene strata of Louisiana. In addition, it has been found in Lower Oligocene sediments throughout the Gulf Coast. The specimens in the present material appear somewhat worn, and may be reworked from earlier Cenozoic deposits, possibly the Marianna Limestone which crops out several miles to the north of the localities collected for this study.

Occurrence: *Arca* and *Ecphora* faunizones.

Discorbis (?) sp.

Discussion: Two small, poorly preserved specimens from a single sample have been questionably assigned to the genus *Discorbis*. Neither specimen is sufficiently well-preserved to permit specific identification.

Occurrence: *Cancellaria* faunizone.

Genus : DYOCIBICIDES Cushman and Valentine, 1930.

Dyocibicides biserialis Cushman and Valentine.

Pl. 12, figs. 7-9.

Dyocibicides biserialis Cushman, J. A., and Valentine, W. W., 1930, Stanford Univ., Dept. Geol., Contrib., vol. 1, no. 1, p. 31, pl. 10, figs. 1, 2. - Cushman, 1930, Florida Geol. Sur., Bull. 4, p. 62, pl. 12, fig. 6. - Cushman and Ponton, G. M., 1932, Florida Geol. Sur., Bull. 9, p. 102. - Puri, H. S., 1953, Florida Geol. Sur., Bull. 36, p. 141.

Discussion: This species has an early trochospiral stage resembling that of *Cibicides lobatulus*. It uncoils and becomes biserial in mature specimens. The chambers are less inflated than those of *Cibicidella variabilis*, and it lacks the supplementary apertures of that species. *D. biserialis* also has an imperforate keel along the margins of the irregularly shaped mature chambers.

Occurrence: *Arca*, *Ecphora*, and *Cancellaria* faunizones.

Genus : ELPHIDIUM de Montfort, 1808.

Elphidium fimbriatulum (Cushman).

Pl. 8, figs. 11, 12.

Polystomella fimbriatula Cushman, J. A., 1918, United States Geol. Sur., Bull. 676, p. 20, pl. 8, fig. 5.

Elphidium fimbriatulum (Cushman): Cole, W. S., 1931, Florida Geol. Sur., Bull. 6, p. 33, pl. 4, fig. 7. - Cushman, J. A., and Ponton, G. M., 1932, Florida Geol. Sur., Bull. 9, p. 70, pl. 11, fig. 2. - Cushman, 1939, United States Geol. Sur., Prof. Paper 191, p. 47, pl. 12, fig. 13. - Puri, H. S., 1953, Florida Geol. Sur., Bull. 36, p. 147.

Polystomella advena Cushman, J. A., 1922, Carnegie Inst. Washington, Pub. 344, p. 56, pl. 9, figs. 11, 12.

Elphidium advenum (Cushman): Cushman, J. A., 1930, United States Nat. Mus., Bull. 104, pt. 7, p. 25, pl. 10, figs. 1, 2. - Cushman, 1930, Florida Geol. Sur., Bull. 4, p. 40, pl. 7, fig. 7. - Cushman and Ponton, G. M., 1932, Florida Geol. Sur., Bull. 9, p. 70, pl. 11, fig. 1. - Cushman and Cahill, E. D., 1933, United States Geol. Sur., Prof. Paper 175-A, p. 22, pl. 7, fig. 10. - Cushman, 1939, United States Geol. Sur., Prof. Paper 191, p. 60, pl. 16, figs. 31-35. - Puri, H. S., 1953, Florida Geol. Sur., Bull. 36, p. 146.

Elphidium fimbriatulum (Cushman), var. *advenum* (Cushman): Cole, W. S., 1931, Florida Geol. Sur., Bull. 6, p. 33, pl. 4, fig. 6.

Occurrence: *Arca*, *Ecphora*, and *Cancellaria* faunizones.

Elphidium hughesi Cushman and Grant.

Pl. 8, figs. 9, 10.

Elphidium hughesi Cushman, J. A., and Grant, U. S., 1927, San Diego Soc. Natur. Hist., Trans., vol. 5, p. 75, pl. 7, figs. 1, 4, 5. -

Cushman, 1939, United States Geol. Sur., Prof. Paper 191, p. 49, pl. 13, fig. 7.

Elphidium hughesi Cushman and Grant, var. *foraminosum* Cushman, J. A., 1939, United States Geol. Sur., Prof. Paper 191, p. 49, pl. 13, fig. 8.

Elphidium hughesi Cushman and Grant, var. *obesum* Cushman, J. A., 1939, United States Geol. Sur., Prof. Paper 191, p. 49, pl. 13, fig. 9.

"*Elphidium incertum* (Williamson)": Cushman, J. A. (*not Polystomella umbilicata*, var. *incerta* Williamson, 1858), 1930, Florida Geol. Sur., Bull. 4, p. 39, pl. 7, fig. 2. - Cushman and Ponton, G. M., 1932, Florida Geol. Sur., Bull. 9, p. 70. - Cushman and Cahill, E. D., 1933, United States Geol. Sur., Prof. Paper 175-A, p. 21, pl. 7, fig. 8. - Puri, H. S., 1953, Florida Geol. Sur., Bull. 36, p. 147, pl. 19, figs. 1, 2.

"*Elphidium poeyanum* (d'Orbigny)": Cushman, J. A. (*not Polystomella poeyana* d'Orbigny, 1839), 1930, Florida Geol. Sur., Bull. 4, p. 39, pl. 7, figs. 3, 4. - Cushman and Ponton, G. M., 1932, Florida Geol. Sur., Bull. 9, p. 69. - Cushman and Cahill, E. D., 1933, United States Geol. Sur., Prof. Paper 175-A, p. 21, pl. 7, fig. 7. - Dorsey, A., 1948, Maryland Dept. Mines, Geol., Water Resources, Bull. 2, p. 302, pl. 35, figs. 7, 8.

"*Elphidiononion poeyanum* (d'Orbigny)": Puri, H. S. (*not Polystomella poeyana* d'Orbigny, 1839), 1953, Florida Geol. Sur., Bull. 36, p. 148.

Elphidium kaicherae McLean, J. D., 1956, Bull. American Paleontol., vol. 36, no. 160, p. 343, pl. 42, figs. 11, 13-17.

Discussion: *E. hughesi* was originally described from the Pliocene of California. It has apparently been confused by some previous authors with *E. incertum* and *E. clavatum*, both of which are Recent temperate to cold water species. *E. incertum* differs from *E. hughesi* in possessing fewer, more arcuate chambers, and short but wide retral processes. *E. clavatum* is more strongly inflated than *E. hughesi*, has a transluscent test, and large umbilical bosses that fill the entire umbilicus. *Cribroelphidium poeyanum* has fewer chambers, a primary aperture consisting of a series of large pores along the base of the final chamber, more numerous retral processes, and a number of large areal pores scattered about the apertural face.

Occurrence: All four faunizones.

Elphidium sagrum (d'Orbigny).

Pl. 8, figs. 7, 8.

Polystomella sagra d'Orbigny, A. (*in* de la Sagra), 1839, *Histoire physique, politique, et naturelle de l'Ile de Cuba, Foraminifères*, Paris, p. 55, pl. 6, figs. 19, 20.

Elphidium sagrum (d'Orbigny): Cushman, J. A., 1930, United States Nat. Mus., Bull. 104, pt. 7, p. 24, pl. 9, figs. 5, 6. - Cushman, 1930, Florida Geol. Sur., Bull. 4, p. 40, pl. 7, fig. 6. - Cushman and Ponton, G. M., 1932, Florida Geol. Sur., Bull. 9, p. 70. - Cushman and Cahill, E. D., 1933, United States Geol. Sur., Prof. Paper 175-A, p. 22, pl. 7, fig. 9. - Cushman, 1939, United States Geol. Sur., Prof. Paper 191, p. 55, pl. 15, figs. 1-3. - Puri, H. S., 1953, Florida Geol. Sur., Bull. 36, p. 148.

Occurrence: *Arca*, *Ecphora*, and *Cancellaria* faunizones.

Elphidium sp.

Discussion: Three small, worn, and broken specimens of *Elphidium* sp. occur in *Ecphora* faunizone material. These specimens are too poorly preserved for specific identification.

Occurrence: *Ecphora* faunizone.

Genus : EPONIDES de Montfort, 1808.

Eponides repandus (Fichtel and Moll).
Pl. 11, figs. 4-6.

Nautilus repandus Fichtel, L., and Moll, J. P. C., 1798, *Testacea microscopica*, Wien, p. 35, pl. 3, figs. a-d.

Eponides repandus (Fichtel and Moll): de Montfort, D., 1808, *Conchyliologie et classification methodique des coquilles*, Paris, vol. 1, p. 127. - Cushman, J. A., and Ponton, G. M., 1932, Florida Geol. Sur., Bull. 9, p. 92, pl. 13, fig. 9.

Discussion: *Eponides repandus* is a neritic zone species that is most frequently found in carbonate sediments. This is a common species throughout the outcrop at Jackson Bluff, but is quite rare elsewhere in the present material.

Occurrence: *Arca*, *Ecphora*, and *Cancellaria* faunizones.

Genus : FISSURINA Reuss, 1850.

Discussion: This genus includes the species with single-chambered, perforate calcareous tests that are compressed and bilaterally symmetrical, and have an entosolenian tube extending from the base of the aperture into the test cavity. This genus differs from *Oolina* in being compressed, and from *Parafissurina* in being bilaterally symmetrical.

Fissurina agassizi Todd and Bronnimann.

Pl. 4, figs. 1, 2.

Fissurina agassizi Todd, R., and Bronnimann, P., 1957, Cushman Found. Foram. Res., Spec. Pub. 3, p. 36, pl. 9, fig. 14.

Discussion: *F. agassizi* was originally described from the inner neritic zone of the eastern Gulf of Paria.

Occurrence: *Arca*, *Ecphora*, and *Cancellaria* faunizones.

Fissurina cf. *F. angulata* (Uchio).

Pl. 4, figs. 3, 4.

Discussion: A single specimen of *Fissurina* resembles *Entosolenia marginata* var. *angulata* Uchio (1951, p. 38, pl. 3, fig. 14), which was originally described from the Pliocene of Japan. In the absence of comparable type specimens of *F. angulata*, identity with that species is uncertain.

Occurrence: One specimen from the *Ecphora* faunizone.

Fissurina flintii (Cushman).

Pl. 4, figs. 5, 6.

"*Lagena castrensis* Schwager": Flint, J. A. (*not L. castrensis* Schwager, 1866), 1899, United States Nat. Mus., Rep. (1897), p. 308, pl. 54, fig. 5.

Lagena orbignyana Seguenza, var. *flintii* (Cushman): Todd, R., and Kniker, H. T., 1952, Cushman Found. Foram. Res., Spec. Pub. 1, p. 22, pl. 4, fig. 15.

Fissurina flintii (Cushman): Todd, R., and Bronnimann, P., 1957, Cushman Found. Foram. Res., Spec. Pub. 3, p. 36, pl. 9, fig. 13.

"*Lagena orbignyana* (Seguenza), var. *lacunata* Burrows and Holland": Cushman, J. A. (*not L. lacunata* Burrows and Holland, 1895), 1930, Florida Geol. Sur., Bull. 4, p. 32, pl. 5, fig. 13. - Cushman and Ponton, G. M., 1932, Florida Geol. Sur., Bull. 9, p. 63. - Cushman and Cahill, E. D., 1933, United States Geol. Sur., Prof. Paper 175-A, p. 16, pl. 5, fig. 12.

"Fissurina orbignyana lacunata (Burrows and Holland)": Puri, H. S. (*not L. lacunata* Burrows and Holland, 1895), 1953, Florida Geol. Sur., Bull. 36, p. 115, pl. 26, figs. 2, 3.

Discussion: *Fissurina lacunata* (Burrows and Holland) resembles the present species, but has larger, irregularly arranged pits scattered over the central part of the test, in contrast to the relatively small and concentrically arranged pits of *F. flintii*. In addition, the peripheral keel of *F. lacunata* does not extend to the base of the test as does the keel of *F. flintii*.

Occurrence: *Ecphora* and *Cancellaria* faunizones.

Fissurina cf. *F. laevigata* Reuss.

Pl. 4, fig. 8.

Discussion: Several specimens with compressed ovoidal shape, acute periphery, and smooth surface are similar to *Fissurina laevigata* Reuss (1850, p. 366, pl. 46, fig. 1). Their identification is tentative because the range of variation in the species is not sufficiently defined, nor is type material readily available for comparison.

Occurrence: *Ecphora* and *Cancellaria* faunizones.

Fissurina marginata (Montagu).

Pl. 4, fig. 7.

"Serpula (Lagena) marginata" Walker, G., and Boys, W., 1784, *Testacea minuta rariora*, London, p. 2, pl. 1, fig. 7.

Vermiculum marginatum Montagu, G., 1803, *Testacea Britannica*, Romsey, p. 524.

Lagena marginata (Montagu): Brown, T., 1827, *Illustrated Conchology of Great Britain and Ireland*, Edinburgh, pl. 1, figs. 30, 31. - Cushman, J. A., 1913, United States Nat. Mus., Bull. 71, pt. 3, p. 37, pl. 22, figs. 1-7. - Cushman and Ponton, G. M., 1932, Florida Geol. Sur., Bull. 9, p. 63, pl. 8, fig. 13.

Fissurina marginata (Montagu): Silvestri, A., 1902, Accad. Pont. Nuovi Lencei, Mem., vol. 19, p. 21, text-figs. 33-35. - Todd, R., and Kniker, H. T., 1952, Cushman Found. Foram. Res., Spec. Pub. 1, p. 22, pl. 4, fig. 13.

Discussion: Authorship of this species has been attributed to both Walker and Boys, and Montagu. In 1794, Walker and Boys published a list of British foraminifera, with illustrations, entitled "*Testacea minuta rariora*". The names they applied to the various species were purely descriptive, generally more than three terms in length rather than binomial, and therefore non-Linnean. In certain instances, as in this species, their descriptive terms appear to conform to a binomial name. However, according to Article II(c) of the *International Code of Zoological Nomenclature*, all of their names are invalid because the principles of binomial nomenclature were not consistently applied. Montagu (1803) discussed this species, utilizing the original illustrations of Walker and Boys, but providing a valid binomial name for the species, plus another description. Therefore, authorship of this species correctly belongs to Montagu.

Occurrence: *Ecphora* faunizone.

Genus : FLORILUS de Montfort, 1808.

Discussion: Although this genus was placed in synonomy with *Nonion* by Cushman (1948), it may be separated from that genus on the basis of its flaring, slightly asymmetric test, and granular umbilical area. *Florilus* lacks the pronounced umbilical chamber extension characteristic of *Nonionella*.

Florilus grateloupi (d'Orbigny).

Pl. 8, figs. 4-6.

Nonionina grateloupi d'Orbigny, A., 1826, Ann. Sci. Natur., Ser. 1, vol. 7, p. 294, no. 12.

Nonion grateloupi (d'Orbigny): Cushman, J. A., 1930, United States Nat. Mus., Bull. 104, pt. 7, p. 10, pl. 3, figs. 9-11. - Cushman, 1930, Florida Geol. Sur., Bull. 4, p. 36, pl. 6, figs. 1-3. - Cushman and Ponton, G. M., 1932, Florida Geol. Sur., Bull. 9, p. 68. - Cushman and Cahill, E. D., 1933, United States Geol. Sur., Prof. Paper 175-A, p. 20. pl. 7, fig. 1. - Cushman, 1939, United States Geol. Sur., Prof. Paper 191, p. 21, pl. 6, figs. 1-7. - Dorsey, A., 1948, Maryland Dept. Mines, Geol., Water Resources, Bull. 2, p. 300, pl. 35, fig. 5. - Puri, H. S., 1953, Florida Geol. Sur., Bull. 36, p. 144.

Florilus grateloupi (Cushman): Akers, W. H., and Dorman, J. H., 1964, Tulane Stud. Geol., vol. 3, no. 1, p. 34, pl. 6, fig. 36.

"*Nonionina scapha* (Fichtel and Moll)": Cushman, J. A. (*not Nautilus scapha* Fichtel and Moll, 1798), 1918, United States Geol. Sur., Bull. 676, p. 68, pl. 25, fig. 2; pl. 26, figs. 2, 3.

Discussion: *F. grateloupi* is a common inner neritic species, generally found in water shallower than 100 meters. It seldom occurs in large numbers at depths greater than 60 meters.

Occurrence: *Arca*, *Ecphora*, and *Cancellaria* faunizones.

Florilus pizarrensis (Berry), new combination.

Pl. 8, figs. 1-3.

"*Nonionina depressula* (Walker and Jacob)": Cushman, J. A. (*not Nautilus depressulus* Walker and Jacob, 1798), 1918, United States Nat. Mus., Bull. 103, p. 72, pl. 25, fig. 5.

Nonionina boueana d'Orbigny: Cushman, J. A. (*not N. boueana* d'Orbigny, 1846), 1918, United States Geol. Sur., Bull. 676, p. 68, pl. 25, fig. 3.

Nonion pizarrensis Berry, E. W., 1928, J. Paleontol., vol. 1, no. 2, p. 269, text-fig. I (1-3). - Cushman, J. A., 1930, Florida Geol. Sur., Bull. 4, p. 37, pl. 6, figs. 7, 8. - Cushman and Ponton, G. M., 1932, Florida Geol. Sur., Bull. 9, p. 69. - Cushman and Cahill, E. D., 1933, United States Geol. Sur., Prof. Paper 175-A, p. 20, pl. 7, fig. 2.

Nonion pizarrense Berry: Cushman, J. A., 1939, United States Geol. Sur., Prof. Paper 191, p. 24, pl. 6, fig. 27. - Dorsey, A., 1948, Maryland Dept. Mines, Geol., Water Resources, Bull. 2, p. 300, pl. 5, fig. 6. - Puri, H. S., 1953, Florida Geol. Sur., Bull. 36, p. 145.

Discussion: The slightly asymmetric test with granular texture in the umbilical area place this species in the genus *Florilus*.

Occurrence: All four faunizones.

Florilus sp.

Discussion: Three minute, broken specimens of *Florilus* from the *Ecphora* faunizone are insufficiently diagnostic to be assigned to a species. These specimens are slightly asymmetrical, with an entire, subacute periphery and a slightly depressed umbilicus. The largest specimen has 8 chambers in the peripheral whorl.

Occurrence: *Ecphora* faunizone.

Genus : FURSENKOINA Loeblich and Tappan, 1961.

?Fursenkoina fusiformis (Williamson), new combination.
Pl. 5, figs. 12, 13.

Bulimina pupoides d'Orbigny, var. *fusiformis* Williamson, W. C., 1858, *On the Recent Foraminifera of Great Britain*, London, p. 63, pl. 5, figs. 129, 130.

"Bulimina" fusiformis Williamson: Hoeglund, H., 1947, Zool. Bidr. Uppsala, vol. 26, p. 232, pl. 20, fig. 3, text-figs. 219-233.

Virgulina fusiformis Cushman, J. A., 1930, Florida Geol. Sur., Bull. 4, p. 45, pl. 8, fig. 8. - Cushman and Ponton, G. M., 1932, Florida Geol. Sur., Bull. 9, p. 79. - Cushman and Cahill, E. D., 1933, United States Geol. Sur., Prof. Paper 175-A, p. 25, pl. 8, fig. 7. - Cushman, 1937, Cushman Lab. Foram. Res., Spec. Pub. 9, p. 18, pl. 2, fig. 29. - Dorsey, A., 1948, Maryland Dept. Mines, Geol., Water Resources, Bull. 2, p. 306, pl. 36, fig. 11. - Puri, H. S., 1953, Florida Geol. Sur., Bull. 36, p. 118, pl. 21, figs. 9, 10.

Discussion: The ontogenetic development of this species has been thoroughly discussed by Hoeglund (1947). Although the adult growth stage fits well into the current concept of *Fursenkoina*, the juvenile stage does not. Juvenile specimens appear to approach the morphological variation observed in *Buliminella subfusiformis* Cushman. The juvenile aperture, especially, is suggestive of relationship with *Buliminella*.

As noted in the above synonymy, Cushman applied the name *"Virgulina fusiformis"* to this species. This name is both a junior subjective synonym and a junior homonym of Williamson's species. Cushman and Parker (1947) listed all the species originally referred to *Bulimina* but considered by them to belong to another genus. They stated that *Bulimina pupoides* d'Orbigny, var. *fusiformis* Williamson is a species of *Virgulina*, but not *V. fusiformis* Cushman. However, inspection of both forms shows them to be identical.

Occurrence: *Arca*, *Ecphora*, and *Cancellaria* faunizones.

Fursenkoina punctata (d'Orbigny), new combination.

Pl. 5, fig. 11.

Virgulina punctata d'Orbigny, A. (*in* de la Sagra), 1839, *Histoire physique, politique, et naturelle de l'Ile de Cuba, Foraminiferes*, Paris, p. 139, pl. 1, figs. 35, 36. - Cushman, J. A., 1930, Florida Geol. Sur., Bull. 4, p. 44, pl. 8, fig. 7. - Cushman and Ponton, G. M., 1932, Florida Geol. Sur., Bull. 9, p. 79. - Cushman and Cahill, E. D., 1933, United States Geol. Sur., Prof. Paper 175-A, p. 25, pl. 8, fig. 8. - Cushman, 1937, Cushman Lab. Foram. Res., Spec. Pub. 9, p. 23, pl. 3, figs. 25-27. - Puri, H. S., 1953, Florida Geol. Sur., Bull. 36, p. 118, pl. 29, figs. 6, 7. - McLean, J. D., 1956, Bull. American Paleontol., vol. 36, no. 160, p. 346, pl. 44, fig. 12; pl. 45, fig. 1.

Discussion: The replacement of the pre-empted name *Virgulina* by *Fursenkoina* requires the application of the new generic name to this species.

Occurrence: *Arca*, *Ecphora*, and *Cancellaria* faunizones.

Genus : GLOBOCASSIDULINA Voloshina, 1960.

Globocassidulina crassa (d'Orbigny).

Pl. 7, figs. 3, 4.

Cassidulina crassa d'Orbigny, A., 1839, *Voyage dans l'Amérique Meridionale*, Paris, vol. 5, pt. 5, p. 56, pl. 7, figs. 18-20. - Cushman, J. A., 1930, Florida Geol. Sur., Bull. 4, p. 58, pl. 11, fig. 6. - Cushman and Ponton, G. M., 1932, Florida Geol. Sur., Bull. 9, p. 97. - Cushman and Cahill, E. D., 1933, United States Geol. Sur., Prof. Paper 175-A, p. 33, pl. 12, fig. 2. - Nørvang, A., 1959, Vidensk. Medd. Dansk. Naturhist. Foren., vol. 120 (1958), p. 36, pl. 8, figs. 20-23; pl. 9, figs. 24, 25.

Globocassidulina crassa (d'Orbigny): Belford, D. J., 1966, Bur. Mineral Resources, Geol., Geophys., Australia, Bull. 79, p. 151, pl. 26, figs. 5-9; text-figs. 17: 9-10.

Discussion: *Globocassidulina crassa* is reported by Phleger (1951) to occur in the Gulf of Mexico not shallower than 50 meters, and generally deeper than 100 meters. However, Boltovskoy (1954), Harrington (1960), and Wilcoxen (1964) have reported this species to be common at depths shallower than 50 meters.

Occurrence: *Arca*, *Ecphora*, and *Cancellaria* faunizones.

Genus : GLOBULINA d'Orbigny, 1826.

Globulina gibba d'Orbigny.

Pl. 2, figs. 11, 12.

Globulina gibba d'Orbigny, A., Ann. Sci. Natur., Ser. 1, vol. 7, p. 266, no. 10. - Cushman, J. A., and Ozawa, Y., 1930, United States

Nat. Mus., Proc., vol. 77, p. 60, pl. 16, figs. 1-4. - Cushman, 1930, Florida Geol. Sur., Bull. 4, p. 34, pl. 5, fig. 21. - Cushman and Ponton, G. M., 1932, Florida Geol. Sur., Bull. 9, p. 66, pl. 10, fig. 3. - Cushman and Cahill, E. D., 1933, United States Geol. Sur., Prof. Paper 175-A, p. 18, pl. 6, fig. 6. - Puri, H. S., 1953, Florida Geol. Sur., Bull. 36, p. 108.

Polymorphina gibba (d'Orbigny): Cushman, J. A., 1918, United States Geol. Sur., Bull. 676, p. 11, pl. 2, fig. 4.

Occurrence: *Arca* and *Ecphora* faunizones.

Globulina inaequalis Reuss.

Pl. 2, figs. 9, 10.

Globulina inaequalis Reuss, A. E., 1850, Kais. Akad. Wiss. Wien, math.-naturwiss. Cl., Denkschr., vol. 1, p. 377, pl. 48, fig. 9. - Cushman, J. A., and Ozawa, Y., 1930, United States Nat. Mus., Proc., vol. 77, p. 73, pl. 18, figs. 2-4. - Cushman, 1930, Florida Geol. Sur., Bull. 4, p. 35, pl. 5, fig. 22. - Cushman and Ponton, G. M., 1932, Florida Geol. Sur., Bull. 9, p. 66, pl. 10, fig. 1. - Cushman and Cahill, E. D., 1933, United States Geol. Sur., Prof. Paper 175-A, p. 18, pl. 6, figs. 7, 8. - Dorsey, A., 1948, Maryland Dept. Mines, Geol., Water Resources, Bull. 2, p. 294, pl. 32, fig. 10. - Puri, H. S., 1953, Florida Geol. Sur., Bull. 36, p. 108.

Occurrence: *Arca*, *Ecphora*, and *Cancellaria* faunizones.

Genus : GUTTULINA d'Orbigny, 1826.

Guttulina rectiornata Dorsey.

Pl. 2, figs. 15, 16.

"*Guttulina costatula* (Galloway and Wissler)": Cushman, J. A., and Ozawa, Y. (*not Polymorphina (Guttulina) costatula* Galloway and Wissler, 1927), 1930, United States Nat. Mus., Proc., vol. 77, p. 35, pl. 6, fig. 3. - Cushman, 1930, Florida Geol. Sur., Bull. 4, p. 33, pl. 6, fig. 3. - Cushman and Ponton, G. M., 1932, Florida Geol. Sur., Bull. 9, p. 65. - Cushman and Cahill, E. D., 1933, United States Geol. Sur., Prof. Paper 175-A, p. 17, pl. 6, fig. 1. - Puri, H. S., 1953, Florida Geol. Sur., Bull. 36, p. 106, pl. 21, fig. 7.

Guttulina rectiornata Dorsey, A., 1948, Maryland Dept. Mines, Geol., Water Resources, Bull. 2, p. 293, pl. 32, figs. 1, 2.

Guttulina pseudocostatula McLean, J. D., 1956, Bull. American Paleontol., vol. 36, no. 160, p. 334, pl. 40, figs. 8, 10, 11.

Occurrence: *Ecphora* and *Cancellaria* faunizones.

Guttulina elegans Dorsey.

Pl. 2, fig. 17.

Guttulina austriaca Cushman, J. A., and Ponton, G. M. (*not G. austriaca* d'Orbigny), 1932, Florida Geol. Sur., Bull. 9, p. 65, pl. 9, figs. 13, 14.

Guttulina elegans Dorsey, A., 1948, Maryland Dept. Mines, Geol., Water Resources, Bull. 2, p. 292, pl. 32, figs. 4, 5.

Occurrence: *Cancellaria* faunizone.

Guttulina sp.

Discussion: Two small hispid specimens of *Guttulina* are insufficiently diagnostic for specific identification. The test is globular, slightly longer than wide. The chamber arrangement appears to be triloculine. The chambers are inflated, with depressed sutures. Greatest width is below the middle of the test. The aperture is radiate, on a short neck.

Occurrence: *Cancellaria* faunizone.

Genus : GYROIDINOIDES Brotzen, 1942.

Gyroidinoides nipponica (Ishizaki).
Pl. 11, figs. 13-15.

Gyroidina nipponica Ishizaki, K., 1944, Natur. Hist. Soc. Taiwan, Trans., vol. 34 (244), p. 102, pl. 3, fig. 3.

Gyroidinoides nipponica (Ishizaki): Matoba, Y., 1967, Sci. Rep., Tohoku Univ., 2nd Ser. (Geol.), vol. 38, no. 2, p. 255, pl. 29, fig. 13.

Discussion: Some broken specimens of this species exhibit the short aperture characteristic of *Gyroidina* on early chambers, but intact specimens all possess the long slit aperture of typical *Gyroidinoides*. Since no complete specimen shows the short aperture, it is probable that this shortening of the aperture results from partial closure during subsequent growth.

Occurrence: *Ecphora* and *Cancellaria* faunizones.

Genus : HANZAWAIA Asano, 1944.

Discussion: This genus includes species considered by Cushman to belong to *Cibicides*, but differing from typical species of that genus by possessing chamber flaps on the umbilical side of the test.

Hanzawaia americana (Cushman), new combination.
Pl. 11, figs. 1-3.

Truncatulina americana Cushman, J. A., 1918, United States Geol. Sur., Bull. 676, p. 63, pl. 20, figs. 2, 3.

Cibicides americana (Cushman): Cushman, J. A., 1930, Florida Geol. Sur., Bull. 4, p. 61, pl. 12, fig. 5.

Cibicides americanus (Cushman): Cushman, J. A., and Cahill, E. D., 1933, United States Geol. Sur., Prof. Paper 175-A, p. 34, pl. 13, fig. 2. - Dorsey, A., 1948, Maryland Dept. Mines, Geol., Water Resources, Bull. 2, p. 314, pl. 39, fig. 4.

Truncatulina basiloba Cushman, J. A., 1918, United States Geol. Sur., Bull. 676, p. 64, pl. 21, fig. 2.

Truncatulina concentrica Cushman, J. A., 1918, United States Geol. Sur., Bull. 676, p. 64, pl. 21, fig. 3.

Cibicides concentrica (Cushman): Cushman, J. A., 1930, Florida Geol. Sur., Bull. 4, p. 61, pl. 12, fig. 4.

Cibicides concentricus (Cushman): Cushman, J. A., and Ponton, G. M., 1932, Florida Geol. Sur., Bull. 9, p. 101. - Cushman and Cahill, E. D., 1933, United States Geol. Sur., Prof. Paper 175-A, p. 35, pl. 13, fig. 3. - Dorsey, A., 1948, Maryland Dept. Mines, Geol., Water Resources, Bull. 2, p. 315, pl. 39, figs. 1, 2.

Hanzawaia concentrica Puri, H. S., 1953, Florida Geol. Sur., Bull. 36, p. 140, pl. 12, figs. 7-9. - McLean, J. D., 1956, Bull. American Paleontol., vol. 36, no. 160, p. 367, pl. 49, figs. 4-6.

Truncatulina americana Cushman, var. *strattoni* Applin, E. R. (*in* Applin, Ellisor, and Kniker), 1925, American Ass. Petrol. Geol., Bull., vol. 9, no. 1, p. 99, pl. 3, fig. 3.

Cibicides americana (Cushman), var. *strattoni* (Applin): Kornfeld, M. M., 1931, Stanford Univ., Dep. Geol., Contrib., vol. 1, no. 3, p. 82.

Cibicidina strattoni (Applin): Parker, F. L., Phleger, F. B., and Peirson, J. F., 1953, Cushman Found. Foram. Res., Spec. Pub. 2, p. 7, pl. 4, figs. 38, 39.

Hanzawaia strattoni (Applin): Bandy, O. L., 1954, United States Geol. Sur., Prof. Paper 254-F, p. 136, pl. 31, fig. 4.

Discussion: Various ontogenetic stages within this species have been given specific names by Cushman (1918). The holotype of *Truncatulina americana* is a juvenile specimen with poorly developed apertural flaps. *T. basiloba* is the name applied to an intermediate form with discrete flaps and a slightly depressed umbilicus. *T. concentrica* is representative of mature specimens, with fused apertural flaps and deeply depressed ventral sutures and umbilicus. The presence of the apertural flaps places this species in *Hanzawaia*.

Truncatulina americana, var. *strattoni* was a name applied by Applin (1925) to specimens from the subsurface Miocene strata of Texas and Louisiana which she considered distinct from "typical" *T. americana* as it was known from the subsurface Oligocene. Various authors have separated *Hanzawaia strattoni* from *H. concentrica* on the basis of its biconvex test, but both forms are comparable to typical *H. americana*.

Hanzawaia americana is a common inner neritic species in the Gulf of Mexico, abundant at depths less than 100 meters. It is the most abundant species in some horizons of the *Arca* and *Cancellaria* faunizones.

Occurrence: All four faunizones.

Genus : HOPKINSINA Howe and Wallace, 1932.

Hopkinsina bononiensis (Fornasini), new combination.

Pl. 5, fig. 1.

Uvigerina bononiensis Fornasini, C., 1888, Soc. Geol. Italia, Boll., vol. 7, p. 48, pl. 3, fig. 12. - Cushman, J. A., and Todd, R., 1941, Cushman Lab. Foram. Res., Contrib., vol. 17, pt. 2, p. 74, pl. 19, figs. 14-16.

Uvigerina parkeri Cushman, J. A., and Ponton, G. M. (*not U. parkeri* Karrer), 1932, Florida Geol. Sur., Bull. 9, p. 86, pl. 12, fig. 12. - Puri, H. S., 1953, Florida Geol. Sur., Bull. 36, p. 124, pl. 17, figs. 8, 9.

Discussion: *H. bononiensis* was originally described from the Pliocene of Italy. Only one specimen has been found in the present material. The biserial arrangement of chambers in the mature test place this species in the genus *Hopkinsina*.

Occurrence: *Ecphora* faunizone.

Genus : LAGENA Walker and Jacob, 1798.

Lagena flexa Cushman and Gray.

Pl. 3, fig. 15.

Lagena flexa Cushman, J. A., and Gray, H. B., 1946, Cushman Lab. Foram. Res., Spec. Pub. 19, p. 68, pl. 12, figs. 18-21.

Occurrence: *Ecphora* faunizone.

Lagena intermedia Rzehak.

Pl. 3, fig. 11.

Oolina striata d'Orbigny, A. (*not Vermiculum striatum* Montagu, 1803), 1839, *Voyage dans l'Amērique Meridionale*, Paris, vol. 5, pt. 5, p. 21, pl. 5, fig. 12.

Lagena striata (d'Orbigny), var. *intermedia* Rzehak, A., 1885, Vereins Bruenn, Verhandl., vol. 23 (1884), p. 81, pl. 1, fig. 6.

"*Lagena substriata* (Williamson)": Cushman, J. A. (*not L. substriata* Williamson, 1848), 1930, Florida Geol. Sur., Bull. 4, p. 31, pl. 5, fig. 14. - Cushman and Ponton, G. M., 1932, Florida Geol. Sur., Bull. 9, p. 63. - Puri, H. S., 1953, Florida Geol. Sur., Bull. 36, p. 103, pl. 26, fig. 1.

Lagena sp. D. Dorsey, A., 1948, Maryland Dept. Mines, Geol., Water Resources, Bull. 2, p. 291, pl. 30, figs. 19-23.

Lagena dorseyae McLean, J. D., 1956, Bull. American Paleontol., vol. 36, no. 160, p. 330, pl. 39, fig. 8.

Discussion: D'Orbigny named this species *Oolina striata*, which is a junior subjective homonym of *Vermiculum striatum* Montagu, 1803. This is a junior objective synonym of *Serpula (Lagena) sulcata* Walker and Jacob, 1798. Both Montagu's and Walker and Jacob's names were proposed for "*Serpula (Lagena) striata sulcata rotunda*" Walker and Boys, 1784, which is invalid under Article II(c) of the *International Code of Zoological Nomenclature*. Rzehak proposed *intermedia* as a new variety of d'Orbigny's species, but the forms included appear identical with d'Orbigny's types, and thus no subspecific distinction is warranted.

Occurrence: *Arca*, *Ecphora*, and *Cancellaria* faunizones.

Lagena laevis (Montagu).

Pl. 3, fig. 13.

"*Serpula (Lagena) laevis ovalis*" Walker, G., and Boys, W., 1784, *Testacea minuta rariora*, London, p. 3, pl. 1, fig. 9.

Vermiculum laeve Montagu, G., 1803, *Testacea Britannica*, Romsey, p. 524.

Lagena laevis (Montagu): Williamson, W. C., 1848, Ann. & Mag. Natur. Hist., Ser. 2, vol. 1, p. 12, pl. 1, figs. 1, 2. - Brady, H. B., 1884, Rep. Voy. Challenger, Zool., vol. 9, p. 455, pl. 56, figs. 7-9, 30. - Cushman, J. A., 1913, United States Nat. Mus., Bull. 71, pt. 3, p. 5, pl. 1, fig. 3; pl. 38, fig. 5. - Dorsey, A., 1948, Maryland Dept. Mines, Geol., Water Resources, Bull. 2, p. 289, pl. 31, figs. 9, 10.

"*Lagena clavata* (d'Orbigny)": Cushman, J. A., and Cahill, E. D. (*not Oolina clavata* d'Orbigny, 1846), 1933, United States Geol. Sur., Prof. Paper 175-A, p. 15, pl. 5, fig. 7.

Discussion: *L. laevis* was first described by Walker and Boys (1784), but their taxonomy was non-Linnean and therefore invalid. Montagu (1803) redescribed this species, referring to the figure published by Walker and Boys, and therefore should be considered the author of this species.

Occurrence: *Ecphora* and *Cancellaria* faunizones.

Lagena palmerae McLean.

Pl. 3, fig. 14.

Lagena palmerae McLean, J. D., 1956, Bull. American Paleontol., vol. 36, no. 160, p. 332, pl. 39, figs. 5, 6. - McLean, 1966, Virginia Div. Min. Resources, Rep. Invest. 9, p. 20.

Lagena hoeglundi Todd, R., and Bronnimann, P., 1957, Cushman Found. Foram. Res., Spec. Pub. 4, p. 31, pl. 5, fig. 17.

Discussion: This species has been reported by Todd and Bronnimann (1957) to be present in the Gulf of Paria in water shallower than 18 fathoms.

Occurrence: *Ecphora* and *Cancellaria* faunizones.

Lagena substriata Williamson.

Pl. 3, fig. 12.

Lagena substriata Williamson, W. C., 1848, Ann. & Mag. Natur. Hist., Ser. 2, vol. 1, p. 15, pl. 1, fig. 12. - Cushman, J. A., 1923, United States Nat. Mus., Bull. 104, pt. 4, p. 56, pl. 10, fig. 11.

Lagena vulgaris (Williamson), var. *substriata* Williamson: Williamson, W. C., 1858, *On the Recent Foraminifera of Great Britain*, London, p. 7, pl. 1, fig. 14.

Lagena striata (d'Orbigny), var. *substriata* Williamson: Cushman, J. A., 1913, United States Nat. Mus., Bull. 71, pt. 2, p. 20, pl. 8, fig. 3.

"*Lagena* cf. *L. striato-punctata* Parker and Jones": Cushman, J. A. (*not L. sulcata*, var. *striatopunctata* Parker and Jones, 1865), 1930, Florida Geol. Sur., Bull. 4, p. 32, pl. 5, fig. 9.

"*Fissurina* cf. *F. striatopunctata* (Parker and Jones)": Puri, H. S. (*not Lagena sulcata*, var. *striatopunctata* Parker and Jones, 1865), 1953, Florida Geol. Sur., Bull. 36, p. 116, pl. 26, fig. 7.

Occurrence: One specimen, from the *Ecphora* faunizone.

Genus : LARYNGOSIGMA Loeblich and Tappan, 1953.

Laryngosigma williamsoni (Terquem).

Polymorphina lactea d'Orbigny, var. *oblonga* Williamson, W. C. (*not P. (Globulina) oblonga* Roemer, 1838; *not P. oblonga* d'Orbigny, 1846), 1858, *On the Recent Foraminifera of Great Britain*, London, p. 71, pl. 6, fig. 149.

Polymorphina williamsoni Terquem, M. O., 1878, Soc. Geol. France, Mem., Ser. 3, vol. 1, p. 37.

Sigmomorphina williamsoni (Terquem): Cushman, J. A., and Ozawa, Y., 1930, United States Nat. Mus., Proc., vol. 77, p. 138, pl. 38, figs.

3, 4. - Cushman, 1930, Florida Geol. Sur., Bull. 4, p. 36, pl. 6, fig. 4. - Puri, H. S., 1953, Florida Geol. Sur., Bull. 36, p. 110, pl. 28, fig. 7.

Laryngosigma williamsoni (Terquem): Loeblich, A. R., and Tappan, H., 1953, Smithsonian Misc. Coll., vol. 121, no. 7, p. 83.

Occurrence: *Ecphora* and *Cancellaria* faunizones.

Genus : LENTICULINA Lamarck, 1804.

Discussion: *Robulus* Montford (1808) has been placed in synonomy with this species following Loeblich and Tappan (1964a).

Lenticulina americana (Cushman), new combination.

Pl. 3, figs. 1, 2.

Cristellaria americana Cushman, J. A., 1918, United States Geol. Sur., Bull. 676, p. 50, pl. 10, figs. 5, 6.

Robulus americanus (Cushman): Cushman, J. A., 1930, Florida Geol. Sur., Bull. 4, p. 24, pl. 3, fig. 7. - Cushman and Ponton, G. M., 1932, Florida Geol. Sur., Bull. 9, p. 58. - Cushman and Cahill, E. D., United States Geol. Sur., Prof. Paper 175-A, p. 12, pl. 3, fig. 6. - Dorsey, A., 1948, Maryland Dept. Mines, Geol., Water Resources, Bull. 2, p. 282, pl. 30, fig. 3. - Puri, H. S., 1954, Florida Geol. Sur., Bull. 36, p. 96.

Christellaria americana Cushman, var. *spinosa* Cushman, J. A., 1918, United States Geol. Sur., Bull. 676, p. 51, pl. 11, fig. 2.

Robulus americanus (Cushman), var. *spinosus* (Cushman): Cushman, J. A., 1930, Florida Geol. Sur., Bull. 4, p. 24, pl. 3, fig. 7. - Cushman and Cahill, E. D., 1933, United States Geol. Sur., Prof. Paper 175-A, p. 12, pl. 3, fig. 7.

Robulus americanus spinosus (Cushman): Puri, H. S., 1953, Florida Geol. Sur., Bull. 36, p. 97, pl. 29, figs. 3, 4.

Discussion: *Lenticulina* Lamarck (1804) has priority over *Cristellaria* Lamarck (1816) and *Robulus* de Montfort (1808). These genera are considered synonomous by Loeblich and Tappan (1964).

Occurrence: All four faunizones.

Lenticulina cf. *L. occidentalis* (Cushman).

Pl. 3, fig. 3.

Discussion: Two small specimens with smooth surface, flush sutures, and acute periphery closely resemble juvenile specimens of *Cristellaria occidentalis* Cushman (1923a, p. 315, pl. 25, fig. 2; pl. 26, figs. 1, 2). Because no large specimens of this form were observed in the present study, positive identification is not possible.

Occurrence: *Arca* faunizone.

Lenticulina vaughani (Cushman).

Pl. 3, fig. 4.

Cristellaria vaughani Cushman, J. A., 1918, United States Nat. Mus., Bull. 103, p. 61, pl. 22, fig. 3.

Robulus vaughani (Cushman): Cushman, J. A., and Ponton, G. M., 1932, Florida Geol. Sur., Bull. 9, p. 59, pl. 8, figs. 5-10. - Puri, H. S., 1953, Florida Geol. Sur., Bull. 36, p. 98.

Planularia cf. *P. vaughani* (Cushman): Ellisor, A. C., 1940, American Ass. Petrol. Geol., Bull., vol. 24, no. 3, p. 440, pl. 3, fig. 8. - Dorsey, A., 1948, Maryland Dept. Mines, Geol., Water Resources, Bull. 2, p. 284, pl. 30, fig. 6.

Lenticulina vaughani (Cushman): Bermudez, P. J., 1949, Cushman Lab. Foram. Res., Spec. Pub. 25, p. 135, pl. 8, figs. 17-20.

Occurrence: *Arca*, *Ecphora*, and *Cancellaria* faunizones.

?*Lenticulina* sp.

Discussion: A single small broken specimen is questionably referred to the genus *Lenticulina*. The test is involute, inflated, and planispiral, with flush sutures and an entire, broadly rounded periphery.

Occurrence: *Cancellaria* faunizone.

Genus : MARGINULINA d'Orbigny, 1826.

?*Marginulina* sp.

Pl. 3, fig. 5.

Discussion: One broken specimen appears to be a juvenile of *Marginulina* sp. All that is present are the proloculus and two elongate, inflated chambers.

Occurrence: *Ecphora* faunizone.

Genus : MARGINULINOPSIS Silvestri, 1904.

Discussion: Although questionably placed in synonomy with *Marginulina* d'Orbigny by Cushman (1948), this genus appears to be distinct, having an early *Lenticulina*-like stage, and a later uncoiled stage similar to true *Marginulina*.

Marginulinopsis sp.

Pl. 3, fig. 6.

Discussion: A single broken specimen of *Marginulinopsis* with a smooth, elongate, inflated test was found in the present material. This specimen is insufficiently diagnostic for specific identification.

Occurrence: *Ecphora* faunizone.

Genus : MASSILINA Schlumberger, 1893.

Massilina sp.

Discussion: Two small, broken specimens of *Massilina* are insufficiently diagnostic for specific identification. The chambers are elongate, smooth, with depressed sutures and rounded peripheries. The aperture of each is small, semicircular, with a short simple tooth. The peripheral chambers of both specimens are broken.

Occurrence: *Ecphora* faunizone.

Juvenile miliolid.

Discussion: A single small miliolid was found in the present material that is not sufficiently developed to allow either specific or generic identification. The test is elongate with a proloculus and two narrow chambers, each of which appears to bear a narrow carina. The aperture is a small round opening on an elongate apertural neck.

Occurrence: *Ecphora* faunizone.

Genus : NEOCONORBINA Hofker, 1951.

Neoconorbina terquemi (Rzehak).

Pl. 8, figs. 15, 16.

Rosalina orbicularis Terquem, M. O. (*not R. orbicularis* d'Orbigny, 1850), 1876, *Essai sur le classement des animaux qui vivent sur la plage et dans les environs de Dunkerque*, Dunkerque, pt. 2, p. 75, pl. 9, fig. 4.

Discorbis orbicularis (Terquem): Berthelin, G. (*not Rosalina orbicularis* d'Orbigny, 1850), 1878, Ann. Soc. Acad. Nantes, Ser. 5, vol. 8, p. 39, no. 63. - Cushman, J. A., and Ponton, G. M., 1932, Florida Geol. Sur., Bull. 9, p. 89, pl. 13, fig. 6.

Discorbina terquemi Rzehak, A., 1888, Geol. Reichsanst. Austria, Verhandl., p. 228.

Neoconorbina terquemi (Rzehak): Hofker, J., 1951, *Siboga Expedition, Foraminifera*, pt. 1, p. 435. - Loeblich, A. R., and Tappan, H., 1964, *Treatise on Invertebrate Paleontology*, pt. C, vol. 2, no. 2, fig. 457, 5.

Discorbis terquemi (Rzehak): Puri, H. S., 1953, Florida Geol. Sur., Bull. 36, p. 131.

"*Discorbis mira* Cushman": Cushman, J. A., 1930 (*not D. mira* Cushman, 1922), Florida Geol. Sur., Bull. 4, p. 52, pl. 10, fig. 2.

Occurrence: *Arca*, *Ecphora*, and *Cancellaria* faunizones.

Genus : NODOSARIA Lamarck, 1816.

Nodosaria catesbyi d'Orbigny.

Pl. 3, fig. 10.

Nodosaria catesbyi d'Orbigny, A. (*in* de la Sagra), 1839, *Histoire physique, politique, et naturelle de l'Ile de Cuba, Foraminiferes,* Paris, p. 16, pl. 11, figs. 8-10. - Cushman, J. A., 1930, Florida Geol. Sur., Bull. 4, p. 28, pl. 5, fig. 4. - Cushman and Ponton, G. M., 1932, Florida Geol. Sur., Bull. 9, p. 61. - Cushman and Cahill, E. D., 1933, United States Geol. Sur., Prof. Paper 175-A, p. 14, pl. 5, fig. 5. - Puri, H. S., 1953, Florida Geol. Sur., Bull. 36, p. 101, pl. 26, fig. 6. - McLean, J. D., 1956, Bull. American Paleontol., vol. 36, no. 160, p. 329, pl. 39, figs. 1-4.

Occurrence: *Ecphora* faunizone.

Nodosaria(?) sp.

Discussion: A single small broken specimen is questionably referred to the genus *Nodosaria*. This specimen consists of a single smooth globose chamber and a fragment of a second one. The complete chamber is largest below the middle, tapering toward the apertural end of the test. The suture is depressed and limbate.

Occurrence: *Ecphora* faunizone.

Genus : NONION de Montfort, 1808.

Nonion cf. *N. cassidulinoides* Hornibrook.
Pl. 7, figs. 10, 11.

Discussion: *Nonion cassidulinoides* has been described from the Oligocene and Lower Miocene of New Zealand by Hornibrook (1961, p. 92, pl. 11, figs. 214, 215). The present specimens differ from the description and illustration of the type only in the amount of curvature of the sutures, which are strongly recurved in typical *N. cassidulinoides*, but only slightly curved in the present suite of specimens. In the absence of type material, positive identification is not possible.

Occurrence: *Ecphora* faunizone.

Genus : NONIONELLA Cushman, 1926.

Nonionella miocenica Cushman.

Pl. 7, figs. 15-17.

"*Nonionina auris* (d'Orbigny)": Cushman, J. A. (*not Valvulina auris* d'Orbigny, 1839), 1925, Cushman Lab. Foram. Res., Contrib., vol. 1, pt. 4, p. 91, pl. 13, fig. 4.

"*Nonionella auris* (d'Orbigny)": Cushman, J. A. (*not Valvulina auris* d'Orbigny, 1839), 1930, Florida Geol. Sur., Bull. 4, p. 38, pl. 7, fig. 1. - Cushman and Ponton, G. M., 1932, Florida Geol. Sur., Bull. 9, p. 69. - Cushman and Cahill, E. D., 1933, United States Geol. Sur., Prof. Paper 175-A, p. 21, pl. 7, fig. 6. - Dorsey, A., 1948, Maryland Dept. Mines, Geol., Water Resources, Bull. 2, p. 301, pl. 35, fig. 3. - Puri, H. S., 1953, Florida Geol. Sur., Bull. 36, p. 145.

Nonionella miocenica Cushman, J. A., 1926, Cushman Lab. Foram. Res., Contrib., vol. 2, pt. 3, p. 64. - Cushman, 1939, United States Geol. Sur., Prof. Paper 191, p. 31, pl. 8, fig. 9.

Occurrence: All four faunizones.

Nonionella opima Cushman.

Nonionella opima Cushman, J. A., 1947, Cushman Lab. Foram. Res., Contrib., vol. 23, pt. 4, p. 90, pl. 20, figs. 1-3. - Parker, F. L., Phleger, F. B., and Peirson, J. F., 1953, Cushman Found. Foram. Res., Spec. Pub. 2, p. 11, pl. 3, figs. 32, 33. - Todd, R., and Bronnimann, P., 1957, Cushman Found. Foram. Res., Spec. Pub. 3, p. 32, pl. 6, figs. 1, 2.

Occurrence: One specimen from the *Arca* faunizone.

Nonionella pulchella Hada.

Pl. 7, figs. 12-14.

Nonionella pulchella Hada, Y., 1931, Sci. Rep., Tohoku Imp. Univ., Ser. 4, Biol., vol. 6, p. 120, fig. 79. - Cushman, J. A., 1939, United States Geol. Sur., Prof. Paper 191, p. 34, pl. 9, fig. 11.

Discussion: This species is reported to inhabit the inner neritic zone off Japan, Argentina, and Australia. The known geologic range is Pliocene to Recent.

Occurrence: *Arca*, *Ecphora*, and *Cancellaria* faunizones.

Nonionella sp.

Discussion: One small broken specimen of *Nonionella* is insufficiently diagnostic for specific identification. This specimen is compressed, with about 11 narrow chambers in the peripheral whorl. The sutures are slightly curved and flush. The final chamber is broken, but bears an umbilical extension. The periphery is entire and rounded. The aperture is not visible.

Occurrence: *Ecphora* faunizone.

Genus : OOLINA d'Orbigny, 1839.

Discussion: This genus has a globular, perforate calcareous test with a round or radiate aperture and an entosolenian tube.

Oolina melo d'Orbigny.

Pl. 3, fig. 16.

Oolina melo d'Orbigny, A., 1839, *Voyage dans l' Amerique Meridionale*, Paris, vol. 5, pt. 5, p. 20, pl. 5, fig. 9. - Loeblich, A. L., and Tappan, H., 1953, Smithsonian Misc. Coll., vol. 121, no. 7, p. 71, pl. 12, figs. 8-15.

Lagena melo (d'Orbigny): McLean, J. D., 1956, Bull. American Paleontol., vol. 36, no. 160, p. 331, pl. 39, fig. 12.

Entosolenia squamosa (Montagu), var. *scalariformis* Williamson, W. C., 1848, Ann. & Mag. Natur. Hist., Ser. 2, vol. 1, p. 20, pl. 2, figs. 21, 22.

Lagena hexagonaria (Williamson), var. *scalariformis* (Williamson): Cushman, J. A., 1913, United States Nat. Mus., Bull. 71, pt. 3, p. 17, pl. 6, fig. 4. - Cushman, 1930, Florida Geol. Sur., Bull. 4, p. 30, pl. 5, fig. 7. - Cushman and Ponton, G. M., 1932, Florida Geol. Sur., Bull. 9, p. 62. - Cushman and Cahill, E. D., 1933, United States Geol. Sur., Prof. Paper 175-A, p. 15, pl. 5, fig. 9.

Oolina hexagonaria scalariformis (Williamson): Puri, H. S., 1953, Florida Geol. Sur., Bull. 36, p. 117, pl. 21, figs. 4, 5.

Occurrence: *Ecphora* and *Cancellaria* faunizones.

Genus : PARAFISSURINA Parr, 1947.

Discussion: This genus has a somewhat compressed, perforate calcareous test, with a slit-like hooded aperture and an entosolenian tube.

Parafissurina sp.

Pl. 3, figs. 17, 18.

Discussion: Two small specimens of *Parafissurina* are insufficiently diagnostic for specific identification. The shape is slightly compressed ovoidal, the wall is smooth and transparent, and there is a short basal spine.

Occurrence: *Ecphora* and *Cancellaria* faunizones.

Genus : PATELLINA Williamson, 1858.

Patellina corrugata Williamson.

Pl. 9, figs. 1-3.

Patellina corrugata Williamson, W. C., 1858, *On the Recent Foraminifera of Great Britain*, London, p. 46, pl. 3, figs. 86-89. - Cushman, J. A., and Ponton, G. M., 1932, Florida Geol. Sur., Bull. 9, p. 87, pl. 13, fig. 1. - Puri, H. S., 1953, Florida Geol. Sur., Bull. 36, p. 130, pl. 19, figs. 7, 8.

Occurrence: *Ecphora* and *Cancellaria* faunizones.

Genus : PLANISPIRILLINA Bermudez, 1952.

Planispirillina orbicularis (Bagg).

Pl. 10, figs. 16-18.

Spirillina orbicularis Bagg, R. M., 1898, Bull. American Paleontol., vol. 2, no. 10, p. 33 (327), pl. 2 (22), fig. 2. - Cushman, J. A., 1918, United States Geol. Sur., Bull. 676, p. 58, pl. 14, fig. 1. - Cushman, J. A., 1930, Florida Geol. Sur., Bull. 4, p. 51, pl. 9, fig. 12.

Planispirillina orbicularis (Bagg): Puri, H. S., 1953, Florida Geol. Sur., Bull. 36, p. 130, pl. 20, figs. 1, 2. - McLean, J. D., 1956, Bull. American Paleontol., vol. 36, no. 160, p. 351, pl. 46, figs. 7, 8.

Occurrence: *Ecphora* faunizone.

Genus : PLANULINA d'Orbigny, 1826.

Planulina sp.

Discussion: Two small, broken specimens of *Planulina* are not sufficiently diagnostic for specific identification. Both specimens are strongly compressed, with raised, limbate sutures, depressed chambers, and lobate, truncate peripheries.

Occurrence: *Ecphora* and *Cancellaria* faunizones.

Genus : PLECTOFRONDICULARIA Liebus, 1902.

Plectofrondicularia floridana Cushman.
Pl. 4, figs. 9, 10.

Plectofrondicularia floridana Cushman, J. A., 1930, Florida Geol. Sur., Bull. 4, p. 41, pl. 8, fig. 1. - Cushman and Ponton, G. M., 1932, Florida Geol. Sur., Bull. 9, p. 74, pl. 11, fig. 8. - Cushman and Cahill, E. D., 1933, United States Geol. Sur., Prof. Paper 175-A, p. 22, pl. 7, fig. 11. - Puri, H. S., 1953, Florida Geol. Sur., Bull. 36, p. 112, pl. 16, fig. 12.

Occurrence: *Arca* faunizone.

Genus : PSEUDOPARRELLA Cushman and Ten Dam, 1948.

Pseudoparrella pontoni (Cushman), new combination.

Pl. 7, figs. 7-9.

Pulvinulinella pontoni Cushman, J. A., 1930, Florida Geol. Sur., Bull. 4, p. 57, pl. 11, fig. 2. - Cushman and Ponton, G. M., 1932, Florida Geol. Sur., Bull. 9, p. 97. - Cushman and Cahill, E. D., 1933, United States Geol. Sur., Prof. Paper 175-A, p. 32, pl. 12, fig. 1.

Epistominella pontoni (Cushman): Puri, H. S., 1953, Florida Geol. Sur., Bull. 36, p. 135, pl. 27, figs. 9-11.

Discussion: This species belongs to the genus *Pseudoparrella* as defined by Lipps (1965, p. 120) on the basis of its biconvex test, lack of peripheral keel, circular outline, and aperture on the umbilical side of the test.

Occurrence: All four faunizones.

Genus : PSEUDOPOLYMORPHINA Cushman and Ozawa, 1930.

Pseudopolymorphina rutila (Cushman).

Pl. 2, figs. 13, 14.

Polymorphina regina Brady, Parker, and Jones, var. *rutila*, Cushman, J. A., 1923, United States Geol. Sur., Prof. Paper 133, p. 34, pl. 5, figs. 7, 8.

Pseudopolymorphina rutila (Cushman): Cushman, J. A., and Ozawa, Y., 1930, United States Nat. Mus., Proc., vol. 77, p. 100, pl. 26, fig. 3. - Cushman, 1930, Florida Geol. Sur., Bull. 4, p. 36, pl. 5, fig. 20. - Cushman and Ponton, G. M., 1932, Florida Geol. Sur., Bull. 9, p. 67. - Cushman and Cahill, E. D., 1933, United States Geol. Sur., Prof. Paper 175-A, p. 19, pl. 6, fig. 11. - Dorsey, A., 1948, Maryland Dept. Mines, Geol., Water Resources, Bull. 2, p. 297, pl. 33, figs. 6-8; pl. 34, fig. 1. - Puri, H. S., 1953, Florida Geol. Sur., Bull. 36, p. 105, pl. 21, fig. 8.

Occurrence: *Ecphora* and *Cancellaria* faunizones.

Genus : PYRGO Defrance, 1824.

Pyrgo subsphaerica (d'Orbigny).

Pl. 1, figs. 14, 15.

Biloculina subsphaerica d'Orbigny, A. (*in* de la Sagra), 1839, *Histoire physique, politique, et naturelle de l'Ile de Cuba, Foraminiferes*, Paris, p. 162, pl. 3, figs. 25-27.

Pyrgo subsphaerica (d'Orbigny): Cushman, J. A., 1929, United States Nat. Mus., Bull. 104, pt. 6, p. 68, pl. 18, figs. 1, 2. - Cushman, 1930, Florida Geol. Sur., Bull. 4, p. 23, pl. 3, fig. 5. - Cushman and Ponton, G. M., 1932, Florida Geol. Sur., Bull. 9, p. 56. - Cushman and Cahill, E. D., 1933, United States Geol. Sur., Prof. Paper 175-A, p. 11, pl. 3, fig. 4. - Dorsey, A., 1948, Maryland Dept. Mines, Geol., Water Resources, Bull. 2, p. 282, pl. 29, fig. 7. - Puri, H. S., 1953, Florida Geol. Sur., Bull. 36, p. 95, pl. 13, figs. 10-12.

Discussion: This species is wide-spread in warm shallow water. It has been reported to occur somewhat deeper in colder water, but seldom deeper than 200 meters.

Occurrence: *Ecphora* faunizone.

Genus : QUINQUELOCULINA d'Orbigny, 1826.

Quinqueloculina agglutinans d'Orbigny.

Pl. 2, figs. 1, 2.

Quinqueloculina agglutinans d'Orbigny, A. (*in* de la Sagra), 1839, *Histoire physique, politique, et naturelle de l'Ile de Cuba, Foraminiferes*, Paris, p. 195, pl. 12, figs. 11-13. - Cushman, J. A., 1918, United States Geol. Sur., Bull. 676, p. 22, pl. 7, fig. 6.

Occurrence: *Ecphora* and *Cancellaria* faunizones.

Quinqueloculina lamarckiana d'Orbigny.

Pl. 2, figs. 5, 6.

Quinqueloculina lamarckiana d'Orbigny, A. (*in* de la Sagra), 1839, *Histoire physique, politique, et naturelle de l'Ile de Cuba, Foraminiferes*, Paris, p. 193, pl. 12, figs. 1-3. - Cushman, J. A., 1929, United States Nat. Mus., Bull. 104, pt. 6, p. 26, pl. 2, fig. 6. - Cushman, 1930, Florida Geol. Sur., Bull. 4, p. 20, pl. 2, figs. 3-5. - Cushman and Ponton, G. M., 1932, Florida Geol. Sur., Bull. 9, p. 44. - Cushman and Cahill, E. D., 1933, United States Geol. Sur., Prof. Paper

175-A, p. 9, pl. 2, fig. 4. - Puri, H. S., 1953, Florida Geol. Sur., Bull. 36, p. 86.

Quinqueloculina auberiana d'Orbigny, A. (*in* de la Sagra), 1839, *Histoire physique, politique, et naturelle de l'Ile de Cuba, Foraminiferes*, Paris, p. 193, pl. 12, figs. 1-3. - Cushman, J. A., 1918, United States Geol. Sur., Bull. 676, p. 23, pl. 5, fig. 3; p. 71, pl. 30, fig. 1.

Discussion: This is the most common species of *Quinqueloculina* in the Choctawhatchee deposits. *Q. lamarckiana* is a wide-spread, generally warm-water species. It is seldom found in water deeper than 100 meters, and is most abundant in water shallower than 30 meters.

Occurrence: *Ecphora* and *Cancellaria* faunizones.

Quinqueloculina cf. *Q. polygona* d'Orbigny.

Pl. 2, figs. 7, 8.

Discussion: A few specimens of *Quinqueloculina* from Jackson Bluff are similar to *Q. polygona* d'Orbigny (1839b, p. 198, pl. 12, figs. 21-23). However, they lack the keeled chamber shoulders of typical *Q. polygona*. These specimens differ from *A. contorta* d'Orbigny in lacking an apertural neck and in the shape of the aperture, which in *Q. contorta* is circular, with a simple tooth.

Occurrence: *Ecphora* faunizone.

Quinqueloculina seminula (Linné).

Serpula seminulum Linné, K., 1767, Systema naturae, Ed. 12, Stockholm, p. 1264.

Quinqueloculina seminulum (Linné): d'Orbigny, A., 1826, Ann. Sci. Natur., Ser. 1, vol. 7, p. 303. - Cushman, J. A., 1918, United States Geol. Sur., Bull. 676, p. 22, pl. 1, fig. 8; p. 70, pl. 28, figs. 2, 4, 5.

Quinqueloculina seminula (Linné): Cushman, J. A., 1929, Cushman Lab. Foram. Res., Contrib., vol. 5, pt. 3, p. 59, pl. 9, figs. 16-18. - Cushman, 1930, Florida Geol. Sur., Bull. 4, p. 19, pl. 2, figs. 1, 2. - Cushman and Ponton, G. M., 1932, Florida Geol. Sur., Bull. 9, p. 43. - Cushman and Cahill, E. D., 1933, United States Geol. Sur., Prof. Paper 175-A, p. 9, pl. 2, fig. 2. - Dorsey, A., Maryland Dept. Mines, Geol., Water Resources, Bull. 2, p. 280, pl. 29, fig. 2. - Puri, H. S., 1953, Florida Geol. Sur., Bull. 36, p. 89, pl. 28, figs. 4-6. - McLean, J. D., 1956, Bull. American Paleontol., vol. 36, no. 160, p. 321, pl. 37, figs. 12, 14.

Discussion: *Q. seminula* is a cosmopolitan species, most abundant in inner neritic environments. This is generally the dominant species of *Quinqueloculina* in cool water.

Occurrence: *Ecphora* and *Cancellaria* faunizones.

Quinqueloculina triloculiniforma McLean.

Pl. 2, figs. 3, 4.

"*Quinqueloculina vulgaris* d'Orbigny": Cushman, J. A. (*not Q. vulgaris* d'Orbigny, 1826), 1929, United States Nat. Mus., Bull. 104, pt. 6, p. 25, pl. 2, fig. 3.

Quinqueloculina triloculiniforma McLean, J. D., 1956, Bull. American Paleontol., vol. 36, no. 160, p. 322, pl. 37, figs. 9-11.

Occurrence: *Ecphora* faunizone.

Quinqueloculina sp.

Discussion: Several juvenile specimens of *Quinqueloculina* sp. occur in scattered horizons throughout the Choctawhatchee deposits. These specimens are insufficiently diagnostic for specific identification.

Occurrence: *Arca*, *Ecphora*, and *Cancellaria* faunizones.

Genus : RECTOBOLIVINA Cushman, 1927.

Rectobolivina advena (Cushman).

Pl. 4, fig. 12.

Siphogenerina advena Cushman, J. A., 1922, Carnegie Inst. Washington, Pub. 311, p. 35, pl. 5, fig. 2. - Cushman and Cahill, E. D., 1933, United States Geol. Sur., Prof. Paper 175-A, p. 28, pl. 9, fig. 7.

Rectobolivina advena (Cushman): Parker, F. L., Phleger, F. B, and Peirson, J. F., 1953, Cushman Found. Foram. Res., Spec. Pub. 2,

p. 13, pl. 4, figs. 10, 11. - Bandy, O. L., 1954, United States Geol. Sur., Prof. Paper 254-F, p. 138, pl. 31, fig. 8. - Bandy, 1956, United States Geol. Sur., Prof. Paper 274-G, p. 196.

Bifarina decorata Phleger, F. B, and Parker, F. L., 1951, Geol. Soc. America, Mem. 46, pt. 2, p. 12, pl. 6, figs. 9, 10.

Occurrence: *Cancellaria* faunizone.

Genus : RECTOCIBICIDES Cushman and Ponton, 1932.

Rectocibicides miocenicus Cushman and Ponton.

Rectocibicides miocenicus Cushman, J. A., and Ponton, G. M., 1932, Cushman Lab. Foram. Res., Contrib., vol. 8, pt. 1, p. 2, pl. 1, figs. 5-7. - Cushman and Ponton, 1932, Florida Geol. Sur., Bull. 9, p. 103, pl. 16, figs. 2-4. - Puri, H. S., 1953, Florida Geol. Sur., Bull. 36, p. 140, pl. 19, figs. 12, 13.

Occurrence: *Ecphora* faunizone.

Genus : REUSSELLA Galloway, 1933.

Reussella glabrata (Cushman).

Pl. 6, figs. 14-16.

Verneuilina glabrata Cushman, J. A., 1918, United States Geol. Sur., Bull. 676, p. 9, pl. 1, fig. 2.

Reussella glabrata (Cushman): Cushman, J. A., 1937, Cushman Lab. Foram. Res., Spec. Pub. 7, p. 20. - Cushman, 1945, Cushman Lab. Foram. Res., Contrib., vol. 21, pt. 2, p. 37, pl. 6, figs. 21-23.

"*Reussia spinulosa* (Reuss)": Cole, W. S. (*not Verneuilina spinulosa* Reuss, 1850), 1931, Florida Geol. Sur., Bull. 5, p. 43, pl. 2, fig. 6. - Cushman, J. A., and Ponton, G. M., 1932, Florida Geol. Sur., Bull. 9, p. 84, pl. 12, fig. 15 (*not* 14, 16).

"*Reussella spinulosa* (Reuss)": Puri, H. S. (*not Verneuilina spinulosa* Reuss, 1850), 1953, Florida Geol. Sur., Bull. 36, p. 123 (pars).

Occurrence: *Arca* faunizone.

Reussella miocenica Cushman.

Pl. 6, figs. 11-13.

"*Reussia spinulosa* (Reuss)": Cushman, J. A. (*not Verneuilina spinulosa* Reuss, 1850), 1930, Florida Geol. Sur., Bull. 4, p. 48, pl. 8, fig. 17. - Cushman and Ponton, G. M., 1932, Florida Geol. Sur., Bull. 9, p. 84, pl. 12, figs. 14, 16 (*not* 15). - Cushman and Cahill, E. D., 1933, United States Geol. Sur., Prof. Paper 175-A, p. 27, pl. 9, fig. 1.

"*Reussella spinulosa* (Reuss)": Puri, H. S. (*not Verneuilina spinulosa* Reuss, 1850), 1953, Florida Geol. Sur., Bull. 36, p. 123 (pars).

Reussella miocenica Cushman, J. A., 1945, Cushman Lab. Foram. Res., Contrib., vol. 21, pt. 2, p. 36, pl. 6, figs. 19, 20.

Discussion: *Reussella miocenica* is morphologically similar to *R. glabrata*, differing only in possessing numerous spines on the peripheries and sutures, and in bearing pustules on the chamber surfaces. *R. miocenica* also possesses a stout basal spine, which is absent in *R. glabrata*.

Occurrence: *Ecphora* and *Cancellaria* faunizones.

Genus : ROSALINA d'Orbigny, 1826.

Discussion: This genus includes species considered by Cushman to belong to *Discorbis*, but differing from typical species of that genus in having an open umbilicus.

Rosalina candeiana d'Orbigny.

Pl. 9, figs. 10-12.

Rosalina candeiana d'Orbigny, A., 1839, *Voyage dans l'Amerique Meridionale*, Paris, vol. 5, pt. 5, p. 97, pl. 4, figs. 2-4.

Discorbis candeiana (d'Orbigny): Cushman, J. A., and Ponton, G. M., 1932, Florida Geol. Sur., Bull. 9, p. 13. - Puri, H. S., 1953, Florida Geol. Sur., Bull. 36, p. 130.

"*Discorbis vilardeboana* (d'Orbigny)": Cushman, J. A. (*not Rosalina vilardeboana* d'Orbigny, 1839), 1930, Florida Geol. Sur., Bull. 4, p. 52, pl. 10, fig. 3.

Occurrence: *Ecphora* and *Cancellaria* faunizones.

Rosalina globularis d'Orbigny.

Pl. 9, figs. 7-9.

Rosalina globularis d'Orbigny, A., 1826, Ann. Sci. Natur., Ser. 1, vol. 7, p. 271, pl. 13, figs. 1-4. - Douglas, R., and Sliter, W. V., 1965, Tulane Stud. Geol., vol. 3, no. 3, p. 155, text-fig. 2; pl. 3, figs. 1-5.

Rosalina bulloides d'Orbigny, A. (*in* de la Sagra), 1839, *Histoire physique, politique, et naturelle de l'Ile de Cuba, Foraminiferes*, Paris, p. 98, pl. 3, figs. 2-5.

Tretomphalus bulloides (d'Orbigny): Moebius, K. A. (*in* Moebius, Richter, and von Martens), 1880, *Beitrage zur Meeresfauna der Insel Maurititius und der Sychellen*, Berlin, p. 98, pl. 10, figs. 6-9. - Cushman, J. A., 1931, United States Nat. Mus., Bull. 104, pt. 8, p. 86, pl. 16, fig. 5.

"*Discorbis consobrina* (d'Orbigny)": Cushman, J. A. (*not Rosalina consobrina* d'Orbigny, 1839), 1930, Florida Geol. Sur., Bull. 4, p. 53, pl. 10, fig. 4. - Cushman and Ponton, G. M., 1932, Florida Geol. Sur., Bull. 9, p. 88, pl. 13, fig. 3. - Cushman and Cahill, E. D., 1933, United States Geol. Sur., Prof. Paper 175-A, p. 30, pl. 10, fig. 4. - Puri, H. S., 1953, Florida Geol. Sur., Bull. 36, p. 131, pl. 24, figs. 4-6.

"*Discorbis floridana* Cushman": Cushman, J. A., and Ponton, G. M. (*not D. floridana* Cushman, 1922), 1932, Florida Geol. Sur., Bull. 9,

p. 88, pl. 13, fig. 2. - Cushman and Cahill, E. D., 1933, United States Geol. Sur., Prof. Paper 175-A, p. 29 (pars). - Puri, H. S., 1953, Florida Geol. Sur., Bull. 36, p. 131, pl. 24, figs. 7-9.

Discussion: The identity and morphology of *Rosalina globularis* are adequately discussed by Douglas and Sliter (1965).

Occurrence: *Arca*, *Ecphora*, and *Cancellaria* faunizones.

Rosalina subaraucana (Cushman).

Pl. 9, figs. 13-15.

Discorbis subaraucana Cushman, J. A., 1922, Carnegie Inst. Washington, Bull. 311, p. 41, pl. 7, figs. 1, 2. - Cushman, 1930, Florida Geol. Sur., Bull. 4, p. 52, pl. 10, fig. 1. - Cushman, 1931, United States Nat. Mus., Bull. 104, pt. 8, p. 32, pl. 7, fig. 2.

Rosalina subaraucana (Cushman): Todd, R., and Low, D., 1960, United States Geol. Sur., Prof. Paper 260-X, p. 837.

"*Discorbis floridana* Cushman": Cushman, J. A., and Ponton, G. M., 1932 (*not D. floridana* Cushman, 1922), Florida Geol. Sur., Bull. 9, p. 88 (pars). - Cushman and Cahill, E. D., 1933, United States Geol. Sur., Prof. Paper 175-A, p. 29, pl. 9, figs. 12, 13. - Puri, H. S., 1953, Florida Geol. Sur., Bull. 36, p. 131 (pars). - Bandy, O. L., 1954, United States Geol. Sur., Prof. Paper 253-F, p. 136, pl. 31, fig. 1.

Discorbis warreni Dorsey, A., 1948, Maryland Dept. Mines, Geol., Water Resources, Bull. 2, p. 310, pl. 37, fig. 5.

Occurrence: *Ecphora* and *Cancellaria* faunizones.

Rosalina williamsoni (Chapman and Parr).

Pl. 9, figs. 4-6.

Rotalina nitida Williamson, W. C. (*not R. nitida* Reuss, 1844), 1858, *On the Recent Foraminifera of Great Britain*, London, p. 54, pl. 4, figs. 106-108.

Discorbis nitida (Williamson): Cushman, J. A. (*not Rotalina nitida* Reuss, 1844), 1931, United States Nat. Mus., Bull. 104, pt. 8, p. 26, pl. 6, fig. 1.

Discorbis williamsoni Chapman, F., and Parr, W. S. (*in* Parr), 1932, Royal Soc. Victoria, Proc. vol. 44 (N.S.), pt. 2, p. 226, pl. 21, fig. 25.

Rosalina williamsoni (Chapman and Parr): van Voorthuysen, J. H., 1958, Meded. Geol. Sticht., N.S., vol. 11, p. 34, pl. 24, fig. 19.

Occurrence: *Ecphora* and *Cancellaria* faunizones.

Genus : SAGRINA d'Orbigny, 1839.

Discussion: This genus includes perforate calcareous species with a triserial early stage and biserial mature stage, elongate aperture with prominent lip, and internal toothplate.

Sagrina pulchella primitive (Cushman), new combination.

Pl. 4, fig. 11.

Bolivina pulchella (d'Orbigny), var. *primitiva* Cushman, J. A., 1930, Florida Geol. Sur., Bull. 4, p. 47, pl. 8, fig. 12. - Cushman and Ponton, G. M., 1932, Florida Geol. Sur., Bull. 9, p. 83. - Cushman and Cahill, E. D., 1933, United States Geol. Sur., Prof. Paper 175-A, p. 26, pl. 8, fig. 13. - Cushman, 1937, Cushman Lab. Foram. Res., Spec. Pub. 9, p. 90, pl. 12, fig. 6.

Bolivina pulchella primitiva Cushman: Puri, H. S., 1953, Florida Geol. Sur., Bull. 36, p. 122, pl. 21, figs. 11, 12.

Discussion: This form is subspecies of the type species of *Sagrina*, *S. pulchella*.

Occurrence: *Ecphora* and *Cancellaria* faunizones.

Genus : SIGMOMORPHINA Cushman and Ozawa, 1928.

Sigmomorphina nevifera Dorsey.

"*Pyrulina albatrossi* Cushman and Ozawa": Cushman, J. A., and Cahill, E. D. (*not P. albatrossi* Cushman and Ozawa, 1930), 1933, United States Geol. Sur., Prof. Paper 175-A, p. 18, pl. 6, fig. 5.

Sigmomorphina nevifera Dorsey, A., 1948, Maryland Dept. Mines, Geol., Water Resources, Bull. 2, p. 298, pl. 34, figs. 6, 7. - McLean,

J. D., 1956, Bull. American Paleontol., vol. 36, no. 160, p. 336, pl. 41, figs. 3-5, 11.

Occurrence: *Ecphora* and *Cancellaria* faunizones.

Genus : SPIHOGENERINA Schlumberger, 1882.

Siphogenerina lamellata Cushman.

Pl. 4, figs. 13, 14.

Siphogenerina lamellata Cushman, J. A., 1918, United States Geol. Sur., Bull. 676, p. 55, pl. 12, fig. 3. - Cushman, 1930, Florida Geol. Sur., Bull. 4, p. 49, pl. 9, fig. 10. - Cushman and Cahill, E. D., 1933, United States Geol. Sur., Prof. Paper 175-A, p. 28, pl. 9, fig. 4. - Dorsey, A., 1948, Maryland Dept. Mines, Geol., Water Resources, Bull. 2, p. 309, pl. 36, fig. 13. - Puri, H. S., 1953, Florida Geol. Sur., Bull. 36, p. 125, pl. 16, fig. 8.

Occurrence: *Arca* faunizone.

Genus : SIPHONINA Reuss, 1850.

Siphonina sp.

Discussion: A single broken specimen of *Siphonina* is insufficiently diagnostic for specific identification. The test is equally biconvex, with 5 chambers in the peripheral whorl. The chambers are low, coarsely punctate, with flush to slightly depressed limbate sutures. The periphery is entire, acute, with a narrow keel. The aperture is elliptical, at the end of a short tube which projects from the apertural face of the final chamber.

Occurrence: *Arca* faunizone.

Genus : SPIROLOCULINA d'Orbigny, 1826.

Spiroloculina depressa d'Orbigny.

Pl. 1, figs. 11, 12.

Spiroloculina depressa d'Orbigny, A., 1826, Ann. Sci. Natur., Ser. 1, vol. 7, p. 298, no. 92. - Cushman, J. A., and Todd, R., 1944, Cushman Lab. Foram. Res., Spec. Pub. 11, p. 28, pl. 1, figs. 1, 6; pl. 5, figs. 1-9. - Bandy, O. L., 1956, United States Geol. Sur., Prof. Paper 274-G, p. 197, pl. 29, fig. 2.

Discussion: This species was originally described from the Pliocene of Italy. In their monograph on the genus *Spiroloculina*, Cushman and Todd (1944) included in this species only European forms. However, the present specimens are comparable to the topotypic specimens upon which Cushman and Todd based their interpretation of the species.

Occurrence: *Ecphora* faunizone.

Genus : SPIROPLECTAMMINA Cushman, 1927.

Spiroplectammina sp.

Discussion: A single specimen of *Spiroplectammina* is insufficiently diagnostic to allow specific identification. The test is finely agglutinated, smooth, elongate, about 2-1/2 times longer than wide. The first few chambers are arranged in a tight planispiral coil, with later chambers added biserially. There are 8 pairs of moderately inflated chambers in the biserial part of the test. The sutures are straight, oblique, and somewhat depressed. The periphery is slightly lobate, rounded. The aperture is a broad arch at the base of the apertural face of the final chamber.

Occurrence: *Ecphora* faunizone.

Genus : STAINFORTHIA Hofker, 1956.

Stainforthia sp.

Pl. 5, fig. 14.

Discussion: A single specimen of *Stainforthia* is not sufficiently diagnostic for specific identification. The test is fusiform, elongate, with greatest width above the middle of the test. The first few chambers are small, arranged triserially, later becoming elongate, inflated, and added in a biserial arrangement. The sutures are limbate, depressed. There is a stout spine at the base of the test. The aperture is a high wide arch, filling most of the apertural face of the final chamber.

Occurrence: *Ecphora* faunizone.

Genus : TEXTULARIA Defrance, 1824.

Textularia agglutinans d'Orbigny.

Pl. 1, figs. 9, 10.

Textularia agglutinans d'Orbigny, A. (*in* de la Sagra), 1839, *Histoire physique, politique, et naturelle de l'Ile de Cuba, Foraminiferes*, Paris, p. 136, pl. 1, figs. 17, 18, 32-34. - Cushman, J. A., 1930, Florida Geol. Sur., Bull. 4, p. 16, pl. 1, fig. 4. - Cushman and Ponton, G. M., 1932, Florida Geol. Sur., Bull. 9, p. 39. - Cushman and Cahill, E. D., 1933, United States Geol. Sur., Prof. Paper 175-A, p. 7, pl. 1, fig. 8. - Puri, H. S., 1953, Florida Geol. Sur., Bull. 36, p. 79, pl. 14, figs. 9, 10.

Occurrence: *Arca*, *Ecphora*, and *Cancellaria* faunizones.

Textularia articulata d'Orbigny.

Pl. 1, figs. 1, 2.

Textularia articulata d'Orbigny, A., 1846, *Foraminiferes fossiles du bassin tertiare de Vienne*, Paris, p. 250, pl. 15, figs. 16-18. - Cushman, J. A., 1918, United States Geol. Sur., Bull. 676, p. 46. - Cushman and Ponton, G. M., 1932, Florida Geol. Sur., Bull. 9, p. 46. - Cushman and Cahill, E. D., 1933, United States Geol. Sur., Prof. Paper 175-A, p. 8, pl. 1, fig. 12. - Puri, H. S., 1953, Florida Geol. Sur., Bull. 36, p. 80.

Discussion: Although the illustration does not adequately show a peripheral keel, a weak keel is present on all specimens.

Topotypic specimens in the U. S. Museum of Natural History do not possess the strong keel shown in the type illustration.

Occurrence: *Arca* and *Ecphora* faunizones.

Textularia candeiana d'Orbigny.

Pl. 1, figs. 3, 4.

Textularia candeiana d'Orbigny, A. (*in* de la Sagra), 1839, *Histoire physique, politique, et naturelle de l'Ile de Cuba, Foraminiferes*, Paris, p. 143, pl. 1, figs. 25-27. - Cushman, J. A., and Ponton, G. M., 1932, Florida Geol. Sur., Bull. 9, p. 41, pl. 8, fig. 4. - Puri, H. S., 1953, Florida Geol. Sur., Bull. 36, p. 80, pl. 30, figs. 9, 10.

Occurrence: *Ecphora* and *Cancellaria* faunizones.

Textularia cf. *T. foliacea occidentalis* Cushman.

Pl. 1, figs. 5, 6.

Discussion: Several broken specimens of *Textularia* appear to be comparable to *T. foliacea* var. *occidentalis* Cushman (1922a, p. 16, pl. 2, fig. 13), which has been reported from Choctawhatchee deposits by Cushman and Ponton (1932). The present specimens have compressed tests with subquadrate to truncate, somewhat serrate peripheries, and coarsely agglutinated, rough walls. The chambers are low, with straight, oblique, depressed to flush sutures.

Occurrence: *Ecphora* and *Cancellaria* faunizones.

Textularia mayori Cushman.

Pl. 1, figs. 7, 8.

"*Textularia gramen* d'Orbigny": Cushman, J. A. (*not T. gramen* d'Orbigny, 1846), 1918, United States Geol. Sur., Bull. 676, p. 45, pl. 9, figs. 4, 5.

Textularia mayori Cushman, J. A., 1922, Carnegie Inst. Washington, Bull. 311, p. 23, pl. 2, fig. 3. - Cushman, 1930, Florida Geol. Sur., Bull. 4, p. 17, pl. 1, figs. 6, 8. - Cushman and Ponton, G. M., 1932, Florida Geol. Sur., Bull. 9, p. 40, pl. 1, figs. 2, 3. - Cushman and Cahill, E. D., 1933, United States Geol. Sur., Prof. Paper 175-A, p. 7, pl. 1, fig. 10. - Dorsey, A., 1948, Maryland Dept. Mines, Geol., Water Resources, Bull. 2, p. 278, pl. 28, fig. 5. - Puri, H. S., 1953, Florida Geol. Sur., Bull. 36, p. 82, pl. 20, figs. 7, 8.

Discussion: *T. mayori* is the most abundant species of *Textularia* in the Choctawhatchee deposits. This species is reported to be restricted to depths shallower than 100 meters in the Gulf of Mexico.

Occurrence: All four faunizones.

Textularia sp.

Discussion: Two worn, aberrant specimens of *Textularia* are insufficiently diagnostic for specific identification. The tests of both specimens are elongate and compressed, with acute, lobate peripheries and coarsely agglutinated walls. The chambers are low, with curved, depressed sutures. The aperture of each is a low arch at the base of the apertural face of the final chamber.

Occurrence: *Ecphora* faunizone.

Genus : TRIFARINA Cushman, 1923.

Trifarina occidentalis (Cushman), new combination.

Pl. 5, fig. 2.

"*Uvigerina angulosa* Williamson": Cushman, J. A. (*not U. angulosa* Williamson, 1858), 1922, Carnegie Inst. Washington, Bull. 311, p. 34, pl. 5, figs. 3, 4.

Uvigerina occidentalis Cushman, J. A., 1923, United States Nat. Mus., Bull. 104, pt. 4, p. 169.

Angulogerina occidentalis (Cushman): Cushman, J. A., 1930, Florida Geol. Sur., Bull. 4, p. 50, pl. 9, figs. 8, 9. - Cushman and Ponton, G. M., 1932, Florida Geol. Sur., Bull. 9, p. 86. - Cushman and Cahill, E. D., 1933, United States Geol. Sur., Prof. Paper 175-A, p. 28, pl. 9, fig. 8. - Puri, H. S., 1953, Florida Geol. Sur., Bull. 36, p. 125, pl. 22, figs. 7, 8. - McLean, J. D., Bull. American Paleontol., vol. 36, no. 160, p. 350, pl. 46, fig. 5.

Discussion: *Trifarina* Cushman (1923) has precedence over *Angulogerina* Cushman (1927). Therefore, this species is included in *Trifarina*.

Occurrence: *Arca*, *Ecphora*, and *Cancellaria* faunizones.

Genus : TRILOCULINA d'Orbigny, 1826.

Triloculina rotunda Schlumberger.

Pl. 1, figs. 16, 17.

Triloculina rotunda d'Orbigny, A., 1826, Ann. Sci. Natur., Ser. 1, vol. 7, p. 299, no. 4 (*nomen nudem*). - Schlumberger, C., 1893, Soc. Zool. France, Mem., vol. 6, p. 206, p. 64, pl. 1, figs. 48-50; text-figs. 11, 12. - Cushman, J. A., 1929, United States Nat. Mus., Bull. 104, pt. 6, p. 59, pl. 14, fig. 3. - Cushman and Ponton, G. M., 1932, Florida Geol. Sur., Bull. 9, p. 54, pl. 6, fig. 10. - Puri, H. S., 1953, Florida Geol. Sur., Bull. 36, p. 93, pl. 30, figs. 1-3.

Occurrence: *Ecphora* and *Cancellaria* faunizones.

Genus : UVIGERINA d'Orbigny, 1826.

Uvigerina auberiana d'Orbigny.

Pl. 4, fig. 17.

Uvigerina auberiana d'Orbigny, A. (*in* de la Sagra), 1839, *Histoire physique, politique, et naturelle de l'Ile de Cuba, Foraminiferes*, Paris, p. 106, pl. 2, figs. 23, 24. - Cushman, J. A., 1930, Florida Geol. Sur., Bull. 4, p. 49, pl. 9, fig. 7. - Cushman and Ponton, G. M., 1932, Florida Geol. Sur., Bull. 9, p. 86. - Cushman and Cahill, E. D., United States Geol. Sur., Prof. Paper 175-A, p. 27, pl. 9, fig. 3. - Cushman and Todd, R., 1941, Cushman Lab. Foram. Res., Contrib., vol. 17, pt. 2, p. 44, pl. 13, figs. 4, 5. - Dorsey, A., 1948, Maryland Dept. Mines, Geol., Water Resources, Bull. 2, p. 307, pl. 36, fig. 23. - Puri, H. S., 1953, Florida Geol. Sur., Bull. 36, p. 124, pl. 27, fig. 8.

Discussion: Some previous authors have considered this species to be indicative of bathyal or abyssal depths. However, *U. auberiana* was originally described from the beach sands of Cuba, Jamaica, and Martinique.

Occurrence: *Arca* and *Ecphora* faunizones.

Uvigerina cf. *U. nuttalli* Cushman and Edwards.

Pl. 4, fig. 15.

Discussion: A single broken specimen of *Uvigerina* has been found in the present material, that closely resembles *U. nuttalli* Cushman and Edwards (1938, p. 82, pl. 14, figs. 3-5). This species was originally described from the Oligocene of Mexico, and has been reported from Lower Oligocene strata throughout the Gulf Coast. The present specimen may be reworked from the nearby Marianna Limestone, from which this species has been reported. Because only a single broken specimen has been found, positive identification of this species, and the resultant extension of the range of the species, is not possible.

Occurrence: *Arca* faunizone.

Uvigerina subperegrina Cushman and Kleinpell.

Pl. 4, fig. 16.

"*Uvigerina* cf. *U. pigmaea* d'Orbigny": Cushman, J. A. (*not U. pigmaea* d'Orbigny, 1846), 1930, Florida Geol. Sur., Bull. 4, p. 49, pl. 9, figs. 3-6.

"*Uvigerina peregrina* Cushman": Cushman, J. A., and Ponton, G. M. (*not U. peregrina* Cushman, 1923), 1932, Florida Geol. Sur., Bull. 9, p. 85. - Puri, H. S., 1953, Florida Geol. Sur., Bull. 36, p. 124.

Uvigerina subperegrina Cushman, J. A., and Kleinpell, R. M., 1934, Cushman Lab. Foram. Res., Contrib., vol. 10, pt. 1, p. 12, pl. 2, figs. 9-11. - Cushman and Todd, R., 1941, Cushman Lab. Foram. Res., Contrib., vol. 17, pt. 2, p. 52, pl. 14, figs. 22, 23. - Dorsey, A., 1948, Maryland Dept. Mines, Geol., Water Resources, Bull. 2, p. 308, pl. 36, fig. 22.

"*Uvigerina peregrina* Cushman, var. *parvula* Cushman": Todd, R., and Bronnimann, P. (*not U. peregrina* Cushman, var. *parvula* Cushman, 1923), 1957, Cushman Found. Foram. Res., Spec. Pub. 3, p. 35, pl. 9, figs. 1, 2.

"*Uvigerina parvula* Cushman": Lankford, R. R. (*not U. peregrina* Cushman, var. *parvula* Cushman, 1923), 1959, American Ass. Petrol. Geol., Bull., vol. 43, no. 9, p. 2099, pl. 3, fig. 12.

Discussion: This species is similar to both *Uvigerina peregrina* and *U. peregrina parvula*, differing in the nature of the costae and the sutures. The costae of *U. peregrina* and *U. peregrina parvula* are thin, high, with jagged edges. The appearance of the costae of these forms suggests that the costae are formed by fusion of closely spaced, acicular spines arranged in longitudinal rows. The early and late chambers of both exhibit the unfused rows of spines. The costae of *U. subperegrina*, however, are comparatively thick, low and smooth, and are generally continuous on early and terminal chambers. Moreover, the sutures of *U. subperegrina* are deeply incised and quite distinct, but those of the other two species are relatively indistinct.

This species has been reported from the Gulf of Mexico in water less than 40 meters deep by Lankford (1959). Todd and Bronnimann (1957) report it from water less than 33 meters deep in the Gulf of Paria.

Occurrence: All four faunizones.

Genus : VALVULINERIA Cushman, 1926.

Valvulineria floridana Cushman.

Pl. 10, figs. 4-6.

Valvulineria floridana Cushman, J. A., 1930, Florida Geol. Sur., Bull. 4, p. 54, pl. 10, fig. 6. - Cushman and Ponton, G. M., 1932, Florida Geol. Sur., Bull. 9, p. 91. - Puri, H. S., 1953, Florida Geol. Sur., Bull. 36, p. 133, pl. 29, figs. 8-10.

Valvulineria washingtoni McLean, J. D., 1956, Bull. American Paleontol., vol. 36, no. 160, p. 354, pl. 47, figs. 3, 4.

Occurrence: All four faunizones.

Valvulineria subrugosa (Cushman), new combination.

Pl. 10, figs. 1-3.

Discorbis subrugosa Cushman, J. A., 1918, United States Geol. Sur., Bull. 676, p. 14, pl. 5, fig. 4. - Cole, W. S., 1931, Florida Geol. Sur., Bull. 5, p. 48, pl. 5, figs. 6, 7.

Discussion: This species fits best within the description of the genus *Valvulineria*.

Occurrence: *Ecphora* faunizone.

Genus : VIRGULINELLA Cushman, 1932.

Virgulinella gunteri (Cushman).

Pl. 5, fig. 10.

"*Virgulina floridana* Cushman": Cushman, J. A., 1929 (*not V. floridana* Cushman, 1920), Cushman Lab. Foram. Res., Contrib., vol. 5, pt. 3, p. 54, pl. 9, figs. 7-10.

Virgulina gunteri Cushman, J. A., 1929, Cushman Lab. Foram. Res., Contrib., vol. 5, pt. 4, p. 105. - Cushman, 1930, Florida Geol. Sur., Bull. 4, p. 44, pl. 9, figs. 1, 2. - Cushman and Ponton, G. M., 1932, Florida Geol. Sur., Bull. 9, p. 80, pl. 12, fig. 7.

Virgulina (Virgulinella) gunteri Cushman: Cushman, J. A., 1932, Cushman Lab. Foram. Res., Contrib., vol. 8, pt. 1, p. 22, pl. 3, fig. 7. - Cushman and Cahill, E. D., 1933, United States Geol. Sur., Prof. Paper 175-A, p. 24, pl. 8, fig. 2. - Cushman, 1937, Cushman Lab. Foram. Res., Spec. Pub. 9, p. 34, pl. 5, figs. 10-13. - Puri, H. S., 1953, Florida Geol. Sur., Bull. 36, p. 119.

Occurrence: *Yoldia* and *Arca* faunizones.

LOCALITIES STUDIED

Yoldia faunizone

Outcrop 1. Cosson Farm, SE 1/4, Sec. 18, T2N, R19W, Walton Co.

About 6 1/2' of gray micaceous clay exposed in a springhead approximately 1/2 mile NW of house.

Sample Y-2: base of outcrop.

Sample Y-3: thin irregular brown clay, less than 2" thick, filled with shell fragments, about 1 1/2' above base.

Sample Y-4: top shell bed, about 4' above base.

Outcrop 2. Chester Spence Farm, NE 1/4, NE 1/4, Sec. 17, T2N, R19W, Walton Co. USGS Loc. 12718. Upper shell bed. Gray micaceous clay.

Sample Y-1.

Arca faunizone

Outcrop 3. Permenter Farm, Sec. 17, T1N, R19W, Walton Co. From road cut on E bank of Alaqua Creek. USGS Loc. 12048. Gray marl, poorly fossiliferous.

Sample A-12.

Outcrop 41. McDaniel Farm, SE 1/4, Sec. 9, T2N, R17W, Walton Co.

About 9' of gray marl exposed in dripping spring.

Sample A-2 (USGS Loc. 25018): 0-2' above base.

Sample A-3 (USGS Loc. 25017): 3-4' above base.

Sample A-4 (USGS Loc. 25016): 4-5.5' above base.

Sample A-5 (USGS Loc. 25015): 5.5-8' above base.

Sample A-6 (USGS Loc. 25014): 8-9' above base.

Outcrop 42. Bell Farm, NE 1/4, NE 1/4, Sec. 29, T2N, R19W, Walton Co. From springhead about 1/4 mile SW of house. Light gray to buff weathered shell marl.

Sample A-10: 5' above base.

Sample A-11: 8 1/2' above base in top shell bed.

Outcrop 45. Blount Creek (Vaughan Creek), Lower Locality. SE 1/4, Sec. 28, T2N, R19W, Walton Co. Gray marl, sparsely fossiliferous.

Sample A-7: From stream bank at water level, about 100 yds. below old ford.

Sample A-8: From stream bank about 2 1/2 feet above waterline, about 100 yds. below old ford.

Sample A-9: From stream bottom at old ford, about 5' above Sample A-7.

Outcrop 64. Will Rushing Farm, Sec. 15, T2N, R17W, Walton Co. USGS Loc. 24708. About 1 mile SE of Red Bay. Gray shell marl. Sample A-1.

Ecphora faunizone

Outcrop 17. Econfina Creek, abt. 100 yds. N of Walsingham Bridge, SE 1/4, Sec. 15, T1N, R13W, Washington Co. From stream bed. Greenish-gray marl.

Sample E-1.

Outcrop 21. Jackson Bluff, NW 1/4, NW 1/4, Sec. 21, T1S, R4W, Leon Co. From drainage ditch in lower brown shell bed.

Sample E-15: Base of lower shell bed at N end of drainage ditch.

Sample E-16: 1' above base of lower shell bed.

Sample E-17: 6' above base of lower shell bed.

Sample E-18: 11' above base of lower shell bed at contact with overlying loose sand.

Sample E-19: From top of lower shell bed at S end of drainage ditch. About 12' above base.

Outcrop 24. Alum Bluff, E 1/2, Sec. 24, T1N, R8W, Liberty Co. Upper shell bed, greenish-gray fossiliferous marl of varying thickness.

Sample E-2: Base of marl, at contact with underlying yellow sand.

Sample E-3: 4' above base of marl.

Sample E-4: 9' above base of marl.

Sample E-5: 14' above base of marl.

Sample E-6: 19' above base of marl, at contact with overlying gray clay.

Outcrop 26. Harvey Creek, "old swimming hole" locality, SE 1/4, Sec. 9, T1S, R3W, Leon Co. Greenish-gray marl.

Sample E-20.

Outcrop 46. Bluff on E bank of Chipola River, about 200 yds. above Darling Slide. NE 1/4, Sec. 17, T1S, R9W, Calhoun Co. Greenish-gray marl.

Sample E-8: Base of outcrop. Shell hash.

Sample E-9: 5' above base.

Sample E-10: 10' above base.

Sample E-11: 15' above base.

Sample E-12: 17' above base, at contact with overlying sandy soil.

Outcrop 48. Dripping spring on Fourmile Creek, NE 1/4, Sec. 36, T1N, R10W, Calhoun Co. 8' section, with basal greenish-gray shell marl grading upward into gray clay.

Sample E-13: Base of marl. Shell hash.

Sample E-14: 2' above base at top of shell marl.

Outcrop 54. Old road cut, NW 1/4, Sec. 30, T1N, R7W, Liberty Co. Thin, hard gray shell marl, poorly exposed.

Sample E-7.

Cancellaria faunizone.

Outcrop 27. Small sinkhole at Gully Pond, NW 1/4, NE 1/4, Sec. 14, T1N, R14W, Washington Co. About 5' of greenish-gray shell marl.

Sample C-8: Base of sinkhole.

Sample C-9: Base of sinkhole in bluish clay layer.

Sample C-10: 5' above base at top of shell marl.

Outcrop 30. Jackson Bluff, NW 1/4, NW 1/4, Sec. 21, T1S, R4W, Leon Co. Poorly exposed light gray shell bed atop river bank.

Sample C-3.

Outcrop 35. Econfina Creek, at site of Gainer's Bridge, SE 1/4, Sec. 33, T1N, R13W, Washington Co. Light gray calcareous shell bed exposed in E bank.

Sample C-12: At waterline.

Sample C-13: 3' above waterline.

Sample C-14: 5' above waterline.

Outcrop 39. Larkin Bluff, SE 1/4, Sec. 30, T1S, R4W, Leon Co. Thin buff fossiliferous sand in E bank, Ochlockonee River.

Sample C-6: Base of fossiliferous sand.

Sample C-7: Top of sand, 2-1/2' above base.

Outcrop 51. Road bed, SE 1/4, Sec. 9, T1S, R13W, Bay Co. Poorly exposed light gray shell bed.

Sample C-14: Base of bed, at contact with underlying yellow sand.

Sample C-15: Top of shell bed, about 3' above base.

Outcrop 52. Hosford (Coe) Mill, NE 1/4, Sec. 12, T1S, R6W, Liberty Co. Gray shell marl.

Sample C-1.

Outcrop 53. Robinson Mill, SW 1/4, Sec. T1S, R6W, Liberty Co.

Gray shell marl.

Sample C-2.

Outcrop 55. Borrow pit, E bank Ochlockonee River, NE 1/4, Sec. 20, T1S, R4W, Leon Co. Gray shell bed, irregular contact with overlying brown clayey sand. Base of bed covered.

Sample C-4: Base of exposure.

Sample C-5: Top of shell bed, about 3' above base.

Outcrop 60. Old road bed, E bank Econfina Creek, NW 1/4, SW 1/4, Sec. 21, T1S, R13W, Bay Co. Poorly exposed buff sandy limestone.

Sample C-16.

Outcrop 61. W. bank Econfina Creek, NE 1/4, SE 1/4, Sec. 20, T1S, R13W, Bay Co. Buff sandy limestone.

Sample C-17: At waterline.

Sample C-18: At top of bed, about 4' above waterline.

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PLATE 1.

Figures 1, 2. *Textularia articulata.*

1. Peripheral view (X55). 2. Side view (X45). Sample E-13.

Figures 3, 4. *Textularia candeiana.*

3. Side view (X52). 4. Peripheral view (X52). Sample E-17.

Figures 5, 6. *Textularia* cf. *T. foliacea occidentalis.*

5. Side view (X52). 6. Peripheral view (X55). Sample E-19.

Figures 7, 8. *Textularia mayori.*

7. Side view (X56). 8. Apertural view (X50). Sample E-19.

Figures 9, 10. *Textularia agglutinans.*

9. Peripheral view (X85). 10. Side view (X81). Sample E-10.

Figures 11, 12. *Spiroloculina depressa.*

11. Side view (X81). 12. Apertural view (X104). Sample E-17.

Figure 13. *Cyclogyra planorbis.*

13. Side view (X135). Sample E-17.

Figures 14, 15. *Pyrgo subsphaerica.*

14. Side view (X64). 15. Apertural view (X62). Sample E-17.

Figures 16, 17. *Triloculina rotunda.*

16. Side view (X61). 17. Apertural view (X78). Sample E-17.

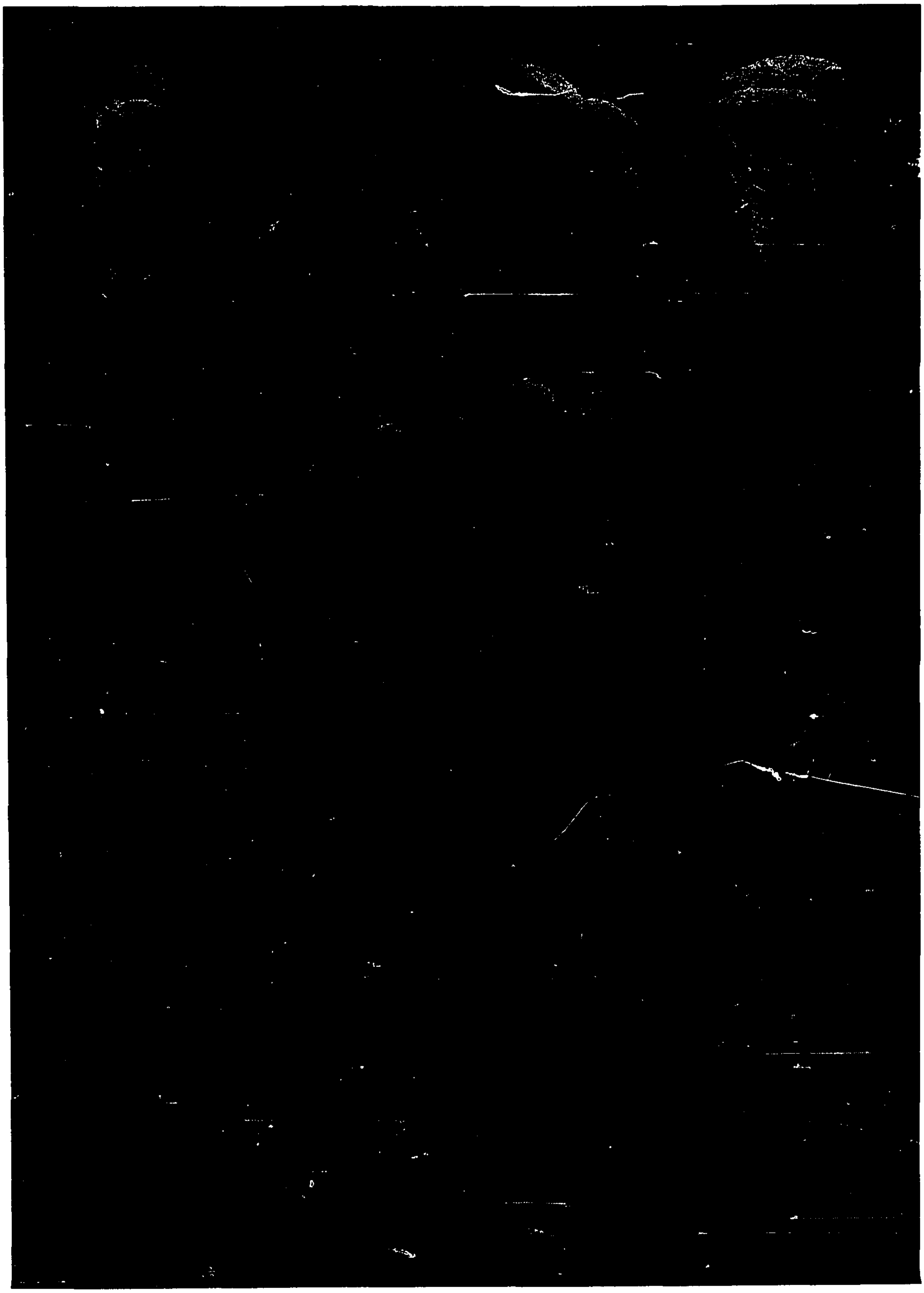

PLATE 2.

Figures 1, 2. *Quinqueloculina agglutinans.*

1. Side view (X105). 2. Apertural view (X108). Sample C-8.

Figures 3, 4. *Quinqueloculina triloculiniforma.*

3. Side view (X95). 4. Side view (X100). Sample E-16.

Figures 5, 6. *Quinqueloculina lamarckiana.*

5. Apertural view (X90). 6. Side view (X74). Sample E-17.

Figures 7, 8. *Quinqueloculina* cf. *Q. polygona.*

7. Apertural view (X130). 8. Side view (X65). Sample E-17.

Figures 9, 10. *Globulina inaequalis.*

9. Apertural view (X94). 10. Side view (X94). Sample E-19.

Figures 11, 12. *Globulina gibba.*

11. Side view (X62). 12. Apertural view (X62). Sample C-18.

Figures 13, 14. *Pseudopolymorphina rutila.*

13. Apertural view (X100). 14. Side view (X38). Sample E-1.

Figures 15, 16. *Guttulina rectiornata.*

15. Side view (X55). 16. Apertural view (X97). Sample E-1.

Figure 17. *Guttulina elegans.*

17. Side view (X100). Sample C-3.

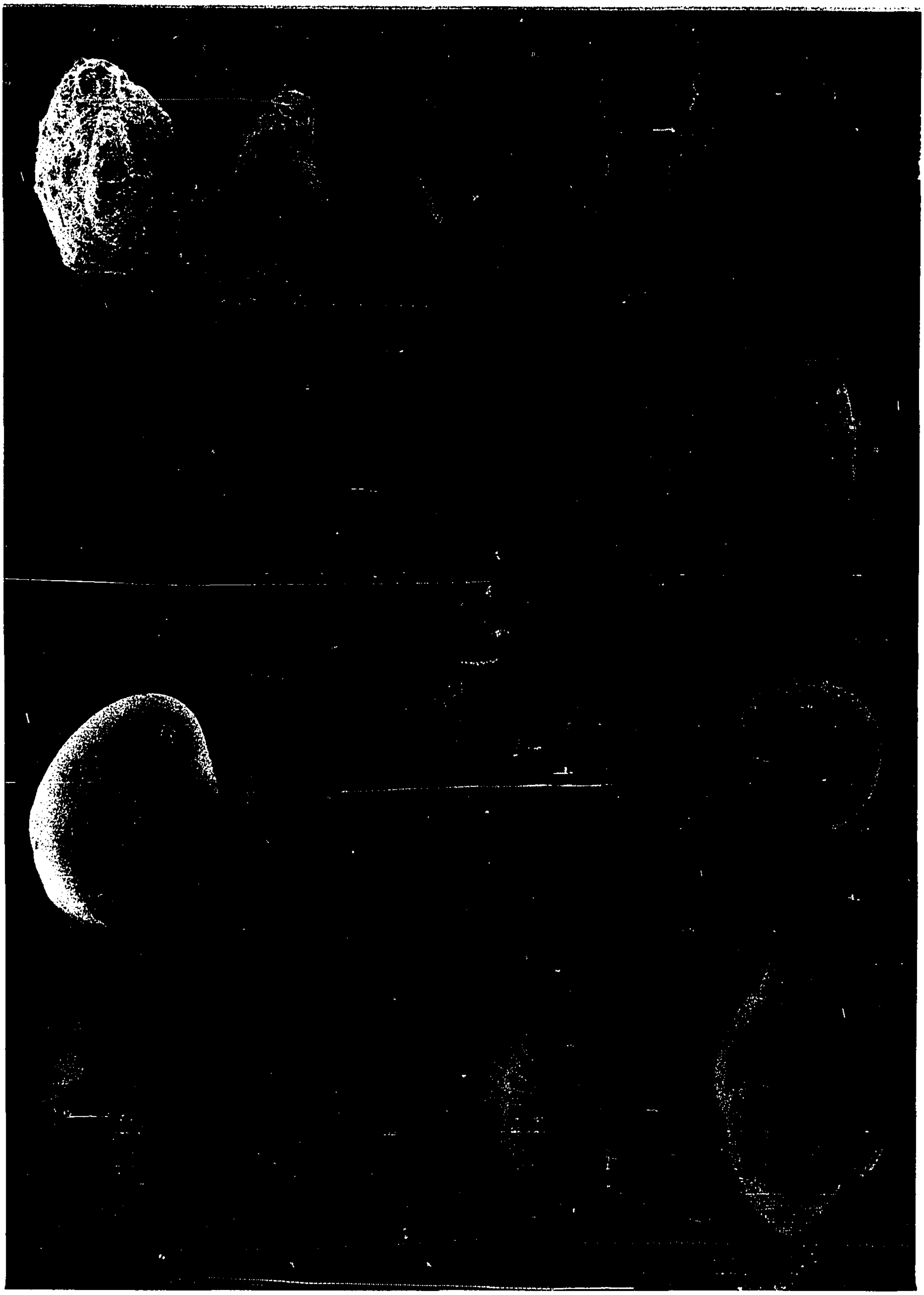

PLATE 3.

Figures 1, 2. *Lenticulina americana.*

1. Apertural view (X58). 2. Side view (X58). Sample A-7.

Figure 3. *Lenticulina* cf. *L. occidentalis.*

3. Side view (X125). Sample A-12.

Figure 4. *Lenticulina* cf. *L. vaughani.*

4. Side view (X79). Sample E-1.

Figure 5. *Marginulina* sp.

5. Side view (X170). Sample E-8.

Figure 6. *Marginulinopsis* sp.

6. Side view (X52). Sample E-1.

Figures 7, 8. *Dentalina* sp.

7. Side view (X110). 8. Apertural view (X262). Sample E-16.

Figure 9. *Dentalina communis.*

9. Side view (X35). Sample A-2.

Figure 10. *Nodosaria catesbyi.*

10. Side view (X88). Sample E-16.

Figure 11. *Lagena intermedia.*

11. Side view (X125). Sample C-3.

Figure 12. *Lagena substriata.*

12. Side view (X141). Sample E-4.

PLATE 3 (continued).

Figure 13. *Lagena laevis*.

13. Side view (X140). Sample E-3.

Figure 14. *Lagena palmerae*.

14. Side view (X100). Sample E-1.

Figure 15. *Lagena flexa*.

15. Side view (X65). Sample E-15.

Figure 16. *Oolina melo*.

16. Side view (X250). Sample E-20.

Figures 17, 18. *Parafissurina* sp.

17. Side view (X135). 18. Peripheral view (X180). Sample E-1.

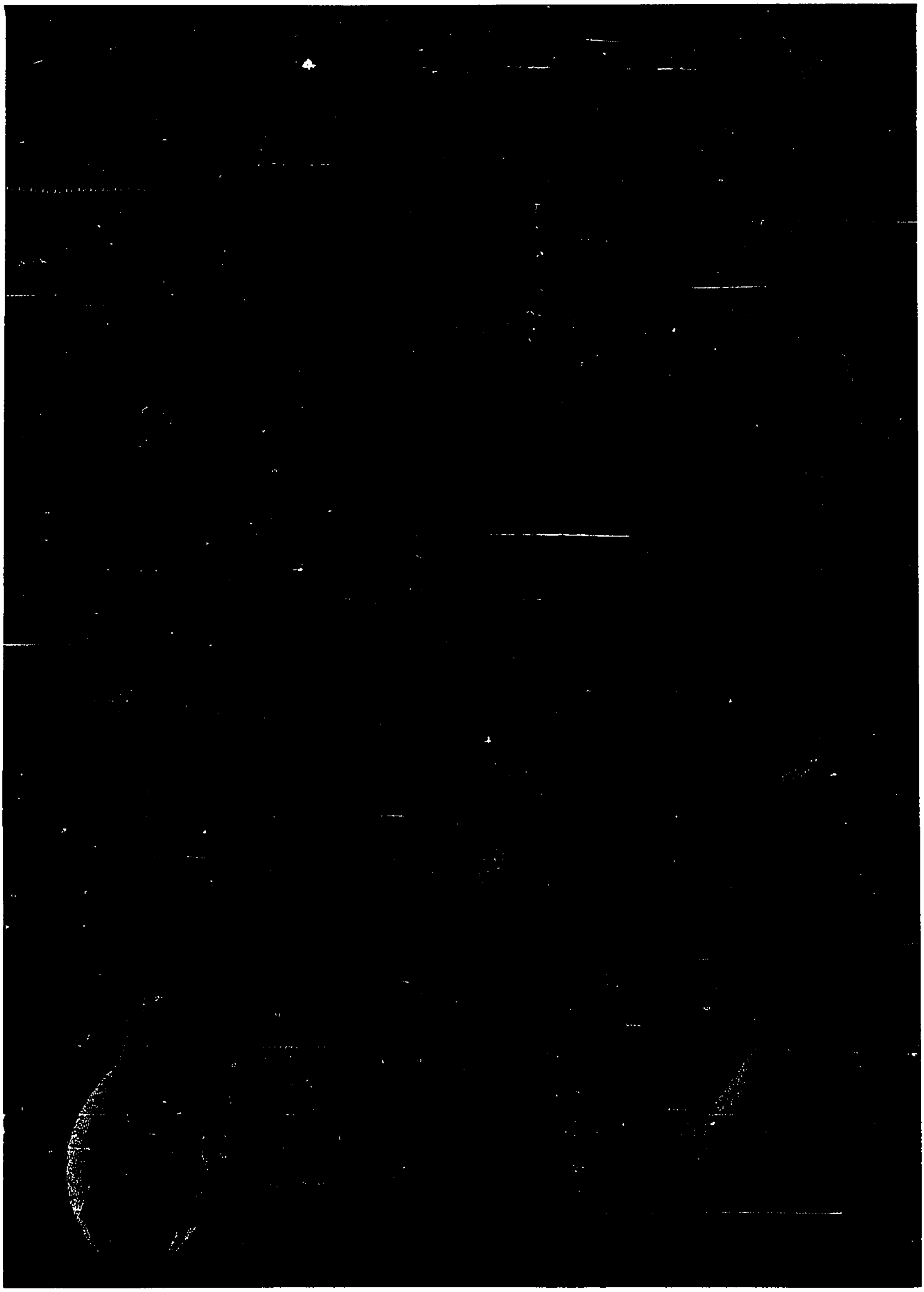

PLATE 4.

Figures 1, 2. *Fissurina agassizi.*

1. Side view (X156). 2. Apertural view (X156). Sample A-11.

Figures 3, 4. *Fissurina angulata.*

3. Side view (X147). 4. Apertural view (X181). Sample E-16.

Figures 5, 6. *Fissurina flintii.*

5. Side view (X250). 6. Apertural view (X256). Sample E-20.

Figure 7. *Fissurina marginata.*

7. Side view (X340). Sample E-4.

Figure 8. *Fissurina* cf. *F. laevigata.*

8. Side view (X134). Sample C-9.

Figures 9, 10. *Plectofrondicularia floridana.*

9. Side view (X50). 10. Peripheral view (X50). Sample A-8.

Figure 11. *Sagrina pulchella primitiva.*

11. Side view (X150). Sample C-14.

Figure 12. *Rectobolivina advena.*

12. Side view (X100). Sample C-14.

Figures 13, 14. *Siphogenerina lamellata.*

13. Side view (X31). 14. Apertural view (X112). Sample A-9.

Figure 15. *Uvigerina* cf. *U. nuttalli.*

15. Side view (X62). Sample A-9.

PLATE 4 (continued).

Figure 16. *Uvigerina subperegrina.*

16. Side view (X100). Sample A-9.

Figure 17. *Uvigerina auberiana.*

17. Side view (X125). Sample C-6.

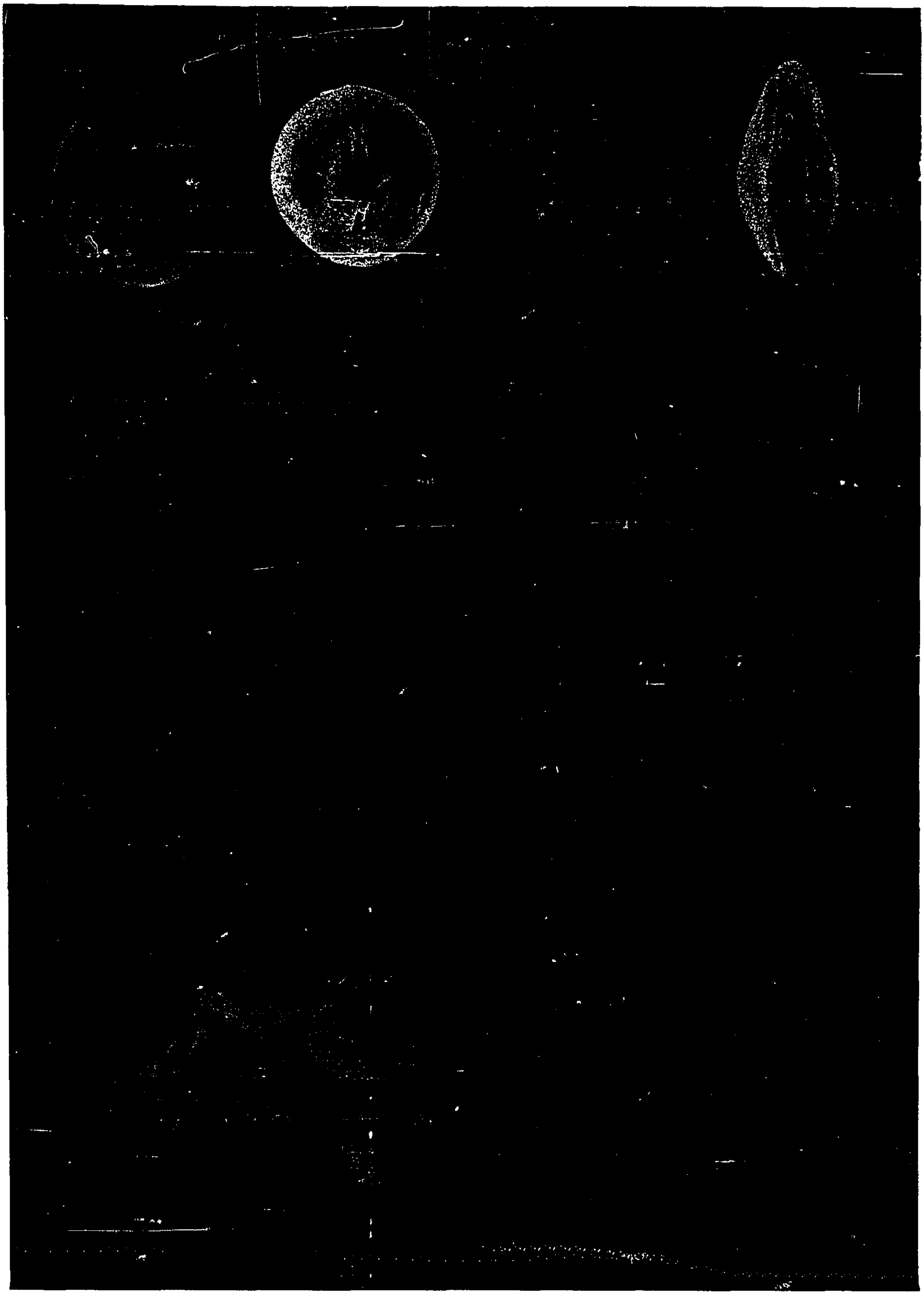

PLATE 5.

Figure 1. *Hopkinsina bononiensis.*

1. Side view (X72). Sample E-2.

Figure 2. *Trifarina occidentalis.*

2. Side view (X156). Sample C-8.

Figure 3. *Caucasina preacanthia.*

3. Side view (X119). Sample E-20.

Figure 4. *Caucasina elongata.*

4. Side view (X150). Sample A-5.

Figure 5. *Bulimina delreyensis.*

5. Side view (X97). Sample Y-3.

Figure 6. *Bulimina* cf. *B. alsatica.*

6. Side view (X62). Sample A-9.

Figure 7. *Bulimina marginata.*

7. Side view (X169). Sample E-2.

Figure 8. *Buliminella subfusiformis.*

8. Side view (X150). Sample A-8.

Figure 9. *Buliminella elegantissima.*

9. Side view (X116). Sample E-10.

Figure 10. *Virgulinella gunteri.*

10. Side view (X62). Sample A-11.

PLATE 5 (continued).

Figure 11. *Fursenkoina punctata*.

11. Side view (X106). Sample E-1.

Figures 12, 13. *Fursenkoina fusiformis*.

12. Side view, exhibiting mature final chamber (X138). Sample E-1.
13. Side view, with final chamber removed, exhibiting immature aperture (X185). Sample E-3.

Figure 14. *Stainforthia* sp.

14. Side view (X125). Sample E-17.

Figures 15-18. *Bolivina bulbosa*.

15. Apertural view of Holotype (X325). 16. Side view of Holotype (X128). 17. Side view of Paratype (X185). 18. Apertural view of Paratype (X375). Sample E-4.

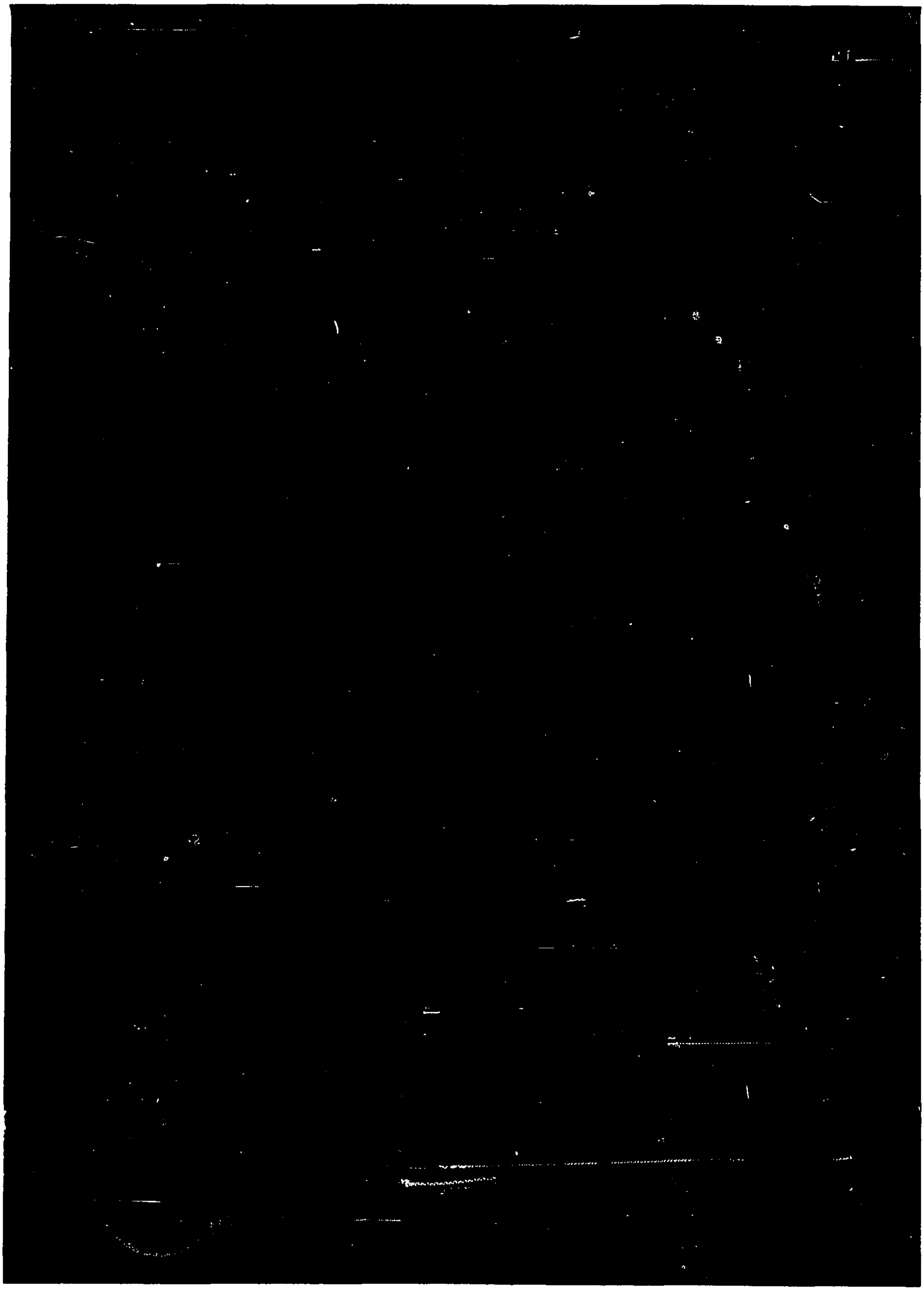

PLATE 6.

Figure 1. *Bolivina marginata.*

1. Side view (X66). Sample Y-2.

Figure 2. *Bolivina ornata.*

2. Side view (X112). Sample A-8.

Figure 3. *Bolivina advena.*

3. Side view (X150). Sample E-3.

Figure 4. *Bolivina plicatella.*

4. Side view (X156). Sample E-2.

Figure 5. *Bolivina californica.*

5. Side view (X78). Sample A-2.

Figure 6. *Bolivina floridana.*

6. Side view (X69). Sample A-8.

Figure 7. *Bolivina paula.*

7. Side view (X106). Sample E-1.

Figures 8-10. *Chrysalidinella miocenica.*

8. Peripheral view (X120). 9. Apertural view (X104).

10. Side view (X110). Sample E-4.

Figures 11-13. *Reussella miocenica.*

11. Peripheral view (X100). 12. Apertural view (X106).

13. Side view (X100). Sample E-1.

PLATE 6 (continued).

Figures 14-16. *Reussella glabrata*.

14. Peripheral view (X119). 15. Apertural view (X119).

16. Side view (X119). Sample A-2.

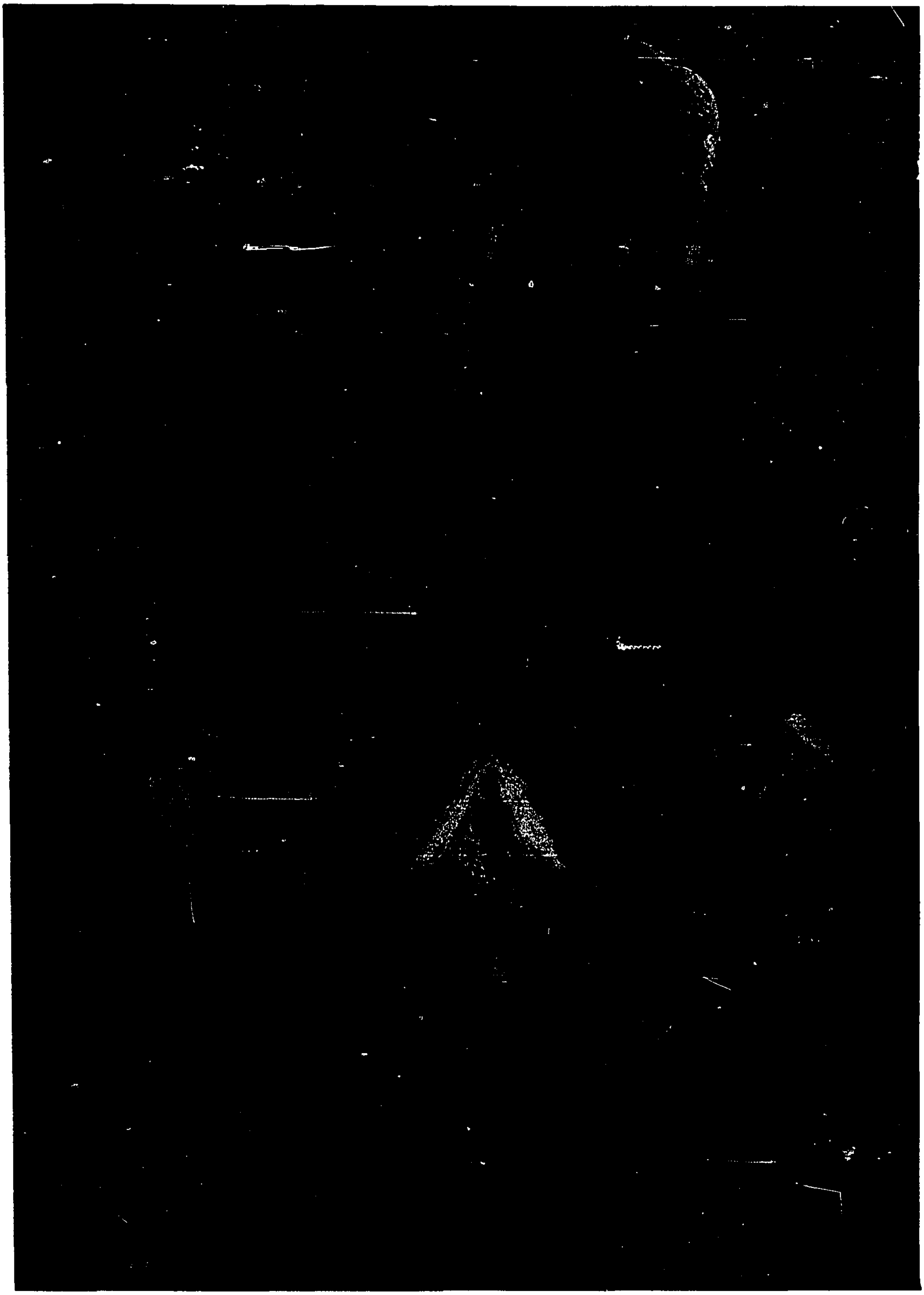

PLATE 7.

Figures 1, 2. *Cassidulinoides compacta.*

1. Side view (X131). 2. Apertural view (X144). Sample E-2.

Figures 3, 4. *Globocassidulina crassa.*

3. Side view (X225). 4. Peripheral view (X225). Sample E-13.

Figures 5, 6. *Cassidulina caribeana.*

5. Peripheral view (X115). 6. Side view (X120). Sample A-8.

Figures 7-9. *Pseudoparella pontoni.*

7. Ventral view (X125). 8. Peripheral view (X125).

9. Dorsal view (X135). Sample A-8.

Figures 10, 11. *Nonion* cf. *N. cassidulinoides.*

10. Side view (X135). 11. Peripheral view (X135). Sample E-2.

Figures 12-14. *Nonionella pulchella.*

12. Ventral view (X58). 13. Peripheral view (X68).

14. Dorsal view (X68). Sample E-16.

Figures 15-17. *Nonionella miocenica.*

15. Ventral view (X100). 16. Peripheral view (X100).

17. Dorsal view (X100). Sample A-10.

Figures 18, 19. *Astrononion stelligerum.*

18. Side view (X128). 19. Peripheral view (X131). Sample C-4.

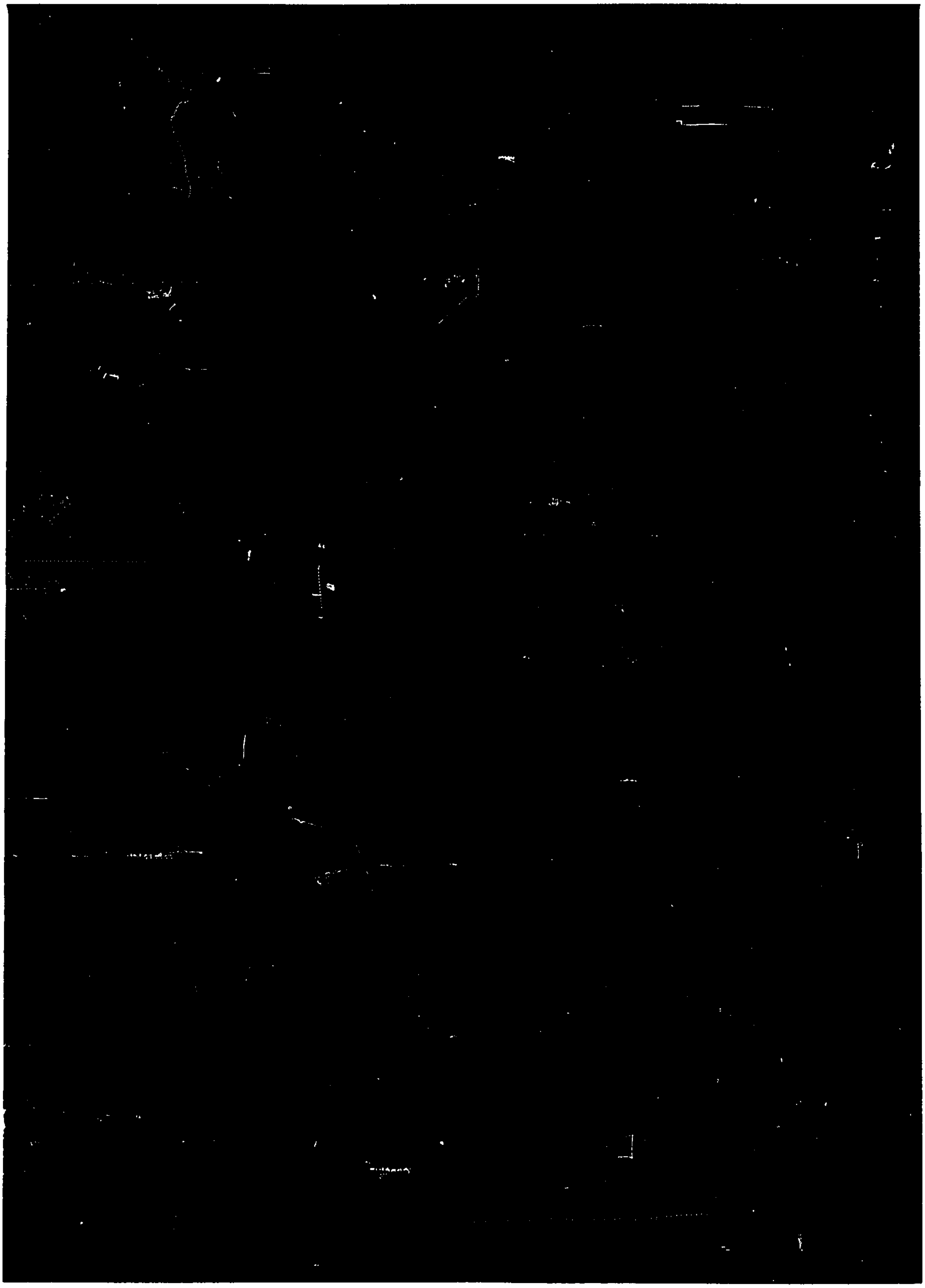

PLATE 8.

Figures 1-3. *Florilus pizarrensis.*

1. Dorsal view (X68). 2. Peripheral view (X68).

3. Ventral view (X64). Sample A-10.

Figures 4-6. *Florilus grateloupi.*

4. Ventral view (X64). 5. Peripheral view (X62).

6. Dorsal view (X62). Sample C-4.

Figures 7, 8. *Elphidium sagrum.*

7. Peripheral view (X60). 8. Side view (X65). Sample A-10.

Figures 9, 10. *Elphidium hughesi.*

9. Side view (X110). 10. Peripheral view (X110). Sample E-4.

Figures 11, 12. *Elphidium fimbriatulum.*

11. Side view (X105). 12. Peripheral view (X105). Sample E-1.

Figures 13, 14. *Alliatina glabrella.*

13. Dorsal view (X100). 14. Peripheral view (X100). Sample C-3.

Figures 15, 16. *Discorbis bassleri.*

15. Ventral view (X288). 16. Peripheral view (X288). Sample E-15.

Figures 17, 18. *Neoconorbina terquemi.*

17. Oblique peripheral view (X138). 18. Ventral view (X144).

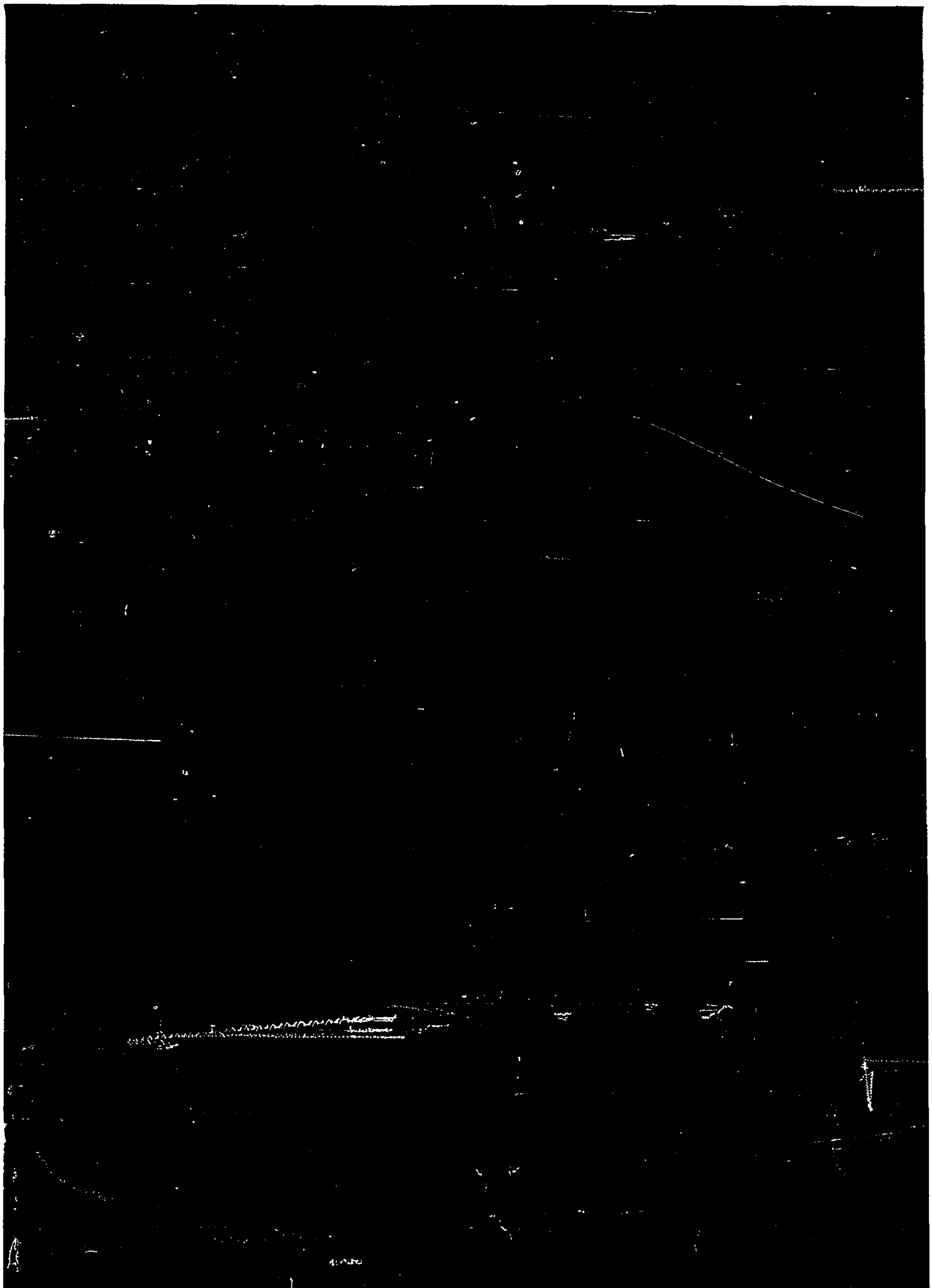

PLATE 9.

Figures 1-3. *Patellina corrugata.*

1. Ventral view (X131). 2. Dorsal view (X131).

3. Oblique peripheral view (X131). Sample C-8.

Figures 4-6. *Rosalina williamsoni.*

4. Peripheral view (X125). 5. Ventral view (X122).

6. Dorsal view (X125). Sample E-10.

Figures 7-9. *Rosalina globularis.*

7. Ventral view (X125). 8. Peripheral view (X115).

9. Dorsal view (X131). Sample E-2.

Figures 10-12. *Rosalina candeiana.*

10. Ventral view (X112). 11. Peripheral view (X112).

12. Dorsal view (X112). Sample C-4.

Figures 13-15. *Rosalina subaraucana.*

13. Ventral view (X106). 14. Peripheral view (X110).

15. Dorsal view (X106). Sample C-1.

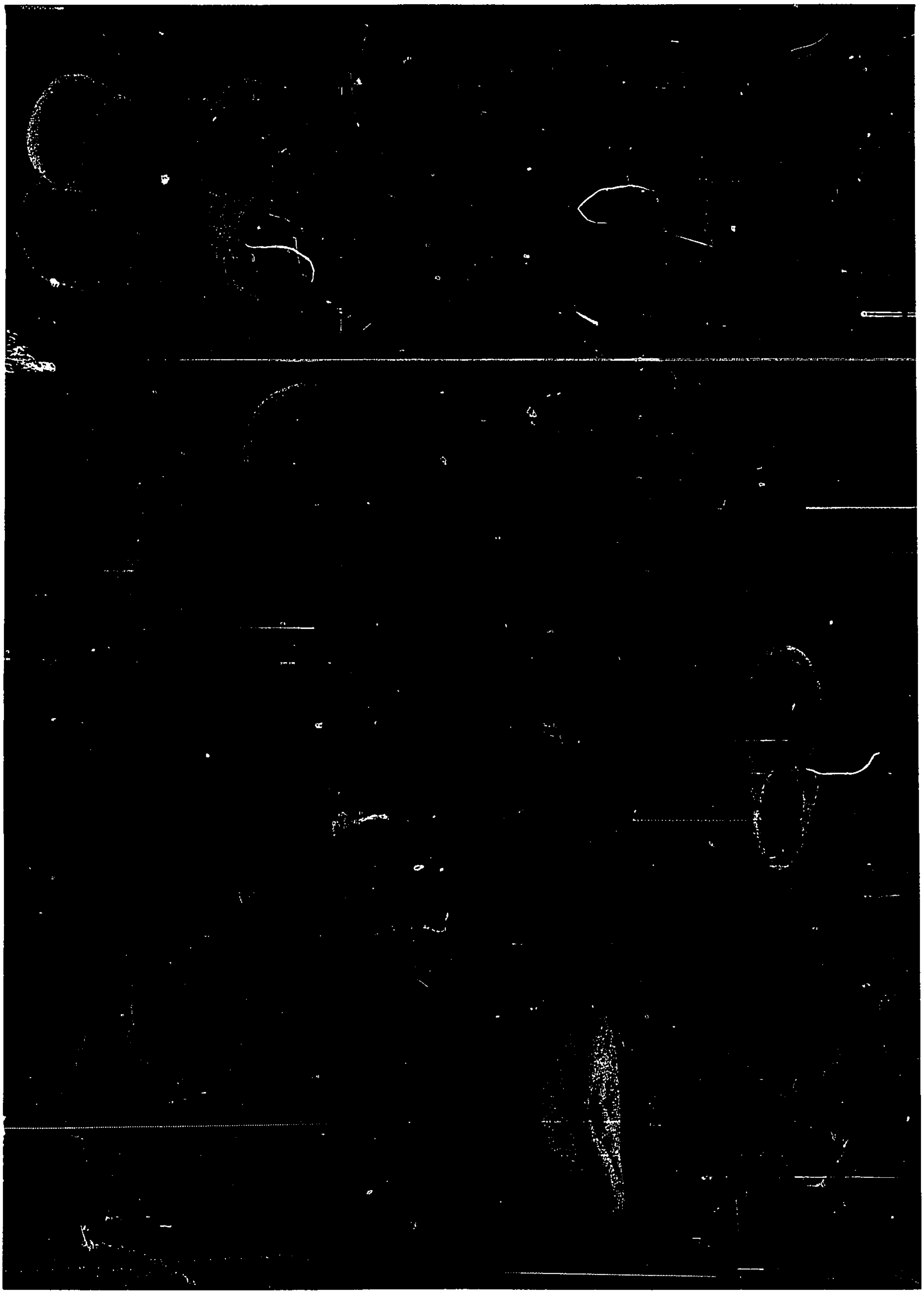

PLATE 10.

Figures 1-3. *Valvulineria subrugosa*.

1. Dorsal view (X125). 2. Ventral view (X115).

3. Peripheral view (X132). Sample E-16.

Figures 4-6. *Valvulineria floridana*.

4. Peripheral view (X48). 5. Dorsal view (X60).

6. Ventral view (X60). Sample A-9.

Figures 7-9. *Cancris communis*.

7. Dorsal view (X60). 8. Ventral view (basal flap of final chamber broken) (X56). 9. Peripheral view (X60). Sample E-1.

Figures 10-12. *Cancris planus*.

10. Peripheral view (X81). 11. Dorsal view (X62).

12. Ventral view (X81). Sample A-10.

Figures 13-15. *Anomalinoides riveroae*.

13. Ventral view (X100). 14. Dorsal view (X100).

15. Peripheral view (X106). Sample C-4.

Figures 16-18. *Planispirillina orbicularis*.

16. Peripheral view (X131). 17. Dorsal view (X131).

18. Ventral view (X131). Sample E-17.

Figures 19-21. *Buccella mansfieldi*.

19. Dorsal view (X115). 20. Peripheral view (X115).

21. Ventral view (X115). Sample E-12.

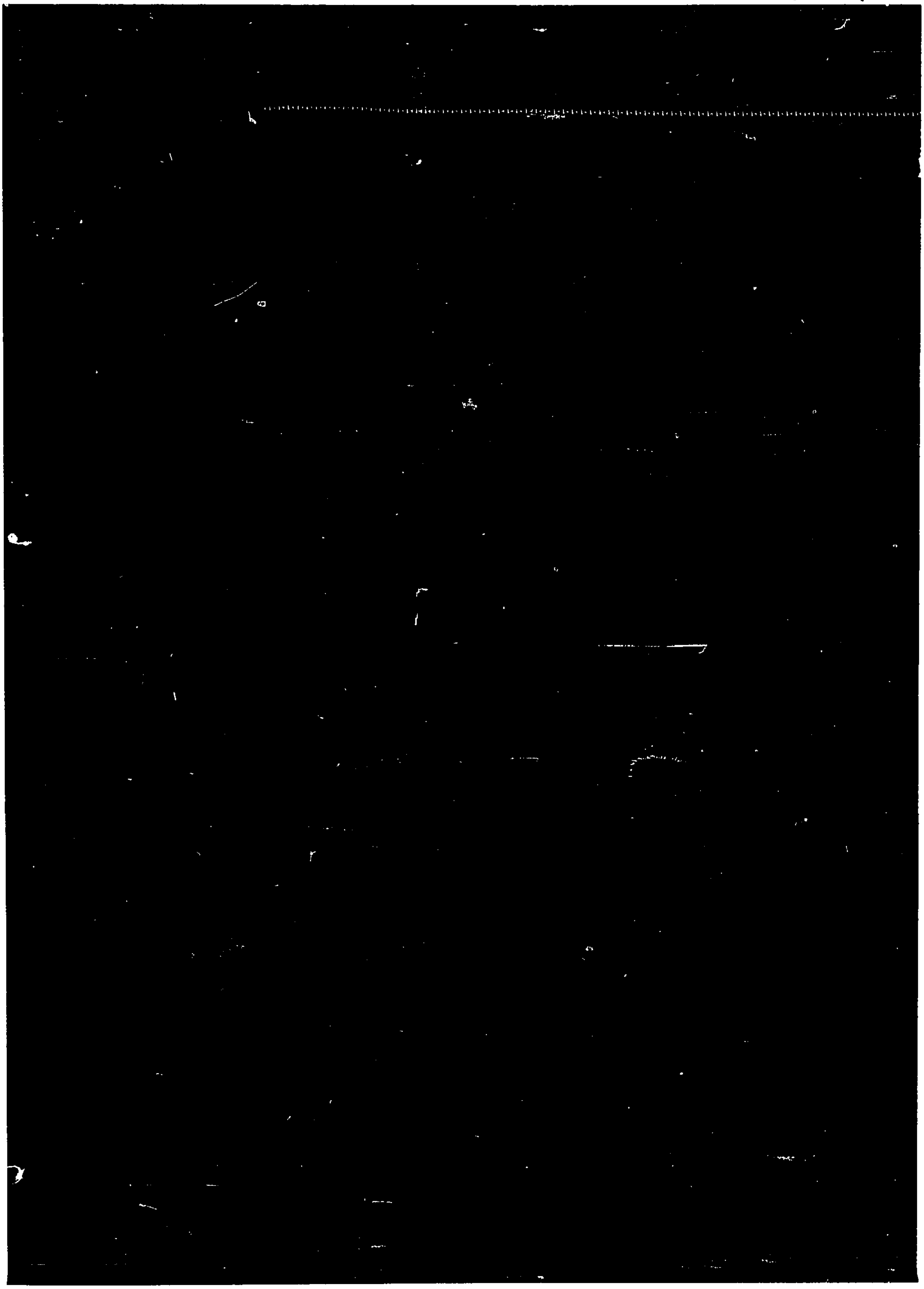

PLATE 11.

Figures 1-3. *Hanzawaia americana.*

1. Ventral view (X68). 2. Peripheral view (X68).

3. Dorsal view (X68). Sample E-1.

Figures 4-6. *Eponides repandus.*

4. Ventral view (X60). 5. Peripheral view (X60).

6. Dorsal view (X61). Sample E-17.

Figures 7-9. *Ammonia beccarii.*

7. Ventral view (X145). 8. Peripheral view (X155).

9. Dorsal view (X140). Sample C-2.

Figures 10-12. *Amphistegina gibbosa.*

10. Ventral view (X70). 11. Peripheral view (X78).

12. Dorsal view (X65). Sample E-1.

Figures 13-15. *Gyroidinoides nipponica.*

13. Ventral view (X131). 14. Peripheral view (X131).

15. Dorsal view (X131). Sample E-2.

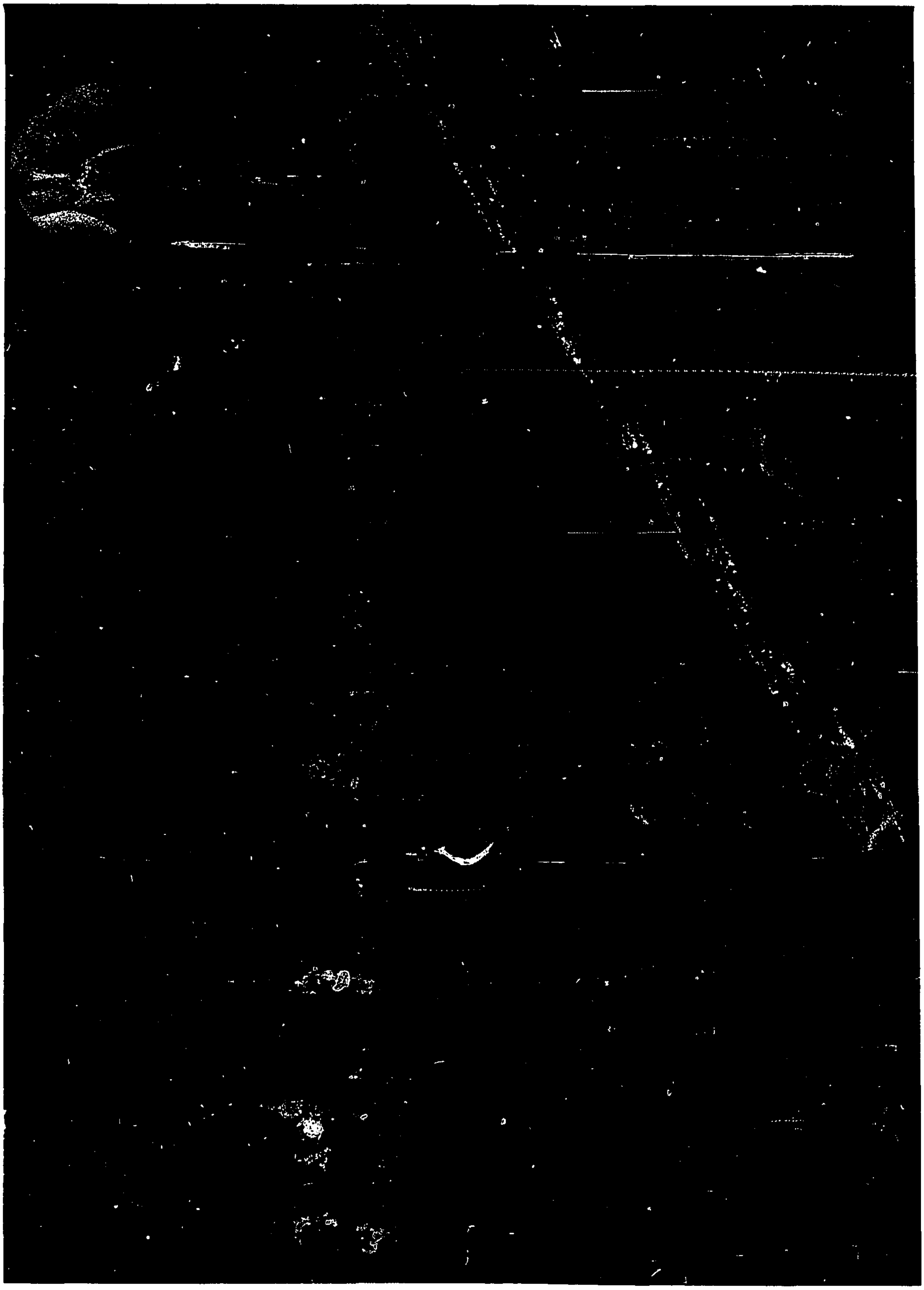

PLATE 12.

Figures 1-3. *Cibicides floridanus.*

1. Dorsal view (X100). 2. Peripheral view (X100).

3. Ventral view (X94). Sample E-16.

Figures 4-6. *Cibicides lobatulus.*

4. Dorsal view (X45). 5. Peripheral view (X45).

6. Ventral view (X45). Sample E-19.

Figures 7-9. *Dyocibicides biserialis.*

7. Dorsal view (X52). 8. Peripheral view (X52).

9. Ventral view (X52). Sample A-10.

Figures 10, 11. *Cibicidella variabilis.*

10. Dorsal view (X58). 11. Oblique ventral view (X60). Sample E-1.