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Biostratigraphy of the Cretaceous-Tertiary Boundary in the East Texas Embayment Based on Planktonic Foraminifera.

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BIOSTRATIGRAPHY OF THE CRETACEOUS-TERTIARY BOUNDARY IN THE EAST TEXAS EMBAYMENT BASED ON PLANKTONIC FORAMINIFERA

A Dissertation

Submitted to the Graduate Faculty of the
Louisiana State University and
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in partial fulfillment of the
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Doctor of Philosophy

in

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by
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ABSTRACT

The biostratigraphic study of the topmost Cretaceous strata in the East Texas Embayment based on planktonic foraminifera, has yielded the following results.

The presence of a saddle shaped arch, referred to as the Grimes-Angelina topographic high, which was undergoing erosion during Maastrichtian and Danian times. The topmost preserved Cretaceous along the trend of the topographic high ranges in age from Campanian to middle Maastrichtian.

The existence of active faults at the end of the Cretaceous for portions of the Mexia-Talco fault system, is suggested by the presence of thick intervals of Midway strata containing reworked Cretaceous fossils located in two separate areas in the vicinity of Freestone and Limestone counties. In addition, at least some minor fault movement in the Mount Enterprise fault system is indicated by the presence of late early Maastrichtian age strata at the top of the Cretaceous in a well in Leon County located just south of a fault.

The remainder of the East Texas Embayment appears to have had no major tectonic movements at the end of the Cretaceous. For most of the East Texas Embayment, the age of the topmost Cretaceous strata appears to be late middle Maastrichtian.

CHAPTER I

INTRODUCTION

The present study of the Cretaceous-Tertiary boundary in the East Texas Embayment was undertaken in order to reconstruct the geological history of this area at the end of the Cretaceous. No major study of the boundary in this area has previously been made. A principal reason for the lack of work has been the absence of good petroleum reservoirs in this part of the stratigraphic section. Therefore, the oil companies have devoted little time to a study of the Cretaceous-Tertiary boundary.

The present work has tried to emphasize certain larger scale regional aspects associated with the Cretaceous-Tertiary boundary, namely the determination of areas of major uplift or subsidence and the determination of movements along major fault zones. For these objectives, a biostratigraphic study of the topmost Cretaceous strata based on planktonic foraminifera was selected as being the most useful. The study of the lithofacies and the biofacies associated with the Cretaceous-Tertiary boundary might be equally relevant, however, this is considered to be beyond the scope of the present work.

CHAPTER II

STRATIGRAPHY

INTRODUCTION

The stratigraphic units dealt with in this study are in descending order: the Tertiary Midway group and the Cretaceous Navarro and Taylor groups. These groups are lithostratigraphic units defined solely on physical characteristics, but several authors have attempted to use the names as time stratigraphic stages. There is no general agreement on the boundaries of the time-stratigraphic units which have been proposed. The stage boundaries based on macrofossils vary from those based upon foraminifera. When the Navarro and the Taylor are used as stages, paleontologists place the boundary at the uppermost range of Exogyra ponderosa and the lowermost range of Exogyra costata. Micropaleontologists prefer to place the boundary at a faunal change that does not coincide with that of E. ponderosa and E. costata (Smith, 1962). Moreover, specimens that can be assigned to E. costata are occasionally found at lower stratigraphic levels in beds assigned to the Taylor (Stephenson, 1941). Exogyra cancellata has been considered to be a good index fossil for the basal Navarro Formation, the Neylandville Marl. The planktonic foraminifera associated with E. cancellata in Texas are characteristic of earliest Maastrichtian age (Pessagno, 1967) whereas those associated with E. cancellata in the Mount Laural Formation in New Jersey, indicate a later Maastrichtian age (Olsson, 1964). Even the age of the boundary between the Navarro and the Midway has been

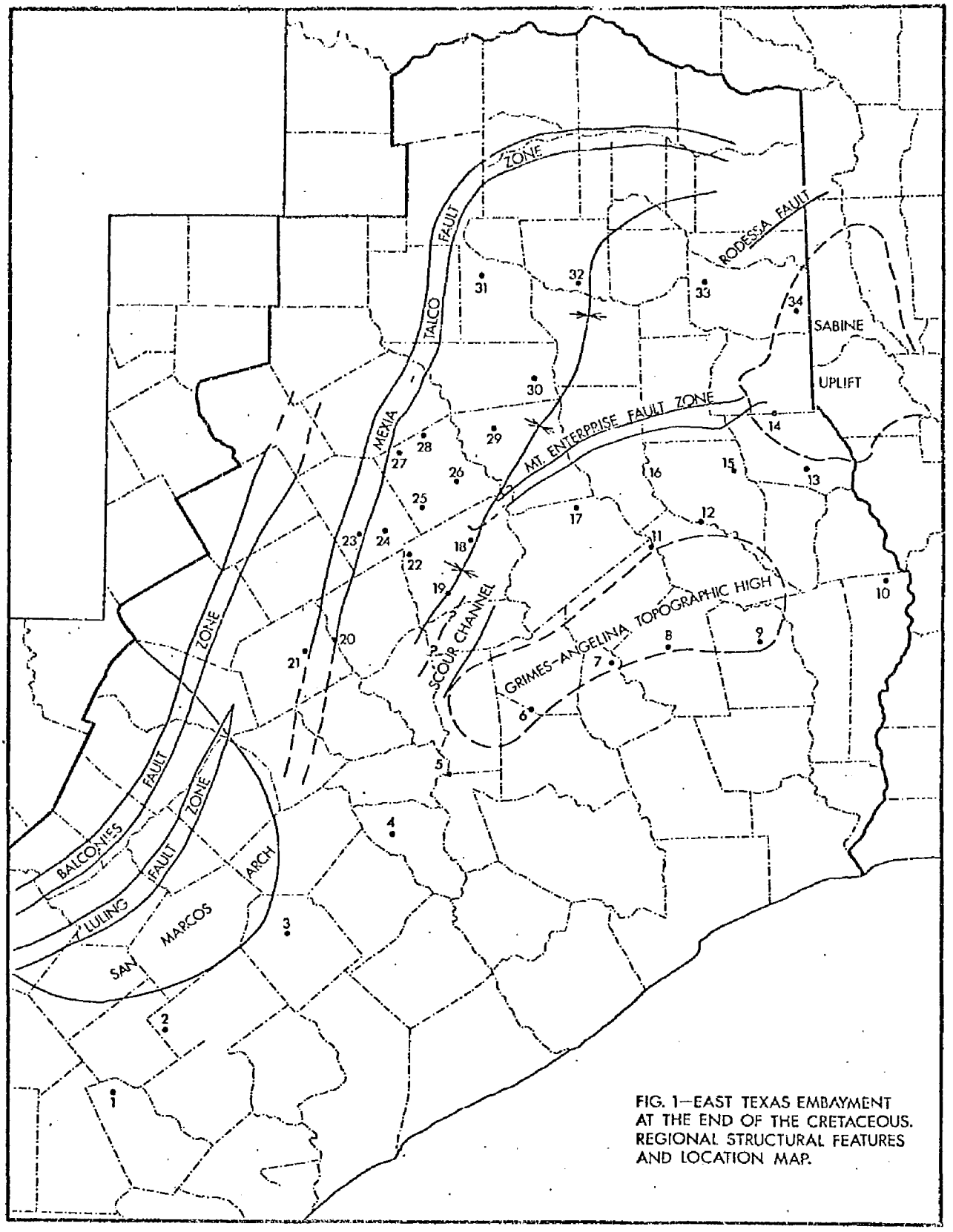


FIG. 1—EAST TEXAS EMBAYMENT AT THE END OF THE CRETACEOUS. REGIONAL STRUCTURAL FEATURES AND LOCATION MAP.

LEGEND FOR TEXT-FIGURE 1

1. Shell, #1 Roesslar, Bee County
2. Texas Eastern, #1 Garbe, Dewitt County
3. Mobil, #1 Spanihel, Lavaca County
4. Mitchell, #1 Peschel, Austin County
5. Shell, #1 Chapman, Waller County
6. Phillips, #A-1 Coal & Coke, Montgomery County
7. Humble, #1 Ogletree, San Jacinto County
8. Shell, #1 Alexander, Polk County
9. Pan American, #1 Longbell, Tyler County
10. Justice Mears, #1 Lutcher Moore, Newton County
11. Lucerne, #1 Southern Pine Lumber Co., Trinity County
12. American Liberty, #1-B, Cameron Heirs, Angelina County
13. Pan American, #1-A Parker, Shelby County
14. Mallard and Locke, #1 Roller Heirs, Shelby County
15. Texas, #1 Strahan, Nacogdoches County
16. Fain et al, #1 Yates, Nacogdoches County
17. Shell, #1 Darsey, Houston County
18. Christie et al, #1 Gordon, Leon County
19. Daniels, #1 Cox Estate, Leon County
20. Placid, #1 Smith, Milam County
21. Walker Creek Locality, near Cameron, Milam County
22. Smith, #1 Busby, Leon County
23. Zephyr, #1 M. Norris, Limestone County
24. Mobil, #1 Brown, Limestone County
25. Union of Calif., #1 Knight, Freestone County
26. Humble, #1 Ball, Freestone County

LEGEND FOR TEXT-FIGURE 1 (continued)

27. Brown, #1 Goolsby, Freestone County

28. Conoco, #1 Williams, Freestone County

29. American Liberty, #1 Gage, Anderson County

30. Texaco, #1 Brown, Henderson County

31. Humble, #1 Surratt, Van Zandt County

32. Bridewell, #1 Coker, Wood County

33. Atlantic-Richfield, #1 Isom, Harrison County

34. Ark-La Gas, #1 J. Davis, Harrison County

disputed. Most authors place the boundary at the end of the Maastrichtian but possibly it may be correlated with part of the lower Danian (Murray, 1961). There is no stratigraphically sound reason for converting the group names of these lithostratigraphically defined units to stage names. In this study the Midway, Navarro and Taylor groups will be used as originally defined, and time stratigraphic designations will be made in reference to the European stages.

TAYLOR GROUP

The Taylor group has many different facies that have been given formational and member names (Adkins, 1933). In this study only the uppermost unnamed marls and the Pecan Gap Chalk have been encountered in the southern portion of the East Texas Embayment along the trend of the Grimes-Angelina topographic high (Fig. 1). Apparently a topographic high existed at the end of the Cretaceous approximately from Grimes County eastward to Angelina and Jasper counties as most or all of the Navarro strata were eroded from this area. The exact boundary of this topographic high is not known. The upper contact is discussed with the Navarro.

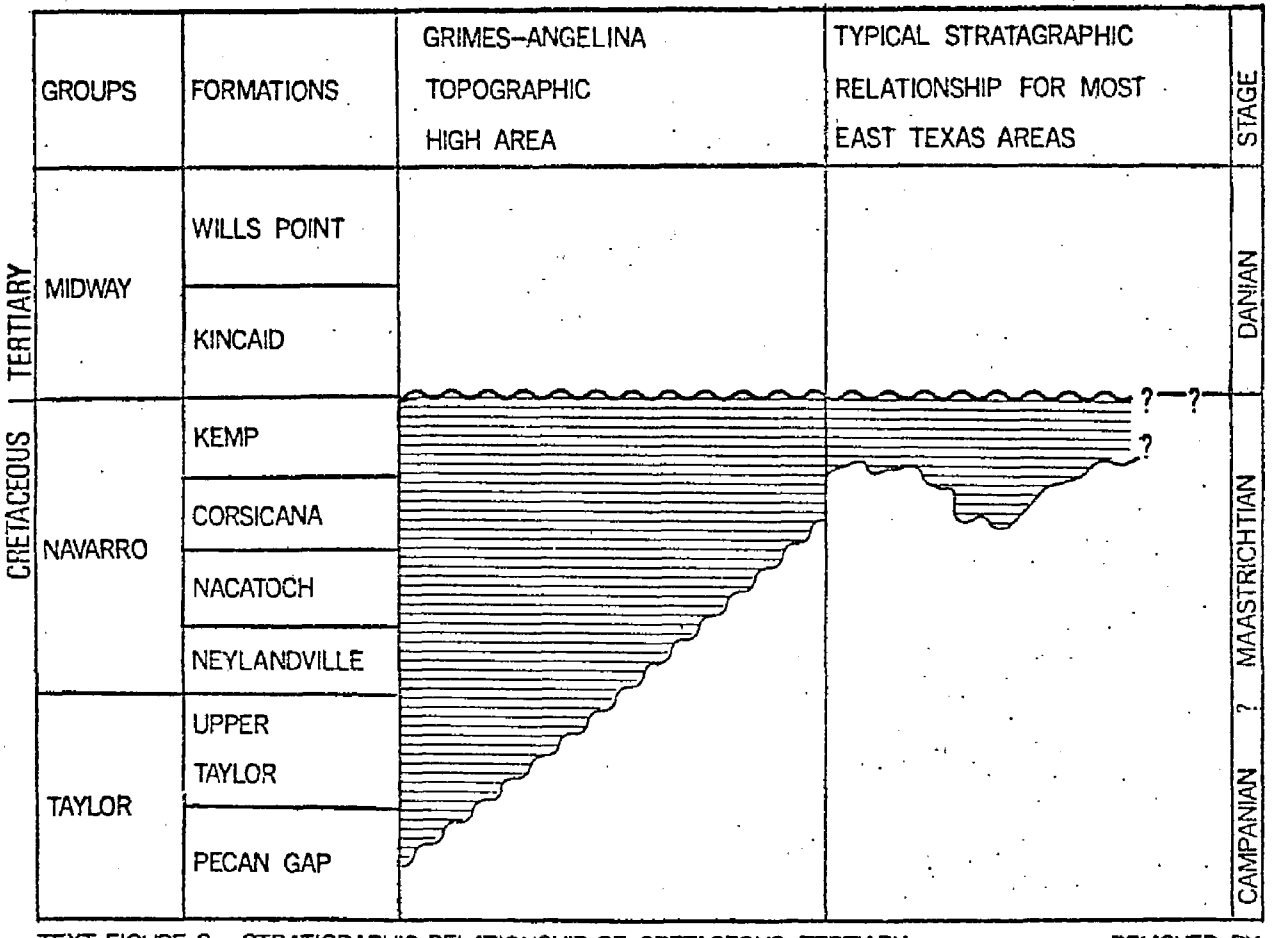
NAVARRO GROUP

The Navarro group has been divided into the following formation in ascending order: Neylandville Marl, Nacatoch Sand, Corsicana Marl and Kemp Clay. The Neylandville Marl is a gray, sandy marl ranging in thickness from around 50 feet to 400 feet (Adkins, 1933; Stephenson, 1941). The Nacatoch Sand is described as a gray, massive calcareous sand usually ranging in thickness from 100 feet to 200 feet, but as much as 400 feet in Arkansas (Adkins, 1933). The Corsicana Marl is

described by Stephenson as a gray chalky marl, 20 feet to 100 feet or more in thickness that is separated from the Nacatoch along the outcrop belt by a disconformity. The Kemp Clay may be a very dark brown clay to a light yellow or gray clay. Both of these lithologices may be seen in the quarry near Littig, Travis County and along Walker Creek near Cameron, Milan County. The thickness of the Kemp Clay is rather variable, partly due to erosion of the upper part. It is difficult to place the boundary between the Corsicana Marl and the Kemp Clay so that they are often undifferentiated, especially in subsurface work. The thickness of the Navarro above the Nacatoch Sand ranges up to 600 feet in the subsurface (Adkins 1933). The upper boundary of the Kemp Clay will be covered in detail in the discussion of the Midway group. The contact between the Navarro group and the Taylor group is disconformable in part (Murray, 1961; Adkins, 1933).

The contact between the Navarro group and the Midway group is disconformable in all outcrops in east Texas and most of the subsurface. Usually basal Midway strata occur above Navarro strata of middle Maastrichtian age to possibly earliest Maastrichtian age. Some wells such as the Pan American, #1-A Parker (Fig. 1, No. 9) and the Shell, #1 Darsey (Fig. 1, No. 17) may include strata of late Maastrichtian age and the contact between the Navarro and the Midway groups may be conformable. However, Abathomphalus mayaorensis, which is characteristic of the late Maastrichtian, has not been found in any of the wells examined in the present study.

In the Pan American, #1-A Parker well, reworked Cretaceous planktonic foraminifera, including Globotruncana linneiana, occur above samples containing a planktonic foraminiferal assemblage that probably

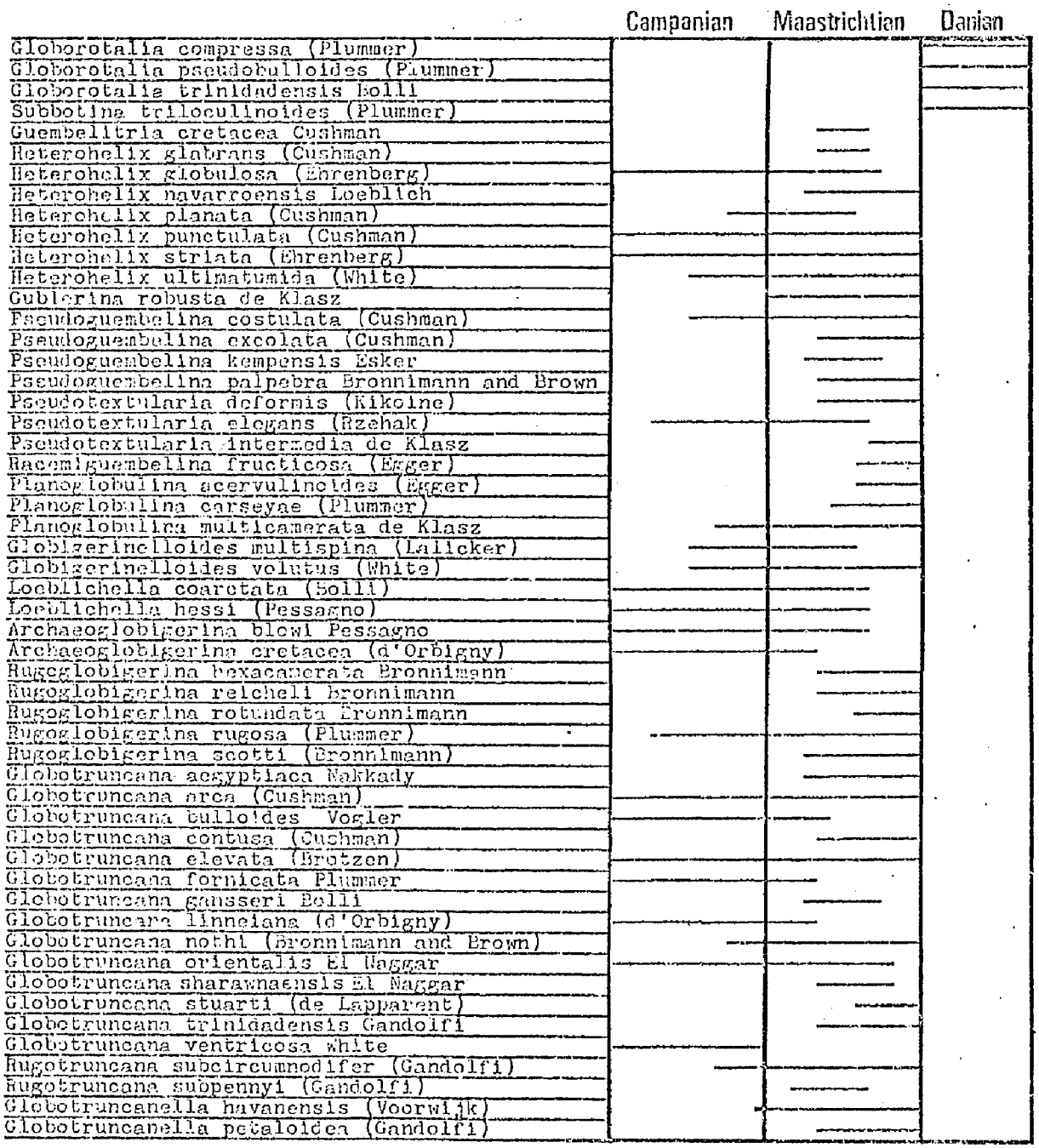


TEXT FIGURE 2. STRATIGRAPHIC RELATIONSHIP OF CRETACEOUS–TERTIARY BOUNDARY IN THE EAST TEXAS EMBAYMENT

REMOVED BY EROSION

indicates an age at least as old as earliest late Maastrichtian. These reworked planktonic foraminifera were most probably eroded from the Grimes-Angelina topographic high and deposited on top of strata containing this earliest late Maastrichtian assemblage. Danian age planktonic foraminifera characteristic of the basal Midway occur above the reworked Cretaceous planktonic foraminifera.

In the Shell, #1 Darsey well, there is a barren interval between samples containing Danian age planktonic foraminifera and samples containing a late middle Maastrichtian age assemblage. This barren interval may be of late Maastrichtian age. The Humble, #1 Ogletree well, is located along the trend of the Grimes-Angelina topographic high due south of the Shell, #1 Darsey well. The top of the Cretaceous in this well is probably of middle Maastrichtian age although this is based on rather meager faunal evidence. This age is younger than that of wells located to the west and to the east-northeast along the trend of the Grimes-Angelina topographic high which are late Campanian to earliest Maastrichtian in age. A possible explanation is that the Grimes-Angelina structure was somewhat saddle shaped, being relatively higher at both ends than in the middle in the vicinity of the Humble, #1 Ogletree well in northeastern San Jacinto County. This interpretation is supported by the report of Nichols (1964) that during the lower upper Cretaceous the Sabine Uplift extended down toward the Angelina-Caldwell arch, a steeply plunging nose being formed at their intersection in the vicinity of Trinity, Walker and San Jacinto counties. If the structure was topographically lower in the middle, then the area to the north may also have been topographically lower than the surrounding areas. Thus sediments during the late Maastrichtian time could have accumulated in



Text Figure 3 FAUNAL RANGE CHART

the area in the vicinity of the Shell, #1 Darsey well while surrounding areas were undergoing erosion and/or nondeposition.

MIDWAY GROUP

All the strata between the Navarro and the Wilcox groups constitute the Midway group. The contact with the sands of the Wilcox group appears to be conformable in most places. The contact with the underlying Cretaceous is disconformable in most places and is usually marked by a layer of glauconite, phosphatic nodules and reworked Cretaceous fossils. The hiatus at the end of the Cretaceous does not appear to be of great magnitude and may not be present everywhere. Generally, strata of middle or late middle Maastrichtian age underlie the basal Tertiary. Significant erosion seems to be restricted to the area along the Grimes-Angelina trend. The age of the uppermost Cretaceous along this trend is as old as late Campanian. There is probably no surface exposure that definitely can be said to have been subaerially exposed at the end of the Cretaceous. However, the existence of bored mud-cracked clay pebbles in the Littig conglomerate in the quarry near Littig, Travis County; indicate that some areas were subaerially exposed. The entire east Texas area does not appear to have undergone extensive erosion at the end of the Cretaceous. The rate of sediment accumulation was probably very slow over much of the area at the end of the Cretaceous and the start of the Tertiary. The Littig Conglomerate at Walker Creek near Cameron, Milam County contains a great abundance of planktonic foraminifera in addition to a large amount of glauconite grains in the basal Midway. Both the abundance of planktonic foraminifera (Kuenen, 1950) and the glauconite (Pettijohn, 1957) indicate a very slow rate of sediment accumulation. Probably the disconformity is the result of

erosion and of a slow rate of sediment accumulation.

The Midway group is divided into the basal Kincaid Formation and the upper Wills Point Formation. The Kincaid Formation extends over all of east Texas in the subsurface. The average thickness of surface exposures of the Kincaid is 150 feet. In the subsurface it may be 300 feet or more (Plummer, 1933). The upper contact is usually placed at the top of the Tehuacana limestone lentil and where this is absent, at the base of the so called second persistent glauconite in the basal Wills Point Formation. Usually the contact between the Kincaid and the Wills Point Formations is disconformable (Plummer, 1933).

The Kincaid has been divided into the basal Littig glauconite member and the Pisgah member. The Littig glauconite member usually contains phosphatic pebbles and reworked fossils. It is never more than a few feet thick. Barrow (1953) states that the Littig glauconite is a persistent horizon that can be used to separate the Tertiary from the Cretaceous when fossil evidence is lacking. However, other authors report that it is not continuous and not present everywhere at the base of the Tertiary (Rainwater, 1960; Plummer, 1933). The author has noted the absence of glauconite at the Cretaceous-Tertiary contact, particularly in wells in the eastern part of the East Texas Embayment. The Pisgah member consists of limestone lentils, clays, glauconitic clays and glauconitic sands.

The Wills Point Formation is discussed in the present study only in connection with the reworking of Cretaceous fossils in Limestone, Freestone and Leon counties (Fig. 1, Nos. 22-24, 26, 28). Therefore, it will not be considered in detail. The Wills Point consists of glauconitic sands, glauconitic clays, and clays and silty to sandy

clays towards the top. The thickness ranges from 250 feet to 700 feet in east Texas (Plummer, 1933).

CHAPTER III

REGIONAL STRUCTURAL FEATURES

INTRODUCTION

In the East Texas Embayment the main structural features associated with the Cretaceous-Tertiary boundary are: to the east, the Sabine Uplift with the Mount Enterprise fault zone and the Rodessa fault; to the north and west, the Mexia-Talco fault zone; to the south, the Grimes-Angelina tropographic high with a southwest trending-flexure which converges with the Balcones and Luling fault zones in the west to form the southwestern boundary of the East Texas Embayment near the San Marcos arch (see text fig. 1).

SABINE UPLIFT, RODESSA FAULT AND MT. ENTERPRISE FAULT ZONE

There is no evidence to indicate that there were any major movements on the Sabine Uplift and the Rodessa Fault at the end of the Cretaceous. The absence of any recognizable reworking of Cretaceous fossils coupled with the presence of late middle Maastrichtian (age) faunas in this area support this conclusion. Some minor movements have been reported but these are reflected only in some small regional highs (Barrow, 1953).

There was possible activity along parts of the Mount Enterprise fault zone at the end of the Cretaceous. Barrow (1953) reports the existence of a V shaped fault in Leon County which may be a southwestern extension of the Mount Enterprise fault zone. This fault is located

north of the Christie et al, #1 Gordon well (Fig. 1, No. 18). The planktonic foraminiferal fauna found at the top of the Cretaceous in this well is indicative of a late early Maastrichtian age. This is an older age than is typically found for the youngest Cretaceous strata in the East Texas Embayment. The presence of this older age fauna at the top of the Cretaceous in this well is probably the result of erosion of younger age Cretaceous strata due to activity along this fault.

GRIMES-ANGELINA TOPOGRAPHIC HIGH

There was uplift along the southern boundary of the East Texas Embayment near the end of the Cretaceous. This is indicated by the presence of older topmost Cretaceous strata along part of the flexure than is found in the remainder of the East Texas Embayment. This uplift formed an arch that acted as a topographic high. The arch extended approximately from Grimes County in the west to Angelina and Jasper counties in the east. Bornhauser (1966) reports a large scour channel in western Madison County which cut down into the Pecan Gap Chalk of the Taylor group at the end of the Cretaceous. This channel was later filled with Midway sediments. The general trend of the channel appears to have been in a northeasterly direction. Apparently currents strong enough to scour out a large channel swept around the western end of the Grimes-Angelina topographic high during the end of the Cretaceous (see fig. 1).

Nichols (1964) reports that the area along the flexure was active during early to early late Cretaceous times but had no influence upon deposition of the Austin sediments. He states that in the early late Cretaceous the Sabine Uplift extended down to the vicinity of Walker, Trinity and San Jacinto counties where it intersected a

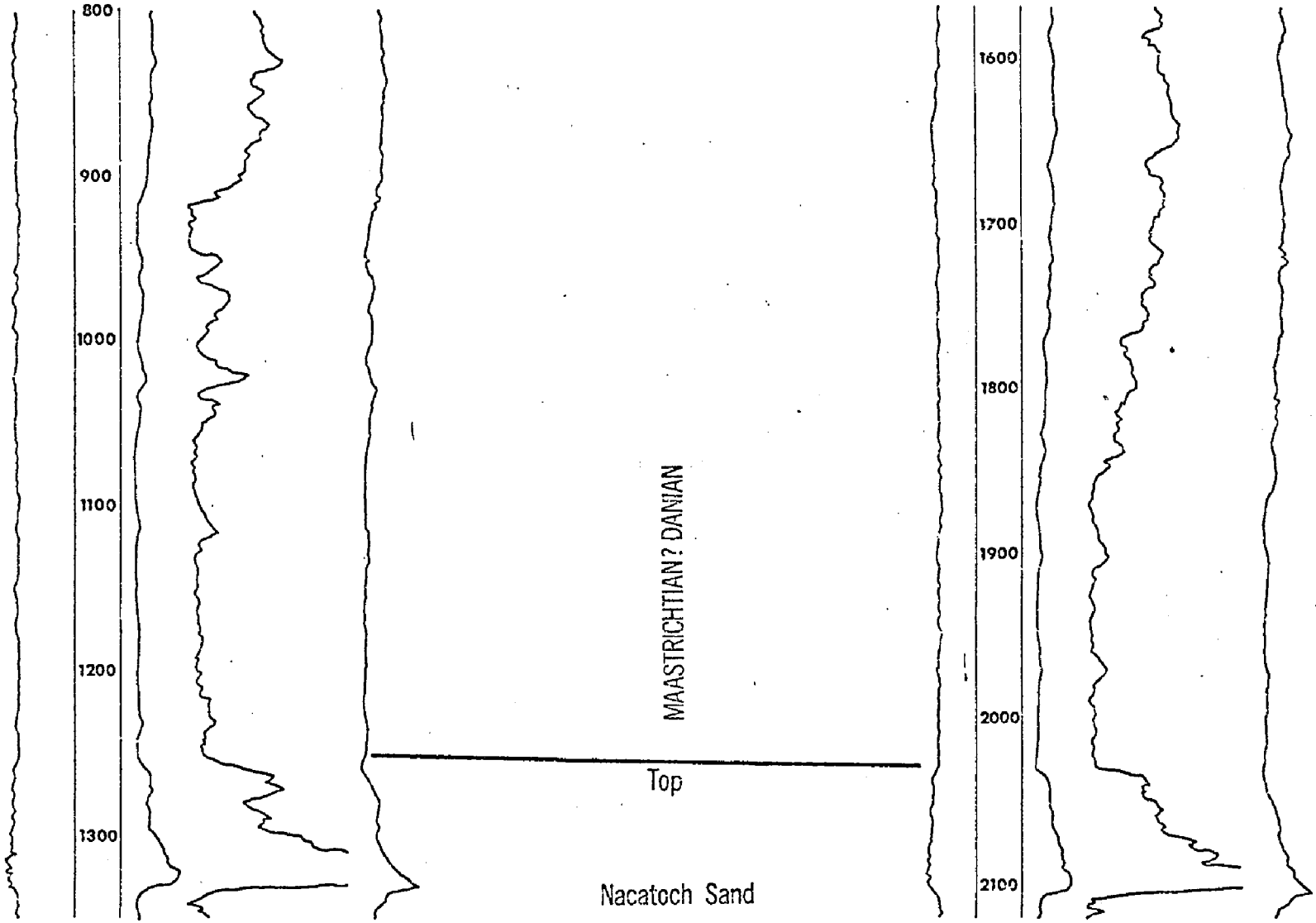
topographic high along part of the flexure, producing a steeply plunging nose. The area of the steeply plunging nose appears to have remained as a topographically low area to the end of the Cretaceous. The Humble, #1 Ogletree well in northeastern San Jacinto County has a fauna at the top of the Cretaceous suggesting a middle Maastrichtian age. This is younger than the uppermost Cretaceous found in wells along the Grimes-Angelina topographic high to the west and to the east. Thus the topographic high appears to have been somewhat saddle shaped, being higher at both ends than in the middle. To the west of Grimes County there was no apparent uplift along the trend of the flexure at the end of the Cretaceous.

MEXIA-TALCO FAULT ZONE

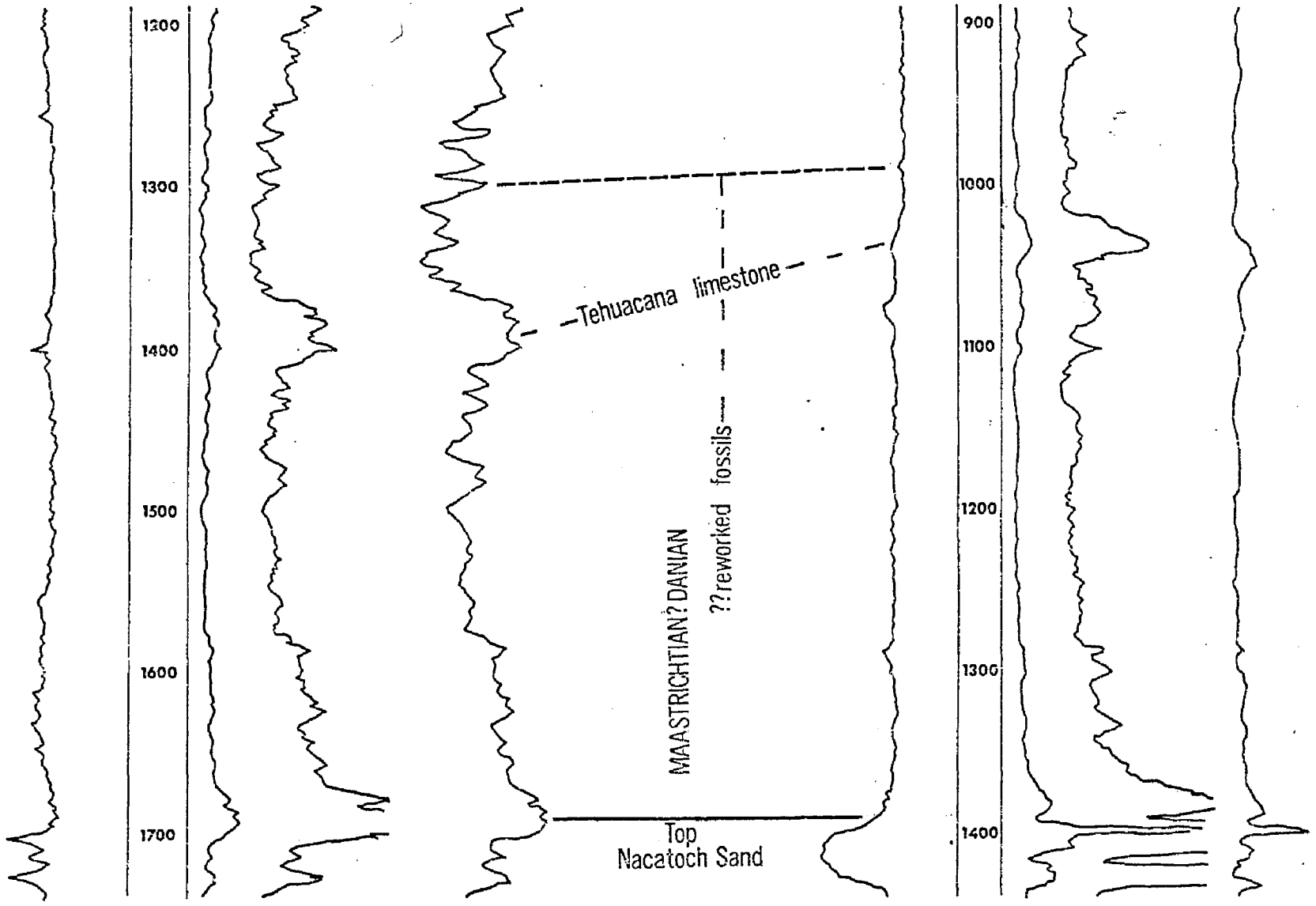
The Mexia-Talco fault zone forms the northern and western boundaries of the East Texas Embayment. This zone is generally parallel to the regional strike. The Mexia-Talco zone extends from Bowie County in extreme northeastern Texas west to Hunt County where it turns south-southwest ending at Lee County as the zone approaches the San Marcos arch. The Mexia-Talco fault system consists of normal dip slip faults with the downthrown side principally to the west and to the north, usually accompanied by some complimentary faults with less displacement and with their downthrown side to the east and to the south forming grabens (Barrow, 1953). Murray (1961) believes the fault system to have been active in the Jurassic or earlier although the oldest activity of this system reported by Barrow (1953) is in the earliest Cretaceous. The Mexia-Talco system had recurrent activity all through the Cretaceous and in the Tertiary and recent times (Barrow, 1953). According to Barrow (1953) the amount of movement along the fault zone decreases

in the younger strata and little or no evidence can be shown to clearly demonstrate that the zone was active during deposition of the Navarro. However, in one of his cross sections, a considerably thicker section of the Neylandville Marl is present in the Mexia-Talco graben indicating that there was movement along the Mexia-Talco fault zone during deposition of the Navarro. The fact that the thickness of the Taylor strata in the graben is essentially no thicker than that of the Taylor to the east of the graben, indicates that the faulting did occur during deposition of the Navarro.

Information gathered in the present study suggests that there was probably fault activity along sections of the Mexia-Talco fault zone in Limestone and eastern Navarro counties, although this can not be definitely proven. Thick intervals of Midway strata in wells in Freestone, Limestone and western Leon counties contain reworked Cretaceous planktonic foraminifera. From the distribution of the wells found to contain reworked fossils, the presence of reworked Cretaceous fossils could be expected also in extreme eastern Falls County, northeastern Robertson County and eastern Navarro County. However, no wells were available for study in these areas. Barrow (1953) states that only fossils from the uppermost Navarro are found reworked and that these reworked fossils are only found in the basal Midway. However, Plummer (1933) reports the presence of reworked Cretaceous fossils in the Tehuacana limestone lentil in places. In some of the wells studied, the reworked Cretaceous fossils extend up into the Wills Point Formation above the Tehuacana limestone lentil that marks the top of the Kincaid Formation of the Midway group (see text fig. 5). The ages of the reworked planktonic foraminifera range from Campanian to late middle Maastrichtian. Thus, at least in the counties mentioned above,


800
900
1000
1100
1200
1300
1600
1700
1800
1900
2000
2100
MAASTRICHTIAN? DANIAN
Top
Nacatoch Sand
Brown, #1 Goolsby
Union of Calif., #1 Knight

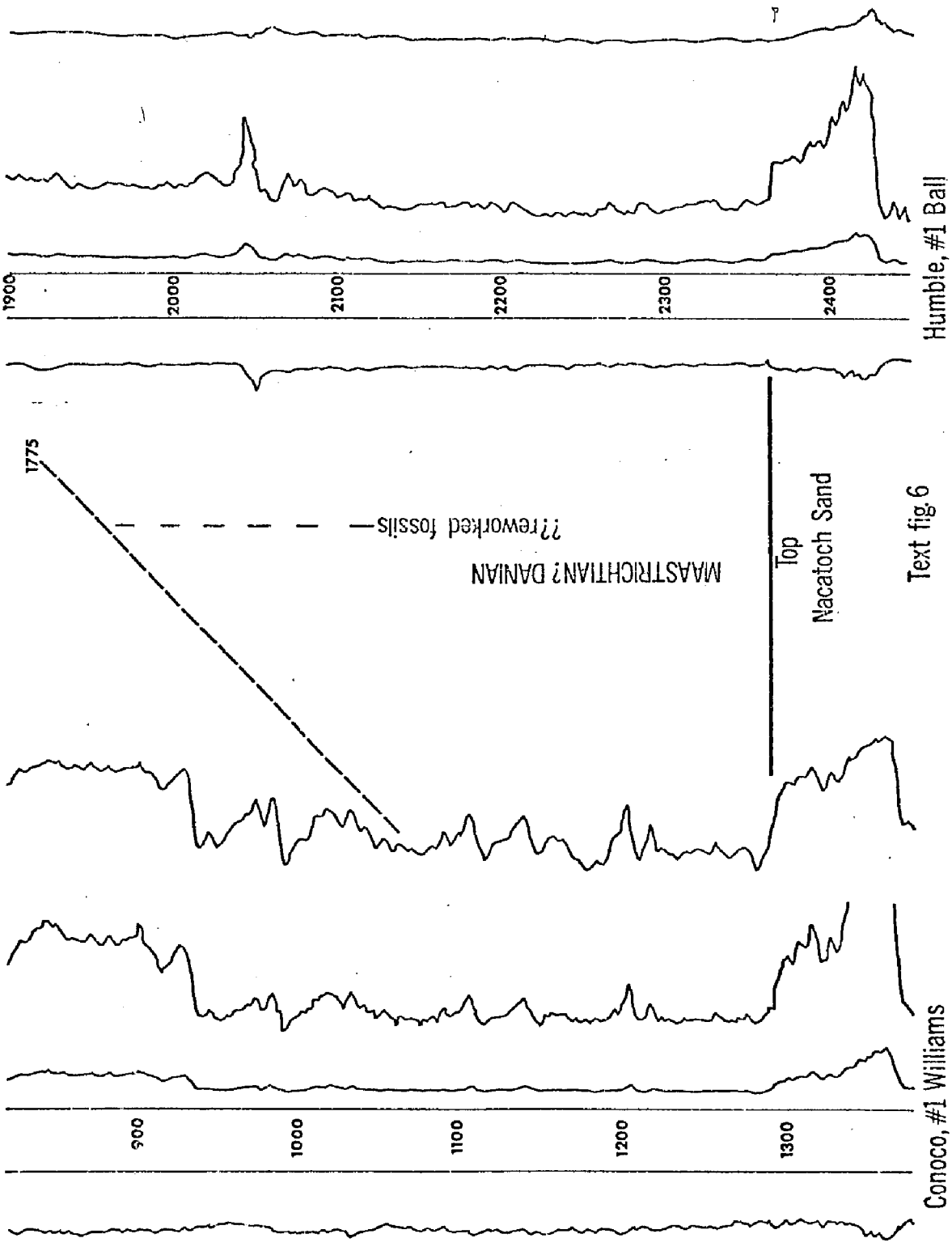
Text fig. 4



Mobil, #1 Brown

Text fig. 5

Zephyr, #1 M. Norris


Humble, #1 Ball
1900
2000
2100
2200
2300
2400
Top
Nacatoch Sand
Text fig. 6
1775
??reworked fossils
MAASTRICHTIAN? DANIAN
Conoco, #1 Williams
900
1000
1100
1200
1300

fossils eroded from Navarro and Taylor strata were being deposited probably from late Maastrichtian time on into Danian time when the Kincaid and Wills Point Formations were being deposited. These fossils probably were reworked as a result of erosion associated with fault movement.

Intervals with reworked Cretaceous fossils occur in the Conoco, #1 Williams well, 100 feet or more (fig. 1, no. 28; fig. 6, tab. 18); the Humble, #1 Ball well, 450 feet or more (fig. 1, no. 28; fig. 6, tab. 18); the Zephyr, #1 M. Norris well, 180 feet or more (fig. 1, no. 23; fig. 5, tab. 13); the Mobil, #1 Brown well, 300 feet or more (fig. 1, no. 24; fig. 5, tab. 14); the Smith, #1 Busby well, exact thickness unknown (fig. 1, no. 22; tab. 16). The probable thicknesses of the intervals containing reworked Cretaceous fossils is based upon electric log correlations with the above wells, except the Smith, #1 Busby well for which no electric log is available; from the top of the Cretaceous as picked in the Union of Calif., Knight #1 well (fig. 1, no. 25; fig. 4, tab. 17); and the Brown, Goolsby #1 well (fig. 1, no. 27; fig. 4, tab. 17) in southern and eastern Freestone County. No reworked fossils were found in these two wells. In the Zephyr, Norris #1 well and the Mobil, Brown #1 well; the reworked fossils extend up into the lower part of the Wills Point Formation. The reworked fossils appear to extend higher up into the Wills Point Formation in the Mobil, Brown #1 well by 40 feet or more. However, this may be more apparent than real because reworked Cretaceous fossils are extremely rare in the upper part of the interval containing reworked fossils. The apparently greater thickness of the interval of reworked fossils in the Smith, Busby #1 well is not definitely proven without the availability of the electric log. Also, this well is located on the flank of the Marguez salt dome, possibly

in a rim syncline associated with this dome which could be responsible for a greater thickness of Midway sediments in this area. In the Conoco, Williams #1 well the interval of reworked fossils appears to be confined to the Kincaid. The greater thickness of the interval of reworked fossils in the Humble, Ball #1 well may possibly be due to a thickening of section downdip as a result of subsidence along the syncline associated with the Bethel salt dome. The Humble, Ball #1 well is located along the axis of this syncline to the southwest. If there was thickening of section downdip, then the top of the Cretaceous might occur higher up in the well rather than at the depth inferred from correlation with the wells without any reworked fossils. Unfortunately, little can be determined by studying the electric log in this well because the first run begins in the Midway and the first distinctive horizon is the Nacatoch Sand, making precise correlation of the interval above the Nacatoch Sand impossible. There appears to be a northwest-southeast trend to the direction in which the reworked fossils occur (fig. 1, nos. 22-24, 26, 28). This apparent trend may be related to current directions during deposition of the sediments.

Evidence suggests that the occurrence of reworked Cretaceous fossils in these wells is a result of erosion associated with fault movements along portions of the Mexia-Talco fault zone. This interpretation is supported by the fact that not all of the wells in the area contain reworked fossils, especially the Brown, #1 Goolsby well and the Union of Calif., #1 Knight well that separate the two areas containing reworked fossils. Thick sections containing reworked fossils and which have an irregular aereal distribution are suggestive of fault activity. If a large land mass were being eroded, a more even aereal distribution would be expected. This irregular distribution of wells containing

reworked Cretaceous fossils does not indicate salt dome activity because this would require currents that only carried the reworked fossils in a general direction towards the Mexia-Talco fault zone. In addition, there is only one minor salt dome located in the vicinity of Limestone County. There is the possibility that the reworking is a result of the scouring of channels by currents. There would have to be almost certainly two such scour channels to supply reworked fossils to the two separate areas. However, the only known scour channel in existence in that general area is the one described by Bornhauser (1966) in western Madison County which appears to have a northeasterly trend rather than a northwesterly trend towards the areas of reworking. In conclusion, erosion associated with fault activity along portions of the Mexia-Talco fault zone was responsible for the intervals containing reworked fossils in the wells. The lack of reworked fossils in the two wells in Freestone County and in the Placid, #1 Smith well in Milam County, located on the Mexia-Talco fault zone, indicate that only portions of the fault zone were active sometime during the Maastrichtian to the Danian ages.

BALCONES AND LULING FAULT ZONES

The Balcones fault zone extends from possibly as far north as Collin County to Val Verde County in southwest Texas (Murray, 1961). In the East Texas Embayment the Balcones fault zone is generally subparallel to the Mexia-Talco fault zone. The Luling fault zone extends approximately from Williamson County across the San Marcos arch to the vicinity of Zavala County in the south. The Luling fault zone is located coastward of the Balcones fault zone and forms in effect a large poorly formed graben with the Balcones fault zone across the area of the San Marcos arch (Murray, 1961). These fault zones are encountered in

the present study only in the southwestern extension of the East Texas Embayment where they converge with the Angelina-Caldwell flexure near the San Marcos arch. The information gathered from wells south and east of the San Marcos arch presents no evidence for activity along the Balcones and Luling fault zones at the end of the Cretaceous. In these wells, the uppermost Cretaceous planktonic foraminifera are indicative of a middle or late middle Maastrichtian age which appears to be the same as that found in most of the wells studied in the East Texas Embayment.

CHAPTER IV

BIOSTRATIGRAPHY

Planktonic foraminifera were used for the present study because of their widely recognized usefulness for biostratigraphic studies. The numerous articles describing and using planktonic foraminifera have enabled reasonably precise zonations to be established for purposes of correlation and age determination. Because of their planktonic nature, these foraminifera are, in general, world wide in occurrence. This makes them excellent fossils for use in biostratigraphic work. The almost total extinction of the typical Mesozoic planktonic foraminifera, especially the Globotruncanidae, at the end of the Cretaceous, and the emergence of the Globigerinidae and Globorotaliidae at the start of the Tertiary, make the planktonic foraminifera ideal fossils to be used in the present study.

Other microfossils were not used for various reasons. There has been much less detailed work done on the stratigraphic occurrences of the benthonic foraminifera and ostracoda. At least some species of benthonic foraminifera and ostracoda are known to cross the Cretaceous-Tertiary boundary. For these reasons it would have been necessary to study numerous surface outcrops and/or core samples containing the Cretaceous-Tertiary contact in order to work out the biostratigraphic relationships in detail. There are not many known outcrops containing the Cretaceous-Tertiary contact in east Texas from which unweathered samples could be collected to study microfossils. Only samples from one surface outcrop, which were found to contain abundant planktonic

foraminifera, were studied. The lack of many surface exposures of the Cretaceous-Tertiary contact is due to the tendency for the shales and clays of the Midway and Navarro to weather and form slopes covered with vegetation. Core samples across the Cretaceous-Tertiary boundary were not available. In the present work ditch samples from wells obtained from Shell Oil Company were almost exclusively studied. Therefore, it seemed best to restrict the study only to the planktonic foraminifera excluding other microfossils.

The ranges of the various species of planktonic foraminifera were mainly obtained from the literature, especially the comprehensive study of the Cretaceous of Mexico and Texas by Pessagno (1967). These ranges were modified in a few instances by personal observations in the examination of numerous samples. In samples of the topmost Cretaceous strata where it was not possible to obtain a very restricted probable-age determination, an older probable-age was favored in the interpretation of the data. This assumption seems to fit best with the other samples where more precisely determined probable-ages were obtained.

The top of the Cretaceous was picked in the wells on the first occurrence in the samples of planktonic foraminifera that are characteristic of the Cretaceous. The only exceptions to this were in the wells that contained reworked Cretaceous planktonic foraminifera. For these wells, an electric log correlation with two nearby wells that did not contain reworked Cretaceous planktonic foraminifera, was used. The Cretaceous-Tertiary boundary was assumed to be at an approximate thickness above the top of the Nacatoch Sand, which provided the distinguishable electric log marker, based upon the position of the Cretaceous-Tertiary boundary in the two wells that did not contain reworked Cretaceous planktonic foraminifera. The top of the Nacatoch

Sand was used to provide the electric log marker horizon due to the lack of any distinctive electric log marker horizon at the contact between the upper Navarro and the lower Midway clays and shales.

CHAPTER V

CONCLUSIONS

From the study of the Cretaceous-Tertiary boundary in the East Texas Embayment based on planktonic foraminifera, the following statements can be made. Most of the area of the East Texas Embayment, including the Sabine Uplift, appears to have had no major tectonic movements at the end of the Cretaceous. Only strata of late Maastrichtian age appear to be missing in most places. A topographic high, referred to as the Grimes-Angelina topographic high, was in existence at the end of the Cretaceous along the southern boundary of the East Texas Embayment. Erosion of Cretaceous strata was associated with this uplift. The ages of the topmost preserved Cretaceous range from Campanian to middle Maastrichtian along this trend.

There were probably some active faults at the end of the Cretaceous in the East Texas Embayment. Portions of the Mexia-Talco fault system in the vicinity of Falls to Navarro counties were apparently active. This activity led to erosion of Cretaceous strata as old as Campanian in age which supplied reworked fossils to two separate areas in the vicinity of the active portions of the Mexia-Talco fault zone. At least some minor fault movement is indicated for at least part of the Mount Enterprise fault system. This is indicated by the presence of late early Maastrichtian age strata at the top of the Cretaceous in a well in Leon County just south of a fault which appears to be a southwestern extension of the Mount Enterprise fault zone.

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APPENDIX

SYSTEMATIC PALEONTOLOGY

Phylum Protozoa

Subphylum Sarcodina

Class Rhizopodea

Order Foraminiferida

Superfamily Globigerinacea

Family Heterohelicidae

Subfamily Guembelitrinae

Genus Guembelitria Cushman, 1933

Guembelitria cretacea Cushman

1933 Guembelitria cretacea Cushman, Contr. Cushman Lab. Foram. Res., vol. 9, p. 37, pl. 4, figs. 12a,b.

1966 Guembelitria cretacea Cushman, Hofker, Palaeontographica, suppl. bd. 10, p. 318, pl. 72, fig. 155; pl. 73, fig. 159.

1967 Guembelitria cretacea Cushman, Pessagno, Palaeontographica Am., vol. V, no. 37, p. 258, pl. 87, figs. 1-3. (see Pessagno for earlier synonymy).

Subfamily Heterohelicinae

Genus Heterohelix Ehrenberg, 1843

Heterohelix glabrans (Cushman)

1938 Guembelina glabrans Cushman, Contr. Cushman Lab. Foram. Res., vol. 14, p. 15, pl. 3, figs. 1,2.

1967 Heterohelix glabrans (Cushman), Pessagno, Palaeontographica Am., vol. V, no. 37, p. 259, pl. 88, figs. 1,2,10,11 (see Pessagno for earlier synonymy).

Heterohelix globulosa (Ehrenberg)

1840 (1838) Textularia globulosa Ehrenberg, K. Preuss. Akad. Wiss. Berlin, Abh., p. 135, pl. 4, figs. 2 beta, 4 beta, 5 beta, 7 beta, 8 beta.

1958 Gumbelina globulosa (Ehrenberg), Ansary and Fakhr, Egypt. Jour. Geol., vol. II, no. 2, pp. 120,121; pl. 1, figs. 22a,b.

1961 Gumbelina globulosa (Ehrenberg), Jurkiewicz, Act. Geol. Polon., 11, (4), pl. 23, figs. 21a,b.

1963 Heterohelix globulosa (Ehrenberg), Graham and Church, Stanford Univ. Pub., Geol. Sci., vol. VIII, no. 1, pp. 61,62; pl. 7, figs. 11a,b.

1966 Guembelina globulosa (Ehrenberg), Hofker, Palaeontographica, suppl. 10, p. 64, pl. 10, fig. 110.

1967 Heterohelix globulosa (Ehrenberg), Pessagno, Palaeontographica Am., vol. V, no. 37, p. 260, pl. 87, figs. 5-9, 11-13. (see Pessagno for earlier synonymy).

Heterohelix navarroensis Loeblich

1951 Heterohelix navarroensis Loeblich, Contr. Cushman Foram. Res., vol. 2, pt. 3, pp. 107,108, pl. 12, figs. 1-3b, text fig. 1.

1967 Heterohelix navarroensis Loeblich, Pessagno, Palaeontographica Am., vol. V, no. 37, p. 261, pl. 89, figs. 8,9. (see Pessagno for earlier synonymy).

Heterohelix planata (Cushman)

1938 Guembelina planata Cushman, Contr. Cushman Lab. Foram. Res., vol. 14, p. 12, pl. 2, figs. 13,14.

1967 Heterohelix planata (Cushman), Pessagno, Palaeontographica Am., vol. V, no. 37, pp. 261,262; pl. 86, figs. 3,4; pl. 89, figs. 6,7. (see Pessagno for earlier synonymy).

Heterohelix punctulata (Cushman)

1938 Guembelina punctulata Cushman, Contr. Cushman Lab. Foram. Res., vol. 14, p. 13, pl. 2, figs, 15,16.

1967 Heterohelix punctulata (Cushman), Pessagno, Palaeontographica Am., vol. V, no. 37, pp. 262,263; pl. 86, figs. 7-10. (see Pessagno for earlier synonymy).

Heterohelix striata (Ehrenberg)

1840 (1838) Textularia striata Ehrenberg, K. Preuss. Akad. Wiss., Berlin, Abh., p. 135, pl. 4, figs. 1 alpha, 1 alpha prime, 2 alpha, 3 alpha, (not 9 alpha).

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1963 Heterohelix striata (Ehrenberg), Graham and Church, Stanford Univ. Pub., Geol. Sci., vol. VIII, no. 1, pp. 62,63; pl. 7, figs. 11a,b.

1966 Guembelina striata (Ehrenberg), Hofker, Palaeontographica, suppl. bd. 10, pp. 30,43,64,79; pl. 3, fig. 68; pl. 6, fig. 46; pl. 10, —fig. 109; pl. 79, figs. 80,81; not p. 318, pl. 73, fig. 145.

1967 Heterohelix striata (Ehrenberg), Pessagno, Palaeontographica Am., vol. V, no. 37, p. 264, pl. 78, figs. 4,5; pl. 88, figs. 3-7; pl. 98, fig. 10. (see Pessagno for earlier synonymy).

Heterohelix ultimatumida (White)

1929 Guembelina ultimatumida White, Jour. Paleo., vol. 3, p. 39, pl. 4, figs. 13a,b.

not 1958 Gumbelina ultimatumida White, Ansary and Fakhr, Egypt. Jour. Geol., vol. II, no. 2, pp. 123,124; pl. 1, figs. 26a,b.

1961 Gumbelina ultimatumida White, Jurkiewicz, Act. Geol. Polon., 11, (4), pl. 23, figs. 22a,b.

not 1966 Guembelina ultimatumida White, Hofker, Palaeontographica, suppl. bd. 10, p. 123, pl. 18, fig. 19.

1967 Heterohelix ultimatumida (White), Pessagno, Palaeontographica Am., vol. V, no. 37, pp. 264,265. (see Pessagno for earlier synonymy).

Genus Gublerina Kikoine, 1948

Gublerina robusta de Klasz

1953 Gublerina acuta subsp. robusta de Klasz, Geol. Bavarica, no. 17, p. 247, pl. 8, figs. ra,b; figs. 5a,b.

1967 Gublerina robusta de Klasz, Pessagno, Palaeontographica Am., vol. V, no. 37, p. 265, pl. 75, fig. 11. (see Pessagno for earlier synonymy).

Genus Pseudoguembelina Bronnimann and Brown, 1953

Pseudoguembelina costulata (Cushman)

1938 Guembelina costulata Cushman, Contr. Cushman Lab. Foram. Res., vol. 14, p. 16, pl. 3, figs. 7-9.

?1958 Gumbelina costulata Cushman, Ansary and Fakhr, Egypt. Jour. Geol., vol. II, no. 2, pp. 119,120; pl. 1, figs. 23a,b.

1967 Pseudoguembelina costulata (Cushman), Pessagno, Palaeontographica Am., vol. V, no. 37, p. 266, pl. 79, fig. 1; pl. 88, figs. 8,9; pl. 90, fig. 3. (see Pessagno for earlier synonymy).

Pseudoguembelina excolata (Cushman)

1926 Guembelina excolata Cushman, Contr. Cushman Foram. Res., vol. 2,

p. 20, pl. 2, fig. 9.

not 1958 Gumbelina excolata (Cushman), Ansary and Fakhr, Egypt. Jour. Geol., vol. II, no. 2, pp. 124,125; pl. 1, fig. 28.

1967 Pseudoguembelina excolata (Cushman), Pessagno, Palaeontographica Am., vol. V, no. 37, pp. 266,267; pl. 68, figs. 4,5; pl. 90, fig. 5. (see Pessagno for earlier synonymy).

Pseudoguembelina kempensis Esker

M.S. Pseudoguembelina kempensis Esker, Contr. Cushman Found. Foram. Res., vol. 19, pt. 4.

Remarks: This species may have a somewhat greater range than originally believed. The range appears to go from late early Maastrichtian to early late Maastrichtian.

Pseudoguembelina palpebra Brönnimann and Brown

1953 Pseudoguembelina palpebra Brönnimann and Brown, Contr. Cushman Found. Foram. Res., vol. 4, pt. 4, p. 155, text figs. 9a,b; 10a.

1967 Pseudoguembelina palpebra Brönnimann and Brown, Pessagno, Palaeontographica Am., vol. V, no. 37, p. 267, pl. 78, figs. 1-3; pl. 89, figs. 3,4. (see Pessagno for earlier synonymy).

Remarks: The specimens figured in the description of this species by Brönnimann and Brown (1953) appear to be towards one extreme in the range of variation of this species. Specimens with more chambers, a less rapid rate of increase in the chamber size, and lacking compressed final chambers seem to be very commonly represented in the samples studied from Texas. Possibly the types studied by Brönnimann and Brown are more commonly found in strata of late Maastrichtian age.

Genus Pseudotextularia Rzehak, 1895

Pseudotextularia deformis (Kikoine)

1948 Guembelina striata (Ehrenberg) var. deformis Kikoine, Soc. Géol. France, Bull., ser. 5, vol. 18, p. 20, pl. 1, figs. 8a-c.

1967 Pseudotextularia deformis (Kikoine), Pessagno, Palaeontographica Am., vol. V, no. 37, p. 269, pl. 90, fig. 16; pl. 92, figs. 19-21; pl. 97, figs. 16,17; pl. 98, figs. 15,17,18. (see Pessagno for earlier synonymy).

Remarks: Pessagno (1967) puts the lower boundary of the range of this species at the start of the middle Maastrichtian. However, the range may extend slightly down into the early Maastrichtian. Specimens that are gradational between P. deformis and P. elegans occur which make the assignment to the one species or to the other, somewhat arbitrary. This would naturally affect the position of the lower boundary of the range of P. deformis.

Pseudotextularia elegans (Rzehak)

1891 Cuneolina elegans Rzehak, Naturhist. Hofmus., Ann., Wien, vol. 6, no. 1, p. 2.

?1958 Gumbelina ultimatumida White, Ansary and Fakhr, Egypt. Jour. Geol., vol. II, no. 2, pp. 123,124; pl. 1, figs. 26a,b.

1965 Heterohelix elegans (Rzehak), van Hinte, Koninkl. Nederl. Akad. Wetensch., Proc., ser. B, 68, no. 1, p. 24, pl. 1, fig. 4.

1967 Pseudotextularia elegans (Rzehak), Pessagno, Palaeontographica Am., vol. V, no. 37, pp. 268,269; pl. 75, figs. 12-17; pl. 85, figs. 10, 11; pl. 88, figs. 14-16; pl. 89, figs. 10,11; pl. 97, fig. 18; pl. 98, figs. 19,20. (see Pessagno for earlier synonymy).

Remarks: In the original description, this species was described as

being costate. Specimens were found in the present study that would be assigned to P. elegans s.l. on shape. However, the surface ornamentation of these specimens ranges from nonstriate to faintly striata. Whether or not this is important enough for separation of a new subspecies has not been determined yet. More studies of Campanian and Maastrichtian age samples will have to be made to determine the amount of variation and the stratigraphic range of this smooth type.

Pseudotextularia intermedia de Klasz

1953 Pseudotextularia intermedia de Klasz, Geol. Bavarica, no. 17, p. 231, pl. 5, figs. 2a-c.

1967 Pseudotextularia intermedia de Klasz, Pessagno, Palaeontographica Am., vol. V, no. 37, pp. 269,270; pl. 86, fig. 11.

Genus Racemiguembelina Gallitelli, 1957

Racemiguembelina fructicosa (Egger)

1900 (1892) Guembelina fructicosa Egger, K. Bayer. Akad. Wiss. Munchen, Math.-Phys. Cl., Bd. 21 (1902), Abt. 1 (1899), p. 35, pl. 14, figs. 8,9,24,(not 25,26).

1961 Pseudotextularia varians Rzehak, Jurkiewicz, Act. Geol. Polon., 11, (4), pl. 23, figs. 26a,b.

1967 Racemiguembelina fructicosa (Egger), Pessagno, Palaeontographica Am., vol. V, no. 37, pp. 270,271; pl. 90, figs. 14,15. (see Pessagno for earlier synonymy).

Genus Planoglobulina Cushman, 1927

Planoglobulina Acervulinoides (Egger)

1899 Guembelina acervulinoides Egger, K. Bayer. Akad. Wiss., Math.-

Naturhist. Abt., Abh., kl. 2, vol. 21, p. 36, pl. 14, figs. 17,18, 20-22.

1967 Planoglobulina acervulinoides (Egger), Pessagno, Palaeontographica Am., vol. V, no. 37, p. 271, pl. 87, fig. 14. (see Pessagno for earlier synonymy).

Remarks: This species appears to be rather widespread in occurrence in Texas, thus making it a useful index fossil for the late middle to late Maastrichtian.

Planoglobulina carseyae (Plummer)

1931 Ventilabrella carseyae Plummer, Univ. Texas Bull. 3101, p. 178, pl. 9, figs. 7-9.

1967 Planoglobulina carseyae (Plummer), Pessagno, Palaeontographica Am., vol. V., no. 37, pp. 271-272; pl. 87, figs. 10,15,16. (see Pessagno for earlier synonymy).

Remarks: Specimens referred to P. carseyae occur in the Kamp Clay at the locality along Walker Creek that are striate rather than costate. These specimens are also slightly more compressed than typical specimens of P. carseyae but probably should be assigned to this species.

Planoglobulina multicamerata de Klasz

1953 Planoglobulina multicamerate de Klasz, Geol. Bavarica, no. 17, p. 230, pl. 5, figs. 1a,b.

1967 Planoglobulina multicamerata de Klasz, Pessagno, Palaeontographica Am., vol. V, no. 37, 00. 272,273; pl. 89, fig. 15. (see Pessagno for earlier synonymy).

Family Planomalinidae

Genus Globigerinelloides Cushman and Ten Dam, 1948

Globigerinelloides multispina (Lalicker)

1948 Biglobigerinella multispina Lalicker, Jour. Paleo., vol. 22, no. 5, p. 624; pl. 92, figs. 1-3.

1966 Globigerina biforaminata Hofker, Palaeontographica, suppl. bd. 10, pp. 79,96; pl. 14, fig. 82; pl. 17, figs. 64,76.

1966 Globigerina cf. aspera (Ehrenberg), Hofker, Palaeontographica, suppl. bd. 10, p. 123, pl. 18, fig. 16.

1967 Globigerinelloides multispina (Lalicker), Pessagno, Palaeontographica Am., vol. V, no. 37, pp. 276,277; pl. 70, figs. 1,2; pl. 82, figs. 10,11; pl. 91, figs. 1,2. (see Pessagno for earlier synonymy).

1968 Globigerinelloides aspera (Ehrenberg), Barr (part), Jour. Paleo., vol. 42, no. 2, pp. 313,314; pl. 37, figs. 6a,b; not figs. 3a,b.

Globigerinelloides volutus (White)

1928 Globigerina voluta White, Jour. Paleo., vol. 2, no. 3, pp. 197, 198; pl. 28, figs. 5a,b.

1967 Globigerinelloides volutus (White), Pessagno, Palaeontographica Am., vol. V, no. 37, pp. 278,279; pl. 62, figs. 9-11; pl. 100, fig. 9. (see Pessagno for earlier synonymy).

Family Rotaliporidae

Subfamily Loeblichellinae

Genus Loeblichella Pessagno, 1967

Loeblichella coarctata (Bolli)

1957 Praeglobotruncana coarctata Bolli, U. S. Nat. Mus. Bull., no. 215, p. 55, pl. 12, figs. 2a-3c.

1967 Loeblichella coarctata (Bolli), Pessagno, Palaeontographica Am., vol. 7, no. 37, pp. 288,289; pl. 48, figs. 14,16,20; pl. 61, figs. 4,5; pl. 62, figs. 1-3, 6-8; pl. 76, figs. 7-9.

Loeblichella hessi (Pessagno)

1962 Praeglobotruncana hessi hessi Pessagno, Micropaleo., vol. 8, no. 3, pp. 358-360, pl. 5, figs. 8-12.

1967 Loeblichella hessi (Pessagno), Pessagno, Palaeontographica Am., vol. V, no. 37, p. 288, pl. 48, figs. 17-19; pl. 61, figs. 6-8, 9-11; pl. 100, figs. 1,2.

Family Globotruncanidae

Genus Archaeoglobigerina Pessagno, 1967

Archaeoglobigerina blowi Pessagno

1966 Globotruncana cretacea (d'Orbigny) Douglas and Sliter, Tulane Stud. Geol., vol. 4, no. 3, pp. 109,110; pl. 1, figs. 7,8.

1967 Archaeoglobigerina blowi Pessagno, Palaeontographica Am., vol. V, no. 37, p. 316, pl. 59, figs. 1-10; pl. 94, figs. 2,3.

Remarks: The specimens assigned to this species often show a faint double keel on the early chambers of the final whorl. According to Pessagno (1967), this is within the variation of this species but only occurs rarely. This species was not found in enough abundance in the present study to warrant any comment on Pessagno's statement.

Archaeoglobigerina cretacea (d'Orbigny)

1840 Globigerina cretacea d'Orbigny, Soc. Géol. France, Mém., Paris, vol. 2, no. 1, p. 34, pl. 3, figs. 12-14.

1958 Globotruncana globigerinoides Brotzen, Bieda, Geol. Inst., Bull. 121, vol. III, Micropaleo. Res., pp. 65,66; figs. 27a-c.

1961 Globotruncana globigerinoides Brotzen, Jurkiewicz, Act. Geol. Polon., 11, (4), pl. 24, figs. 7a-c.

1965 Globotruncana cretacea (d'Orbigny), van Hinte, Koninkl. Nederl. Akad. Wetensch., Proc., Ser. b, 68, no. 1, p. 21, pl. 3, fig. 1.

1966 Globotruncana pura Hofker, Palaeontographica, suppl. bd. 10, p. 30, pl. 4, fig. 69.

not 1966 Globigerina cretacea d'Orbigny, Hofker, Palaeontographica, suppl. bd. 10, pp. 30, 79; pl. 3, fig. 64; pl 14, fig. 86.

1967 Archaeoglobigerina cretacea (d'Orbigny), Pessagno, Palaeontographica Am., vol. V, no. 37, pp. 317,318; pl. 70, figs. 3-8; pl. 94, figs. 4,5. (see Pessagno for earlier synonymy).

Genus Rugoglobigerina Brönnimann, 1952

Rugoglobrigerina hexacamerata Brönnimann

1952 Rugoglobigerina reicheli hexacamerata Brönnimann, Bull. Am. Paleo., vol. 34, no. 140, pp. 23-25, pl. 2, figs. 10-12; text figs. 8a-m.

1967 Rugoglobigerina hexacamerata Brönnimann, Pessagno, Palaeontographica Am., vol. V, no. 37, pp. 364,365; pl. 74, fig. 4; pl. 91, figs. 5-7. (see Pessagno for earlier synonymy).

Rugoglobigerina reicheli Brönnimann

1952 Rugoglobigerina reicheli reicheli Brönnimann, Bull. Am. Paleo., vol. 34, no. 140, pp. 18-20, pl. 3, figs. 10-12; text figs. 4a-m, text figs. 5a-c.

1967 Rugoglobigerina reichelli Brönniman, Pessagno, Palaeontographica Am., vol. V, no. 37, p. 365, pl. 65, figs. 5-7; pl. 91, fig. 3.

Rugoglobigerina rotundata Brönnimann

1952 Rugoglobigerina rugosa rotundata Brönnimann, Bull. Am. Paleo.,

vol. 34, no. 140, pp. 34-36, pl. 4, figs. 7-9; text figs. 15a-e, text figs. 16a-c.

1966 Rugoglobigerina rotundata Brönnimann, Douglas and Sliter, Tulane Stud. Geol., vol. 4, no. 3, p. 116, pl. 1, fig. 5, ?fig. 6.

1966 Globigerina (Rugoglobigerina) rugosa (Plummer), Hofker, Palaeontographica, suppl. bd. 10, p. 96, pl. 17, figs. 49,60,62.

1967 Rugoglobigerina rotundata Brönnimann, Pessagno, Palaeontographica Am., vol. V, no. 37, pp. 365,366; pl. 65, figs. 1-4; pl. 68, figs. 1-3. (see Pessagno for earlier synonymy).

Remarks: Specimens that appear to be transitional between R. rotundata and R. rugosa were found often in samples in this study. However, the rather restricted stratigraphic range of typical specimens of R. rotundata warrents the separation of these forms from R. rugosa.

Rugoglobigerina rugosa (Plummer)

1927 Globigerina rugosa Plummer, Univ. Tex Bull. 2644, p. 38, pl. 2, fig. 10.

1966 Rugoglobigerina rugosa (Plummer), Douglas and Sliter, Tulane Stud. Geol., vol. 4, no. 3, pp. 116,117; pl. 1, fig. 2.

1966 Globigerina (Rugoglobigerina) rugosa (Plummer), Hofker, Palaeontographica, suppl. bd. 10, p. 79, pl. 14, fig. 83; not pl. 17, figs. 59,60,62.

1966 Globigerina cretacea d'Orbigny, Hofker, Palaeontographica, suppl. bd. 10, pp. 30,64; pl. 3, fig. 64; pl. 11, figs. 119,122; ?p. 79, pl. 14, fig. 86.

1966 Globigerina pseudobulloides (Plummer), Hofker, Palaeontographica, suppl. bd. 10, p. 209, pl. 34, figs. 97,101.

1967 Rugoglobigerina rugosa (Plummer), Pessagno, Palaeontographica Am., vol. V, no. 37, pp. 366,367; pl. 75, figs. 2,3; pl. 101, figs. 8,9. (see Pessagno for earlier synonymy).

Remarks: This species appears to have been the stem species of most of the species of Rugoglobigerina. Transitional forms between R. rugosa and other species of Rugoglobigerina were often found in samples studied, particularly forms intermediate between R. macrocephala and R. rugosa.

Rugoglobigerina scotti (Brönnimann)

1952 Trinitella scotti Brönnimann, Bull. Am. Paleo., vol. 34, no. 140, p. 57, pl. 4, figs. 4-6; text figs. 30a-m.

1967 Rugoglobigerina scotti (Brönnimann), Pessagno, Palaeontographica Am., vol. V, no. 37, p. 367, pl. 74, figs. 9-14; pl. 75, figs. 4-6. (see Pessagno for earlier synonymy).

Remarks: According to Brönnimann (1952) there are five to six chambers in the final whorl with the last one or two chambers being flattened. This appears to be characteristic of most specimens. However, specimens with seven to eight chambers in the final whorl are not uncommon. Also, in the forms with a higher number of chambers, the last three chambers, rarely four, are flattened and lack rugosities on the spiral side.

Genus Globotruncana Cushman, 1927

Globotruncana aegyptiaca Nakkady

1950 Globotruncana aegyptiaca Nakkady, Jour. Paleo., vol. 24, no. 6, p. 690, pl. 90, figs. 20-22.

not 1958 Globotruncana aegyptiaca var. duwi Nakkady, Ansary and Fakhr, Egypt. Jour. Geol., vol. II, no. 2, pp. 133,134; pl. 2, figs. 13a-c.

1966 Globotruncana aegyptiaca aegyptiaca Nakkady, El-Naggar, Bull. Brit. Mus. (Nat. Hist.), Geol. suppl. 2, pp. 76-80, pl. 3, figs. 4a-d; pl. 4, fig. 1.

1966 Globotruncana aegyptiaca duwi Nakkady, El-Naggar, Bull. Brit. Mus. (Nat. Hist.), Geol. suppl. 2, pp. 80,81; pl. 3, figs. 5a-c.

1966 Globotruncana gagnebini Tilev, El-Naggar, Bull. Brit. Mus. (Nat. Hist.), Geol. suppl. 2, pp. 111,113, pl. 2, figs. 1a-3d, not 4a-d; pl. 3, figs. 3a-d,6, not 1a-d.

1967 Globotruncana aegyptiaca Nakkady, Pessagno, Palaeontographica Am., vol. V, no. 37, pp. 319-321, pl. 79, figs. 2-4; pl. 83, figs. 8-10; pl. 94, fig. 6; pl. 95, figs. 8,9. (see Pessagno for earlier synonymy).

1967 Globotruncana duwi Nakkady, Pessagno, Palaeontographica Am., vol. V, no. 37, pp. 333-336, pl. 83, figs. 2-7, pl. 95, figs. 12-14.

Remarks: G. aegyptiaca has been divided by some authors into various species (El-Naggar, 1966; Pessagno, 1967). Most authors agree that G. gagnebini Tilev is a junior synonym of G. aegyptiaca. From specimens examined in the present study, the author is of the opinion that G. duwi can not be separated from G. aegyptiaca. A study of large populations of specimens belonging in this "group" was made to determine the variability. Different combinations of the morphological features of G. aegyptiaca and G. duwi were found to occur. Some specimens could be definitely placed in one "species" or the other but there remained specimens that could not be clearly placed in either one or the other. In addition, both G. duwi and

G. aegyptiaca appear to have the same stratigraphic range. Therefore, it seems advisable to place both in the same species, G. aegyptiaca.

Globotruncana arca (Cushman)

1926 Pulvinulina arca Cushman, Contr. Cushman Lab. Foram. Res., vol. 2, pt. 1, p. 23, pl. 3, figs. 1a-c.

1958 Globotruncana arca (Cushman), Bieda, Geol. Inst., bull. 121, vol. III, Micropaleo. Res., pp. 60,61; figs. 24a-c.

not 1958 Globotruncana arca caribica Gandolfi, Ansary and Fakhr, Egypt. Jour. Geol., Vol. II, no. 2, p. 134, pl. 2, fig. 14.

?1958 Globotruncana aegyptiaca var. duwi Nakkady, Ansary and Fakhr, Egypt. Jour. Geol., pp. 133,134; pl. 2, figs. 13a-c.

1961 Globotruncana arca (Cushman), Jurkiewicz, Act. Geol. Polon., 11, (4), pl. 24, figs. 6a-c.

1965 Globotruncana arca (Cushman), van Hinte, Koninkl. Nederl. Akad. Wetensch. Proc., Ser. B, 68, no. 1, p. 20, pl. II, fig. 3; pl. III, fig. 3.

not 1966 Globotruncana arca (Cushman), Christodoulou and Marangoudakis, Eclogae Geol. Helv., vol. 59, no. 1, pp. 304,305; pl. I, figs. 5a-c, 7a-c.

1966 Globotruncana arca (Cushman), Douglas and Sliter, Tulane Stud. Geol., vol. 4, no. 3, pp. 107,108; pl. 2, figs, 6,7.

1966 Globotruncana cf. arca (Cushman), Caron, Rev. Micropaleo., vol. 9, no. 2, p. 83, pl. 5, figs. 5a-c, not figs. 6a-c.

1966 Globotruncana arca (Cushman), El-Naggar, Bull. Brit. Mus. (Nat. Hist.), Geol. suppl. 2, pp. 83-86, pl. 1, figs. 1a-c, not fig. 2. (Nat. Hist.), Geol. suppl. 2, p. 113, pl. 3, figs. 2a-d.

1966 Globotruncana leupoldi Bolli, El-Naggar, Bull. Brit. Mus. (Nat. Hist.), Geol. suppl. 2, pp. 121,122; pl. 1, figs. 4a-c.

1966 Globotruncana arca (Cushman), Hofker, Palaeontographica, suppl. bd. 10, p. 140, pl. 21, fig. 65.

1966 Globotruncana rugosa (Marie), Hofker, Palaeontographica, suppl. bd. 10, p. 30, pl. 3, fig. 67.

1967 Globotruncana arca (Cushman), Pessagno. Palaeontographica Am., vol. V, no. 37, pp. 321-323, pl. 79, figs. 5-8; pl. 90, figs. 6-9; pl. 96, figs. 7,8,17. (see Pessagno for earlier synonymy).

1968 Globotruncana arca (Cushman), Barr, Jour. Paleo., vol. 42, no. 2, p. 315, pl. 39, figs. 3a-c.

Globotruncana bulloides Vogler

1941 Globotruncana linnei (d'Orbigny) subsp. bulloides Vogler, Palaeontographica, suppl. bd. 4, abt. 4, p. 287, pl. 23, figs. 32-39.

not 1958 Globotruncana lapparenti bulloides Vogler, Bieda, Geol. Inst., Bull. 121, vol. III, Micropaleo. Res., pp. 58,59; figs. 23a-c.

1958 Globotruncana fornicata ackermanni Gandolfi, Ansary and Fakhr, Egypt. Jour. Geol., vol. II, no. 2, p. 135, pl. II, figs. 16a-c.

1958 Globotruncana arca caribica Gandolfi, Ansary and Fakhr, Egypt. Jour. Geol., vol. II, no. 2, p. 134, pl. II, fig. 14.

1963 (1962) Globotruncana marginata (Reuss), Lehamnn, Notes Serv. géol. Maroc., vol. 21, no. 156, p. 151, fig. 2x, pl. X, fig. 3.

1963 Globotruncana sp. aff. Globotruncana marginata (Reuss), Graham and Clark, Stanford Univ. Pub., Geol. Sci., vol. VIII, no. 1, p. 64, pl. 7, figs. 15a-c, 16a-c.

1967 Globotruncana bulloides Vogler, Pessagno, Palaeontographica Am., vol. V, no. 37, pp. 324-326, pl. 64, figs. 15-17; pl. 67, figs. 1-3;

pl. 73, figs. 9,10; pl. 75, figs. 4-8; pl. 97, figs. 14,15. (see Pessagno for earlier synonymy).

Remarks: The occurrence of this species with some forms that are characteristic of the middle Maastrichtian may indicate that the upper range of this species is slightly higher than that reported by Pessagno (1967).

Globotruncana contusa (Cushman)

1926 Pulvinulina arca Cushman var. contusa Cushman, Contr. Cushman Lab. Foram. Res., vol. 2, pt. 1, p. 23.

1958 Globotruncana contusa (Cushman), Bieda, Geol. Inst., Bull. 121, vol. III, Micropaleo. Res., pp. 63-65, figs. 26a-c.

1966 Marginotruncana contusa (Cushman), Hofker, Palaeontographica, suppl. bd., 10, p. 95, pl. 17, fig. 78.

1966 Globotruncana contusa contusa (Cushman), El-Naggar, Bull. Brit. Mus. (Nat. Hist.), geol. suppl. 2, pp. 90-93, pl. 7, figs. 2a-3c; pl. 11, figs. 1a,b.

1966 Globotruncana contusa patelliformis Gandolfi, El-Naggar, Bull. Brit. Mus. (Nat. Hist.), geol. suppl. 2, pp. 93-95, pl. 8, figs. 1a-c.

1966 Globotruncana contusa witwickae Gandolfi, El-Naggar, Bull. Brit. Mus., (Nat. Hist.), geol. suppl. 2, pp. 95-97, pl. 7, figs. 1a-c.

1967 Globotruncana caliciformis caliciformis (de Lapparent), El-Naggar and Haynes, Contr. Cushman Found. Foram. Res., vol. 18, pt. 1, pp. 5-8, pl. 1, figs. 2a-3c; pl. 4, figs. 1-6.

1967 Globotruncana caliciformis galeodis Herm, El-Naggar and Haynes, Contr. Cushman Found. Foram. Res., vol. 18, pt. 1, p. 8, pl. 2, figs. 3a-5c.

1967 Globotruncana caliciformis patelliformis Gandolfi, El-Naggar and Haynes, Contr. Cushman Found. Foram. Res., vol. 18, pt. 1, pp. 8-10, pl. 1, figs. 1a-c.

1967 Globotruncana caliciformis witwickae El-Naggar, Contr. Cushman Found. Foram. Res., vol. 18, pt. 1, pp. 10-11, pl. 1, figs. 4a-c.

1967 Globotruncana contusa (Cushman), Pessagno, Palaeontographica Am., vol. V, no. 37, pp. 330-332, pl. 75, figs. 18-20; pl. 77, figs. 1-9; pl. 78, figs. 6-11; pl. 92, figs. 10-12; pl. 96, figs. 11, 13-16. (see Pessagno for earlier synonymy).

Remarks: As noted by many authors, G. contusa is completely gradational with G. fornicata. It seems worthwhile to separate the forms with a very high spire from the longer ranging, low spire forms. The range of the high spire forms, G. contusa, is from the middle to the late Maastrichtian making them a very useful guide fossil.

Globotruncana elevata (Brotzen)

1934 Rotalia elevata Brotzen, Deutsch. Ver. Palastinas Zeitschr., Leipzig, Deutschland, vol. 57, p. 66, pl. 3, fig. c.

1961 Globotruncana canaliculata (Reuss), Jurkiewicz, Act. Geol. Polon., 11, (4), pl. 24, figs. 4a,b.

1963 (1962) Globotruncana cf. andori de Klasz, Lehmann, Notes Serv. geol. Maroc., vol. 21, no. 156, p. 151, fig. 2z, pl. X, fig. 1.

1963 (1962) Globotruncana stuartiformis Dalbiez, Lehamnn, Notes Serv. geol. Marco, vol. 21, no. 156, p. 151, pl. X, fig. 2.

1963 Globotruncana elevata elevata (Brotzen), Graham and Church, Stanford Univ. Pub., Geol. Sci., vol. VIII, no. 1, p. 63, pl. 7, figs. 13a-c.

1965 Globotruncana stuarti (de Lapparent), Herm, Zeitschr. Deutsch. Geol. Gesell., vol. 115, pt. 1, text fig. 15, fig. 1.

1966 Globotruncana stuarti parva Gandolfi, El-Naggar, Bull. Brit. Mus. (Nat. Hist.), Geol. suppl. 2, pp. 131-133, pl. 9, figs. 2a-d.

1966 Globotruncana stuarti stuarti (de Lapparent), El-Naggar, Bull. Brit. Mus. (Nat. Hist.), Geol. suppl. 2, pp. 133-136, pl. 8, figs. 4a-d; not pl. 9, figs. 1a-d.

1966 Globotruncana stuarti subspinosa (Pessagno), El-Naggar, Bull. Brit. Mus. (Nat. Hist.), Geol. suppl. 2, pp. 139,140; pl. 10, figs. 3a-c; not fig. 2.

1966 Globotruncana elevata elevata (Brotzen), Christodoulou and Marangoudakis, Eclogae Geol. Helv., vol. 59, no. 1, p. 306, pl. 1, figs. 10a-c, 11a-c; text fig. 4, nos. 1,3,5,6,9.

1966 Globotruncana elevata (Brotzen), Douglas and Sliter, Tulane Stud. Geol., vol. 4, no. 3, p. 110, pl. 3, fig. 2.

1966 Globotruncana stuartiformis Dalbiez, Douglas and Sliter, Tulane Stud. Geol., vol. 4, no. 3, pp. 114,115; pl. 3, fig. 3, not figs. 4,5.

1966 Globotruncana esnehensis (Nakady)sic., Hofker, Palaeontographica, suppl. bd. 10, p. 95, pl. 17, fig. 73.

1967 Globotruncana elevata (Brotzen), Pessagno, Palaeontographica Am., vol. V, no. 37, pp. 336-338, pl. 78, figs. 12-14; pl. 80, figs. 1-6; pl. 81, figs. 9-14; pl. 93, figs. 1-5,8; text fig. 44. (see Pessagno for earlier synonymy).

1967 Globotruncana stuartiformis Dalbiez, Pessagno, Palaeontographica Am., vol. V, no. 37, pp. 357-359, pl. 80, figs. 3-6; pl. 92, figs. 1-3; pl. 93, figs. 6,7; text fig. 44, fig. 17.

1968 Globotruncana andori de Klasz, Barr, Jour. Paleo., vol. 42, no. 2, pp. 314,315; pl. 38, figs. 4a-c.

1968 Globotruncana stuartiformis Dalbiez, Barr, Jour. Paleo., vol. 42, no. 2, p. 318, pl. 38, figs. 3a-c; pl. 40, figs. 1a-c, 2a-c.

Remarks: The author includes forms within this species that show a wide variation in sutural shape from those with partly tangential to entirely curved sutures. Only when all of the sutures on the final whorl are nearly tangential should specimens be referred to G. elevata stuartiformis. This follows the description of this subspecies by Dalbiez (1955). All types of transitional forms exist between G. elevata stuartiformis and G. elevata elevata. Various authors have used their own subjective views in placing specimens in one subspecies or the other, leading to confusion in the literature between these forms. The reported ranges of both of these subspecies are essentially the same, Campanian to Maastrichtian.

Globotruncana fornicata Plummer

1931 Globotruncana fornicata Plummer, Univ. Texas Bull. 3101, pp. 198, 199; pl. 13, figs. 4a-c,5,6.

1958 Globotruncana fornicata Plummer, Bieda, Geol. Inst., Bull. 121, vol. III, Micropaleo. Res., pp. 61-63, figs. 25a-c.

not 1958 Globotruncana fornicata ackermanni Gandolfi, Ansary and Fakhr, Egypt. Jour. Geol., vol. II, no. 2, p. 135, pl. 2, figs. 16a-c.

1963 (1962) Globotruncana fornicata Plummer, Lehmann, Notes Serv. geol. Marco, vol. 21, no. 156, p. 148, figs. 2v,w,3m,r,t; pl. VII, figs. 1-4.

1963 Globotruncana fornicata Plummer, Graham and Church, Stanford Univ. Pub., Geol. Sci., vol. III, no. 1, pp. 63,64; pl. 7, figs. 14a-c.

1965 Globotruncana fornicata Plummer, van Hinte, Koninkl. Nederl. Akad. Wetensch., Proc., Ser. B, 68, no. 1, pp. 21-23, pl. I, fig. 1; pl. II, figs. 1,2.

1966 Globotruncana fornicata Plummer, Caron, Rev. Micropaleo., vol. 9, no. 2, p. 80, pl. 4, figs. 6a-c.

1966 Globotruncana fornicata Plummer, El-Naggar, Bull. Brit. Mus. (Nat. Hist.), Geol. suppl. 2, pp. 102,103; pl. 14, figs. 3a-5d.

1966 Globotruncana fornicata cesarensis Gandolfi, El-Naggar, Bull. Brit. Mus. (Nat. Hist.) Geol. suppl. 2, pp. 103-105, pl. 13, figs. 3a-4c; pl. 14, figs. 6a-c.

1966 Globotruncana fornicata fornicata Plummer, El-Naggar, Bull. Brit. Mus. (Nat. Hist.) Geol. suppl. 2, pp. 105-108, pl. 13, figs. 5a-c, 6; pl. 14, figs. 1z-c.

1966 Globotruncana fornicata globulocamerata El-Naggar, Bull. Brit. Mus. (Nat. Hist.) Geol. suppl. 2, pp. 108,109; pl. 13, figs. 1a-c; pl. 14, figs. 2a-c.

1966 Globotruncana fornicata manaurensis Gandolfi, El-Naggar, Bull. Brit. Mus. (Nat. Hist.), Geol. suppl. 2, pp. 109-11; pl. 13, figs. 2a-c.

1966 Globotruncana adamsi El-Naggar, Bull. Brit. Mus. (Nat. Hist.), Geol. suppl. 2, pp. 75,76; pl. 8, figs. 2a-d.

1966 Globotruncana fornicata Plummer, Douglas and Sliter, Tulane Stud. Geol., vol. 4, no. 3, pp. 110,111; pl. 2, figs. 2,4; not figs. 1,3.

1966 Globotruncana arca (Cushman), Christodoulou and Marangoudakis, Eclogae Geol. Helv., vol. 59, no. 1, pp. 304,305; pl 1, figs. 7a-c; not figs. 5a-c.

1967 Globotruncana fornicata Plummer, Pessagno, Palaeontographica Am., vol. V, no. 37, pp. 338-341, pl. 63, figs. 1-9; pl. 80, figs. 7-9;

pl. 96, figs. 3,4. (see Pessagno for earlier synonymy).

1968 Globotruncana fornicata Plummer, Barr, Jour. Paleo., vol. 42, no. 2, p. 315, pl. 39, figs. 1a-c, 2a-c.

Globotruncana gansseri Bolli

1951 Globotruncana gansseri Bolli, Jour. Paleo., vol. 25, no. 2, pp. 196, 197; pl. 34, figs. 1-3.

1958 Globotruncana gansseri Bolli, Ansary and Fakhr, Egypt. Jour. Geol., vol. II, no. 2, pp. 135,136; pl. II, figs. 17a-c.

1966 Globotruncana youssefi El-Naggar, Bull. Brit. Mus. (Nat. Hist.), Geol. suppl. 2, pp, 144,145; pl. 6, figs 4a-d.

1966 Globotruncana gansseri gandolfi El-Naggar, Bull. Brit. Mus. (Nat. Hist.), Geol. suppl. 2, pp. 115,116; pl. 5, figs. 2a-d.

1966 Globotruncana gansseri gansseri Bolli, El-Naggar, Bull. Brit. Mus. (Nat. Hist.), Geol. suppl. 2, pp. 117-119, pl. 5, figs. 1a-d; pl. 11, fig. 3.

1966 Globotruncana gansseri subgansseri Gandolfi, El-Naggar, Bull. Brit. Mus. (Nat. Hist.), Geol. suppl. 2, pp. 119,120; pl. 5, figs. 3a-d.

1966 Globotruncana lugeoni Tilev, El-Naggar, Bull. Brit. Mus. (Nat. Hist.), Geol. suppl. 2, pp. 122,123; pl. 6, figs. 1a-d; pl. 11, fig. 2.

not 1966 Globotruncana gansseri dicarinata Pessagno, El-Naggar, Bull. Brit. Mus. (Nat. Hist.), Geol. suppl. 2, pp. 114,115; pl. 5, figs. 4a-d.

1967 Globotruncana gansseri Bolli, Pessagno, Palaeontographica Am., vol. V, no. 37, pp. 341-343, pl. 75, fig. 1; pl. 92, figs. 13-18; pl. 95, figs. 1-4. (see Pessagno for earlier synonymy).

Globotruncana linneiana (d'Orbigny)

1839 Rosalina linneiana d'Orbigny, in Ramon de La Sagra, Historii physique et Naturelle de l'Île de Cuba; A. Bertrand, Paris, France, p. 110, vol. 8, pl. 5, figs. 10-12.

1958 Globotruncana lapparenti tricarinata (Quereau), Bieda, Geol. Inst., Bull. 121, vol. III, Micropaleo. Res., pp. 55-58, figs. 22a-c.

1958 Globotruncana lapparenti bulloides Vogler, Bieda, Geol. Inst., Bull. 121, vol. III, Micropaleo. Res., pp. 58,59; figs. 23a-c.

1961 Globotruncana lapparenti tricarinata (Quereau), Jurkiewicz, Act. Geol. Polon., 11, (4), pl. 24, figs. 9a-c.

?1961 Globotruncana ventricosa White, Jurkiewicz, Act. Geol. Polon., 11, (4), pl. 24, figs. 8a-c.

1963 (1962) Globotruncana linneiana (d'Orbigny), Lehmann, Notes Serv. geol. Marco, vol. 21, no. 156, pp. 149,150; pl. VIII, figs. 4,5.

not 1963 (1962) Globotruncana cf. tricarinata (Quereau), Lehmann, Notes Serv. geol. Marco, vol. 21, no. 156, p. 147, pl. IV, fig. 2.

1965 Globotruncana linneiana (d'Orbigny), van Hinte, Koninkl. Nederl. Akad. Wetensch., Proc., Ser. B, 68, no. 1, p. 23, pl. 1, fig. 3.

1965 Globotruncana tricarinata (Quereau), van Hinte, Koninkl. Nederl. Akad. Wetensch., Proc., Ser. B, 68, no. 1, p. 23, pl. III, fig. 2.

1966 Globotruncana lapparenti lapparenti Brotzen, Marianos and Zingula, Jour. Paleo., vol. 40, no. 2, p. 340, pl. 39, figs. 3a-c.

1966 Globotruncana sp. B. Marianos and Zingula, Jour. Paleo., vol. 40, no. 2, p. 341, pl. 39, figs. 7a-c.

1966 Globotruncana linneiana (d'Orbigny), Caron, Rev. Micropaleo., vol. 9, no. 2, p. 83, pl. 5, figs. 3a-c.

1966 Globotruncana lapparenti tricarinata (Quereau), Caron, Rev. Micropaleo., vol. 9, no. 2, p. 83, pl. 5, figs. 1a-c.

not 1966 Globotruncana lapparenti lapparenti Brotzen, Caron, Rev. Micropaleo., vol. 9, no. 2, p. 80, pl. 5, figs. 4a-c.

1966 Globotruncana linneiana (d'Orbigny), Douglas and Sliter, Tulane Stud. Geol., vol. 4, no. 3, p. 112, pl. 4, fig. 8, not figs. 6,7; pl. 4, figs. 4,6,9.

1966 Globotruncana tricarinata (Quereau), Douglas and Sliter, Tulane Stud. Geol., vol. 4, no. 3, p. 115, pl. 4, figs. 9,10.

1966 Globotruncana fornicata Plummer, Douglas and Sliter, Tulane Stud. Geol., vol. 4, no. 3, pp. 110,111; pl. 2, figs. 1,3; not figs. 2,4.

1966 Globotruncana lapparenti lapparenti Bolli, Christodoulou and Marangoudakis, Eclogae Geol. Helv., vol. 59, no. 1, p. 305, pl. 1, figs. 2a-c, 6a-c.

1966 Globotruncana aspera Hofker, Palaeontographica, suppl. bd. 10, p. 30, pl. 3, fig. 66.

1967 Globotruncana lapparenti Brotzen, Pessagno, Palaeontographica Am., vol. V, no. 37, pp. 344-346, pl. 71, figs. 6-13; pl. 97, figs. 8,9.

1967 Globotruncana linneiana (d'Orbigny), Pessagno, Palaeontographica Am., vol. V, no. 37, pp. 346-349, pl. 72, figs. 1-4; 7-9; pl. 97, figs. 11-13. (see Pessagno for earlier synonymy).

1968 Globotruncana tricarinata (Quereau), Barr, Jour. Paleo., vol. 42, no. 2, p. 319, pl. 38, figs. 1a-c, figs. 8a-c.

Remarks: Pessagno (1967) reports that G. lapparenti is completely gradational with G. linneiana, being separated from this species only by processing a narrower double keel. There seems to be little reason for maintaining two specific names for one natural group in

which the only difference is a change in the height of the double keel. It should be sufficient to note that there is a general increase in the height of the double keel of G. linneiana in younger age strata. Therefore, G. lapparenti is regarded as a junior synonym of G. linneiana.

Globotruncana nothi (Brönnimann and Brown)

1956 Rugotruncana nothi Brönnimann and Brown, Eclogae Geol. Helv., vol. 48, no. 2, p. 551, pl. 22, figs. 16-18.

1966 Globotruncana cf. convexa Sandidge, El-Naggar, Bull. Brit. Mus. (Nat. Hist.), Geo. suppl. 2, pp. 97,98; pl. 1, figs. 5a-c.

not 1966 Globotruncana nothi Brönnimann and Brown, Douglas and Sliter, Tulane Stud. Geol., vol. 4, no. 3, p. 113, pl. 2, fig. 5.

1967 Globotruncana nothi (Brönnimann and Brown), Pessagno, Palaeontographica Am., vol. V, no. 37, pp. 350,351; pl. 67, figs. 4-9; pl. 68, figs. 6-8; pl. 96, fig. 10. (see Pessagno for earlier synonymy).

Globotruncana orientalis El-Naggar

1963 (1962) Globotruncana cf. conica White, Lehmann, Notes Serv. geol. Maroc, vol. 21, no. 156, pp. 150,151; fig. 2y, pl. X, fig. 4.

1965 Globotruncana bolli-rosetta-conica, Herm, Zeitschr. Deutsch. Geol. Gesell., vol. 115, pt. 1, text fig. 5.

1966 Globotruncana orientalis El-Naggar, Bull. Brit. Mus. (Nat. Hist.), Geol. suppl. 2, pp. 125-127, pl. 12, figs. 4a-d.

1966 Globotruncana fareedi El-Naggar, Bull. Brit. Mus. (Nat. Hist.), Geol. suppl. 2, pp. 100-102, pl. 9, figs. 4a-d.

1966 Globotruncana sp. El-Naggar, Bull. Brit. Mus. (Nat. Hist.), Geol. suppl. 2, pp. 145,146; pl. 1, figs. 6a-c.

1967 Globotruncana stephensoni Pessagno, Palaeontographica Am., vol. V,

no. 37, pp. 354-356, pl. 69, figs. 1-7; pl. 96, figs. 5,6. (see Pessagno for earlier synonymy).

Remarks: Apparently the species named by Pessagno is a junior synonym of G. orientalis El-Naggar. Pessagno places the upper limit of this species questionably in the middle Maastrichtian. El-Naggar places the upper limit of G. orientalis in the Abathomphalus mayaroensis zone. The author has observed specimens of G. orientalis associated with Abathomphalus mayaroensis in a sample from the Mendez shale of Mexico. Therefore it seems safe to assume that the range of G. orientalis extends up into the late Maastrichtian. G. fareedi El-Naggar appears to be just a variant of G. orientalis. El-Naggar even shows that G. orientalis and G. fareedi have exactly the same stratigraphic range. Since the holotype of G. orientalis best displays the characteristics that serve to distinguish the species of G. orientalis-fareedi, it seems best to suppress the name fareedi in favor of orientalis. As Pessagno has stated, some specimens of this species may be exact homeomorphs of some specimens of G. stuarti. This has made assignment of some specimens to one species or the other, questionable in some cases in the present study. However, nowhere has this problem influenced the age determination of a particular sample due to the occurrence of other diagnostic species.

Globotruncana sharawnaensis El-Naggar

1966 Globotruncana sharawnaensis El-Naggar, Bull. Brit. Mus. (Nat. Hist.), Geol. suppl. 2, pp. 130,131; pl. 12, figs. 3a-d.

Remarks: Only a single specimen was found that could definitely be assigned to this species. The distinctive character of this species appears to be the single keel on the final whorl becoming a double

keel on the last couple of chambers. The other morphological features of this species are very close to those of some specimens of G. orientalis and G. stuarti. Possibly some specimens of this species may be homeomorphs of G. orientalis and G. stuarti. More study of this species needs to be done in order to determine its relationship to G. orientalis and G. stuarti.

Globotruncana stuarti (de Lapparent)

1918 Rosalina stuarti de Lapparent, Serv. Carte Géol. Mem., Paris, France, p. 11, pl. 1, ?figs. 5,6,7; text fig. 4 (p. 12); text figs. 5a,b,?c (p. 13).

1958 Globotruncana citae Bolli, Ansary and Fakhr, Egypt. Jour. Geol., vol. II, no. 2, pp. 134,135; pl. II, figs. 15a-c.

1966 Globotruncana conica White, El-Naggar, Bull. Brit. Mus. (Nat. Hist.), Geol. suppl. 2, pp. 87-90, pl. 12, figs. 2a-d.

1966 Globotruncana esnehensis Nakkady and Osman, El-Naggar, Bull. Brit. Mus. (Nat. Hist.), Geol. suppl. 2, pp. 98-100, pl. 12, figs. 1a-d.

1966 Globotruncana stuarti stuarti (de Lapparent), El-Naggar, Bull. Brit. Mus. (Nat. Hist.), Geol. suppl. 2, pp. 133-136, pl. 8, figs. 4a-d; not pl. 9, figs. 1a-d.

1966 Globotruncana stuarti subspinosa (Pessagno), El-Naggar, Bull. Brit. Mus. (Nat. Hist.), Geol. suppl. 2, pp. 139,140; pl. 10, figs. 2a-c, not figs. 3a-c.

not 1966 Globotruncana stuarti parva Gandolfi, El-Naggar, Bull. Brit. Mus. (Nat. Hist.), Geol. suppl. 2, pp. 131-133, pl. 9, figs. 2a-d.

1966 Globotruncana conica White, Douglas and Sliter, Tulane Stud. Geol., vol. 4, no. 3, pp. 108,109; pl. 3, fig. 9.

1967 Globotruncana conica White, Pessagno, Palaeontographica Am., vol.

V, no. 37, pp. 338-340, pl. 65, figs. 8-10; pl. 82, figs. 1-5; pl. 93, figs. 12,13.

1967 Globotruncana stuarti (de Lapparent), Pessagno, Palaeontographica Am., vol. V, no. 37, pp. 356,357; pl. 81, figs. 1-6; pl. 93, figs. 9-11; pl. 94, fig. 7. (see Pessagno for earlier synonymy).

Remarks: G. conica White appears to be a junior synonym of G. stuarti (de Lapparent). Both have essentially the same stratigraphic range. Pessagno (1967) reports that these forms differ chiefly in the degree of convexity of the spiral side of the test. An arbitrary value based on the thickness of the umbilical side divided by the thickness of the spiral side was used to separate these forms into "species" by Pessagno. Such a division does not appear to be natural and apparently has no practical significance. Therefore, G. conica is considered to be a junior synonym of G. stuarti.

Globotruncana trinidadensis Gandolfi

1955 Globotruncana caliciformis trinidadensis Gandolfi, Bull. Am. Paleo., vol. 36, no. 155, p. 47, pl. 3, figs. 2a-c.

1967 Globotruncana trinidadensis Gandolfi, Pessagno, Palaeontographica Am., vol. V, no. 37, pp. 359-362, pl. 84, figs. 4-12; pl. 90, figs. 9,10; pl. 96, figs. 1,2; text fig. 57. (see Pessagno for earlier synonymy).

Globotruncana ventricosa White

1928b Globotruncana canaliculata var. ventricosa White, Jour. Paleo., vol. 2, no. 4, p. 284, pl. 38, figs. 3a-c.

1963 (1962) Globotruncana cf. ventricosa White, Lehmann, Notes Serv. geol. Maroc, vol. 21, no. 156, p. 150, pl. VI, fig. 5.

1966 Globotruncana ventricosa White, Douglas and Sliter, Tulane Stud. Geol., vol. 4, no. 3, pp. 115,116; pl. 3, fig. 1.

1967 Globotruncana ventricosa White, Pessagno, Palaeontographica Am., vol. V, no. 37, pp. 362-364, pl. 75, figs. 21-26; pl. 79, figs. 9-14; pl. 95, figs. 10,11; pl. 99, fig. 2. (see Pessagno for earlier synonymy).

1968 Globotruncana ventricosa White, Barr, Jour. Paleo., vol. 42, no. 2, p. 319, pl. 40, figs. 3a-c.

Genus Rugotruncana Bronnimann and Brown, 1956

Rugotruncana subcircumnodifer (Gandolfi)

1955 Globotruncana (Rugoglobigerina) circumnodifer subcircumnodifer Gandolfi, Bull. Am. Paleo., vol. 36, no. 155, p. 44, pl. 2, figs. 8a-c.

1966 Globotruncana gansseri dicarinata Pessagno, El-Naggar, Bull. Brit. Mus. (Nat. Hist.), Geol. suppl. 2, pp. 114,115; pl. 5, figs. 4a-d.

1967 Rugotruncana subcircumnodifer (Gandolfi), Pessagno, Palaeontographica Am., vol. V, no. 37, pp. 369,370; pl. 62, figs. 14-16; pl. 74, figs. 1-3. (see Pessagno for earlier synonymy).

1968 Globotruncana subcircumnodifer Gandolfi, Barr, Jour. Paleo., vol. 42, no. 2, pp. 318,319; pl. 38, figs. 6a-c; pl. 40, figs. 4a-c.

Rugotruncana subpennyi (Gandolfi)

1955 Globotruncana (Rugoglobigerina) pennyi subpennyi Gandolfi, Bull. Am. Paleo., vol. 36, no. 155, p. 73, pl. 7, figs. 7a-c.

1966 Globotruncana nothi Bronnimann and Brown, Douglas and Sliter, Tulane Stud. Geol., vol. 4, no. 3, p. 113, pl. 2, fig. 5.

1967 Rugotruncana subpennyi (Gandolfi), Pessagno, Palaeontographica Am., vol. V, no. 37, pp. 370,371; pl. 76, figs. 12-14; pl. 91, figs.

8-15. (see Pessagno for earlier synonymy).

Family Abathomphalidae

Genus Globotruncanella Reiss, 1957

Globotruncanella havanensis (Voorwijk)

1937 Globotruncana havanensis Voorwijk, Kon. Akad. Wetensch., Proc., vol. 40, p. 195, pl. 1, figs. 25,26,29.

1966 Globotruncanella havanensis (Voorwijk), Douglas and Sliter, Tulane Stud. Geol., vol. 4, no. 3, pp. 111, pl. 1, figs. 9,10.

1967 Globotruncanella havanensis (Voorwijk), Pessagno, Palaeontographica Am., vol. V, no. 37, p. 373, pl. 84, figs. 1-3. (see Pessagno for earlier synonymy).

1968 Praeglobotruncana havanensis (Voorwijk), Barr, Jour. Paleo., vol. 42, no. 2, p. 314, pl. 37, figs. 1,2.

Remarks: This species has usually been described as having four chambers in the final whorl. In the present study specimens with five chambers in the final whorl were observed. The forms with a higher number of chambers have a less rapid increase in chamber size.

Globotruncanella petaloidea (Gandolfi)

1955 Globotruncana (Rugoglobigerina) petaloidea Gandolfi, Bull. Am. Paleo., vol. 36, no. 155, p. 52, pl. 3, figs. 13a-c.

1966 Globotruncana petaloidea Gandolfi, Douglas and Sliter, Tulane Stud. Geol., vol. 4, no. 3, pp. 113,114; pl. 1, fig. 11.

1967 Globotruncanella petaloidea (Gandolfi), Pessagno, Palaeontographica Am., vol. V, no. 37, pp. 374,375; pl. 82, figs. 6-9. (see Pessagno for earlier synonymy).

Remarks: This species like the closely related species G. havanensis, has usually been described as having four chambers in the outer whorl.

In the present study specimens with as many as six chambers in the final whorl have been observed.

Family Globorotaliidae

Subfamily Globorotaliinae

Genus Globorotalia Cushman, 1927

Globorotalia compressa (Plummer)

1927 Globigerina compressa Plummer, Univ. Texas Bull. 2644, p. 135, pl. 8, figs. 11a-c.

1964 Globorotalia compressa (Plummer), Nogan, Cushman Found. Foram. Res., Spec. Pub. no. 7, p. 40, pl. 5, figs. 7-9. (see Nogan for earlier synonymy).

1966 Globigerina compressa Plummer, Hofker, Palaeontographica, suppl. bd. 10, pp. 156,231,317; pl. 25, fig. 167; pl. 43, fig. 94; pl. 74, fig. 168; pl. 75, fig. 184.

Globorotalia pseudobulloides (Plummer)

1927 Globigerina pseudobulloides Plummer, Univ. Texas Bull. 2644, pp. 133, 134; pl. 8, figs. 9a-c.

1964 Globorotalia pseudobulloides (Plummer), Nogan, Cushman Found. Foram. Res., Spec. Pub. no. 7, p. 41, pl. 6, figs. 1-3. (see Nogan for earlier synonymy).

1966 Globigerina pseudobulloides Plummer, Hofker, Palaeontographica, suppl. bd. 10, pp. 96,157,209,245,317; pl. 17, figs. 63,65,67,68, 75; pl. 25, fig. 167; not pl. 34, figs. 97,101; not pl. 39, fig. 49; pl. 48, fig. 37; pl. 72, fig. 152, not 153; pl. 73, figs. 156,157, 161; pl. 74, figs. 167,173,176; pl. 76, figs. 186,189.

Globorotalia trinidadensis Bolli

1957 Globorotalia trinidadensis Bolli, U. S. Nat. Mus., Bull., no. 215, p. 73, pl. 16, figs. 19-21.

1964 Globorotalia trinidadensis Bolli, Luterbacher, Eclogae Geol. Helv., vol. 57, no. 2, pp. 651,652; figs. 26-29.

1965 Globorotalia praecursoria (Morozova), Berggren (part), Micropaleo., vol. 11, no. 3, pp. 293,294; pl. 1, figs. 1-4. (see Berggren for earlier synonymy).

1966 Globigerina pseudobulloides Plummer, Hofker, Palaeontographica, suppl. bd. 10, p. 245, pl. 39, fig. 49; pl. 72, fig. 153.

Remarks: Berggren (1965) considers G. trinidadensis to be a junior synonym of G. praecursoria. Berggren states that G. praecursoria is at one end of the variability of G. trinidadensis, but the typical forms of G. praecursoria are difficult to recognize in the lower Danian. Luterbacher (1964) has kept these forms separated as two distinct species. The specimens in the present study fit in well with Bolli's species, therefore they are referred to G. trinidadensis.

Family Globigerinidae

Subfamily Globigerininae

Genus Subbotina Brotzen and Pozaryska, 1961

Subbotina triloculinoides (Plummer)

1927 Globigerina triloculinoides Plummer, Univ. Texas Bull. 2644, pp. 134,135; pl. 8, figs. 10a-c.

1957 Globigerina triloculinoides Plummer, Bolli, U. S. Nat. Mus., Bull., no. 215, p. 70, pl. 15, figs. 18-20; pl. 17, figs. 25,26. (see Bolli for earlier synonymy).

1966 Globigerina triloculinoides Plummer, Hofker, Palaeontographica, suppl. bd. 10, p. 245, pl. 48, figs. 31,39.

Genus Globoconusa Khalilov, 1956

1953 Globigerina daubjergensis Bronnimann, Eclogae Geol. Helv., vol. 45, no. 2, pp. 340,341; fig. 1.

1964 Globigerinoides daubjergensis (Bronnimann), Nogan, Cushman Found. Foram. Res., Spec. Pub. no. 7, p. 38, pl. 4, figs. 10-12. (see Nogan for earlier synonymy).

1966 Globigerina daubjergensis Bronniman, Hofker, Palaeontographica, suppl. bd. 10, pp. 96,157,210,231,245,314-317; pl 17, figs. 61,74; pl. 24, fig. 140; pl. 25, fig. 168; pl 39, figs. 50,68; pl. 43, figs. 107,111; pl. 48, figs. 35,36,38; pl. 72, fig. 154; pl. 73, figs. 160, 163,164; pl. 74, figs. 169,174,175,177; pl. 75, figs. 181,182,185; pl. 76, figs. 187,188,190; text figs. 173,174.

Remarks: G. daubjergensis is rare in occurrence in the samples of the Littig Cng. from the Walker Creek locality. This species was not recognized in any of the well samples. This absence may be due to the rareity of this species or due to the small size of this species, only the size fraction of the samples above a 150 mesh sieve being studied.

FAUNAL DISTRIBUTION TABLES

	Harrison County Atlantic-Richfield Co. #1 Isom		Harrison County Ark-La Gas Co. #1 J. Davis	
	Well sample interval		Well sample interval	
	1630–40'	1640–70'	800–30'	860–90'
Globorotalia compressa (Plummer)		X		
Globorotalia pseudobulloides (Plummer)	X	X	X	
Globorotalia trinidadensis Bolli		X	X	
Subbotina trilocullnoides (Plummer)		X	X	
Guembelitria cretacea Cushman		X		
Heterohelix glabrans (Cushman)				
Heterohelix globulosa (Ehrenberg)	X			X
Heterohelix navarroensis Loeblich				
Heterohelix planata (Cushman)		X		
Heterohelix punctulata (Cushman)				X
Heterohelix striata (Ehrenberg)		X		X
Heterohelix ultimatumida (White)				
Gublerina robusta de Klasz				
Pseudoguembelina costulata (Cushman)				X
Pseudoguembelina excolata (Cushman)		X		
Pseudoguembelina lempensis Esker		X		
Pseudoguembelina palpebra Pronnimann and Brown				X
Pseudotextularia deformis (Kikoine)				
Pseudotextularia elegans (Rzehak)		X		X
Pseudotextularia intermedia de Klasz				
Racemiguembelina fructicosa (Egger)				
Planoglobulina acervulinoides (Egger)		X		
Planoglobulina carseyae (Plummer)				
Planoglobulina multicamerata de Klasz				
Globigerinelloides multispina (Lalicker)		X		
Globigerinelloides volutus (White)		X		
Loeblichella coarctata (Bolli)				
Loeblichella hessi (Pessagno)				X
Archaeoglobigerina blowi Pessagno		X		X
Archaeoglobigerina cretacea (d'Orbigny)				
Rugoglobigerina hexacamerata Bronnimann				
Rugoglobigerina reicheli Bronnimann		X		
Rugoglobigerina rotundata Bronnimann				X
Rugoglobigerina rugosa (Plummer)		X		X
Rugoglobigerina scotti (Bronnimann)		X		
Globotruncana aegyptiaca Nakkady		X		X
Globotruncana arca (Cushman)				X
Globotruncana bulloides Vogler				
Globotruncana contusa (Cushman)				
Globotruncana elevata (Brotzen)		X		
Globotruncana fornicata Plummer		X		
Globotruncana gansseri Bolli				X
Globotruncana linneiana (d'Orbigny)				
Globotruncana ochi (Bronnimann and Brown)		X		
Globotruncana orientalis El Naggar				X
Globotruncana sharaynaensis El Naggar				
Globotruncana stuarti (de Lapparent)				
Globotruncana trinidadensis Gandolfi				
Globotruncana ventricosa White				
Rugotruncana subcircumnodifer (Gandolfi)				
Rugotruncana subpennyi (Gandolfi)				
Globotruncanella havanensis (Voorwijk)		X		
Globotruncanella petaloidea (Gandolfi)				

Table 1, faunal distribution, Harrison County

	Wood County Bridewell Co. #1 Coker		Van Zandt County Humble Oil Co. #1 Surratt		
	Well sample interval		Well sample interval		
	2190–200'	2230–30'	966–97'	997–1028'	1026–58'
Globorotalia compressa (Plummer)					
Globorotalia pseudobulloides (Plummer)	X		X		
Globorotalia trinidadensis Bolli				X	
Subbotina triloculinoides (Plummer)					
Guembelitria cretacea Cushman					X
Heterohelix glabrans (Cushman)					X
Heterohelix globulosa (Ehrenberg)	X	X		X	X
Heterohelix navarroensis Loeblich					
Heterohelix planata (Cushman)					X
Heterohelix punctulata (Cushman)				X	X
Heterohelix striata (Ehrenberg)				X	X
Heterohelix ultimatumida (White)					
Gublerina robusta de Klasz					
Pseudoguembelina costulata (Cushman)					
Pseudoguembelina excolata (Cushman)				X	
Pseudoguembelina kempensis Esker				X	
Pseudoguembelina palpebra Bronnimann and Brown				X	X
Pseudotextularia deformis (Kikoine)				X	
Pseudotextularia elegans (Rzehak)	X				
Pseudotextularia intermedia de Klasz					
Racemiguembelina fructicosa (Egger)					
Planoglobulina acervulinoides (Egger)					
Planoglobulina carseyae (Plummer)					
Planoglobulina multicamerata de Klasz					
Globigerinelloides multispina (Lalicker)				X	
Globigerinelloides volutus (White)				X	
Loeblichella coarctata (Bolli)					
Loeblichella hessi (Pessagno)					
Archaeoglobigerina blowi Pessagno					
Archaeoglobigerina cretacea (d'Orbigny)					
Rugoglobigerina hexacamerata Bronnimann					
Rugoglobigerina reicheli Bronnimann	X				
Rugoglobigerina rotundata Bronnimann					
Rugoglobigerina rugosa (Plummer)		X		X	
Rugoglobigerina scotti (Bronnimann)				X	
Globotruncana aegyptiaca Nakkady				X	
Globotruncana arca (Cushman)					
Globotruncana bulloides Vogler					
Globotruncana contusa (Cushman)					
Globotruncana elevata (Brotzen)					
Globotruncana fornicata Plummer					
Globotruncana gansseri Bolli					
Globotruncana linneiana (d'Orbigny)					
Globotruncana nothi (Bronnimann and Brown)					
Globotruncana orientalis El Naggar					
Globotruncana sharawnaensis El Naggar					
Globotruncana stuarti (de Lapparent)				X	
Globotruncana trinidadensis Gandolfi					
Globotruncana ventricosa White					
Rugotruncana subcircumnodifer (Gandolfi)					
Rugotruncana subpennyi (Gandolfi)					
Globotruncanella havanensis (Voorwijk)					X
Globotruncanella petaloidea (Gandolfi)					

Table 2, faunal distribution, Wood and Van Zandt Counties

	Shelby County Pan American Oil Co. #1-A Parker			Shelby County Mallard and Locke Co. #1 Roller Heirs	
Well sample interval	2600-30'	2630-60'	2660-90'	1550-80'	1580-610'
Globorotalia compressa (Plummer)					
Globorotalia pseudobulloides (Plummer)	X			X	
Globorotalia trinidadensis Bolli	X			X	
Subbotina triloculinoides (Plummer)	X				
Guembelitria cretacea Cushman	X				
Heterohelix glabrans (Cushman)		X			
Heterohelix globulosa (Ehrenberg)		X		X	
Heterohelix navarroensis Loeblich		X			
Heterohelix planata (Cushman)					X
Heterohelix punctulata (Cushman)		X			
Heterohelix striata (Ehrenberg)					X
Heterohelix ultimatumida (White)					
Gubierina robusta de Klasz					
Pseudoguembelina costulata (Cushman)		X			
Pseudoguembelina excolata (Cushman)		X	X		X
Pseudoguembelina kempensis Esker		X	X		X
Pseudoguembelina palpebra Bronnimann and Brown		X	X		X
Pseudotextularia deformis (Kikoine)		X	X		X
Pseudotextularia elegans (Rzehak)	X	X	X	X	X
Pseudotextularia intermedia de Klasz					
Racemiguembelina fructicosa (Egger)		X			X
Planoglobulina acervulinoides (Egger)		X	X		X
Planoglobulina carseyae (Plummer)		X			X
Planoglobulina multicamerata de Klasz					X
Globigerinelloides multispina (Lalicker)		X			X
Globigerinelloides volutus (White)		X			
Loeblichella coarctata (Bolli)					
Loeblichella hessi (Pessagno)					
Archaeoglobigerina blowi Pessagno					
Archaeoglobigerina cretacea (d'Orbigny)					
Rugoglobigerina hexacamerata Bronnimann		X		X	
Rugoglobigerina reicheli bronnimann		X	X		
Rugoglobigerina rotundata Bronnimann			X		
Rugoglobigerina rugosa (Plummer)		X	X		X
Rugoglobigerina scotti (Bronnimann)		X	X		X
Globotruncana aegyptiaca Nakkady		X	X	X	X
Globotruncana arca (Cushman)		X	X		X
Globotruncana bulloides Vogler					
Globotruncana contusa (Cushman)		X			
Globotruncana elevata (Brotzen)		X	X		X
Globotruncana fornicata Plummer					
Globotruncana gansseri Bolli			X		
Globotruncana linneiana (d'Orbigny)	X				
Globotruncana nothi (Bronnimann and Brown)					
Globotruncana orientalis El Naggar		X		X	X
Globotruncana sharawnaensis El Naggar					
Globotruncana stuarti (de Lapparent)		X	X		X
Globotruncana trinidadensis Gandolfi			X		
Globotruncana ventricosa White					
Rugotruncana subcircumnodifer (Gandolfi)	X				
Rugotruncana subpennyi (Gandolfi)					
Globotruncanella havanensis (Voorwijk)	X				
Globotruncanella petaloidea (Gandolfi)					X

Table 3, faunal distribution, Shelby County

	Nacogdoches County Texas Co. #1 Strahan			Nacogdoches County Fain et al Co. #1 Yates
	Well sample interval			Well sample interval
	3340-70'	3370-400'	3400-30'	3740-70'
Globorotalia compressa (Plummer)				
Globorotalia pseudobulloides (Plummer)			X	X
Globorotalia trinidadensis Bolli				
Subbotina triloculinoides (Plummer)				
Guembelitria cretacea Cushman				
Heterohelix glabrans (Cushman)				
Heterohelix globulosa (Ehrenberg)	X	X		
Heterohelix navarroensis Loeblich				
Heterohelix planata (Cushman)			X	X
Heterohelix punctulata (Cushman)			X	
Heterohelix striata (Ehrenberg)	X		X	X
Heterohelix ultimatumida (White)				
Gublerina robusta de Klasz				
Pseudoguembelina costulata (Cushman)				
Pseudoguembelina excolata (Cushman)		X	X	
Pseudoguembelina kempensis Esker				
Pseudoguembelina palpebra Bronnimann and Brown	X	X	X	X
Pseudotextularia deformis (Kikoine)		X	X	X
Pseudotextularia elegans (Rzehak)	X	X	X	
Pseudotextularia intermedia de Klasz			X	
Racemiguembelina fructicosa (Egger)	X	X	X	X
Planoglobulina acervulinoides (Egger)	X		X	X
Planoglobulina carseyae (Plummer)			X	
Planoglobulina multicamerata de Klasz				
Globigerinelloides multispina (Lalicker)	X			
Globigerinelloides volutus (White)		X		
Loeblichella ccarctata (Bolli)		X		
Loeblichella kessi (Pessagno)				
Archaeoglobigerina blowi Pessagno				
Archaeoglobigerina cretacea (d'Orbigny)				
Rugoglobigerina hexacamerata Bronnimann				
Rugoglobigerina reichelli Bronnimann				X
Rugoglobigerina rotundata Bronnimann	X		X	
Rugoglobigerina rugosa (Plummer)	X	X	X	X
Rugoglobigerina scotti (Bronnimann)	X	X	X	
Globotruncana aegyptiaca Nakkady	X	X	X	X
Globotruncana arca (Cushman)	X	X	X	X
Globotruncana bulloides Vogler				
Globotruncana contusa (Cushman)			X	
Globotruncana elevata (Brotzen)		X	X	X
Globotruncana fornicata Plummer				
Globotruncana gansseri Bolli			X	X
Globotruncana linneiana (d'Orbigny)				
Globotruncana nothi (Bronnimann and Brown)				
Globotruncana orientalis El Naggar	X		X	X
Globotruncana sharawnaensis El Naggar	X			
Globotruncana stuarti (de Lapparent)	X	X	X	X
Globotruncana trinidadensis Gandolfi				
Globotruncana ventricosa White				
Rugotruncana subcircumnodifer (Gandolfi)		X		
Rugotruncana subpennyi (Gandolfi)				
Globotruncanella havanensis (Voorwijk)				
Globotruncanella petaloidea (Gandolfi)			X	X

Table 4, faunal distribution, Nacogdoches County

	Henderson County Texaco Oil Co. #1 Brown			Anderson County American Liberty Co. #1 Gage		
	Well sample interval			Well sample interval		
	2080-113'	2370-400'	2400-30'	2135-65'	2166-98'	2198-228'
Globorotalia compressa (Plummer)		X				
Globorotalia pseudobulloides (Plummer)	X	X		X	X	
Globorotalia trinidadensis Bolli		X				
Subbotina triloculinoides (Plummer)				X		
Guembelitria cretacea Cushman						
Heterohelix glabrans (Cushman)						
Heterohelix globulosa (Ehrenberg)						
Heterohelix navarroensis Loeblich						
Heterohelix planata (Cushman)						
Heterohelix punctulata (Cushman)					X	X
Heterohelix striata (Ehrenberg)						X
Heterohelix ultimatumida (White)						
Gublerina robusta de Klasz						
Pseudoguembelina costulata (Cushman)						
Pseudoguembelina excolata (Cushman)						
Pseudoguembelina kempensis Esker						
Pseudoguembelina palpebra Bronnimann and Brown						
Pseudotextularia deformis (Kikoine)						
Pseudotextularia elegans (Rzehak)						
Pseudotextularia intermedia de Klasz						
Racemiguembelina fructicosa (Egger)						
Planoglobulina acervulinoides (Egger)						
Planoglobulina carseyae (Plummer)						
Planoglobulina multicamerata de Klasz						
Globigerinelloides multispina (Lalicker)						
Globigerinelloides volutus (White)						
Loeblichella coarctata (Bolli)						
Loeblichella hessi (Pessagno)						
Archaeoglobigerina blowi Pessagno						
Archaeoglobigerina cretacea (d'Orbigny)						
Rugoglobigerina hexacamerata Bronnimann						
Rugoglobigerina reicheli Bronnimann						
Rugoglobigerina rotundata Bronnimann						
Rugoglobigerina rugosa (Plummer)		X				
Rugoglobigerina scotti (Bronnimann)						
Globotruncana aegyptiaca Nakkady			X			
Globotruncana area (Cushman)						X
Globotruncana bulloides Vogler						
Globotruncana contusa (Cushman)						
Globotruncana elevata (Brotzen)						
Globotruncana fornicata Plummer						
Globotruncana gansseri Bolli						X
Globotruncana linneiana (d'Orbigny)						
Globotruncana nothi (Bronnimann and Brown)						
Globotruncana orientalis El Naggar						X
Globotruncana sharawnaensis El Naggar						
Globotruncana stuarti (de Lapparent)						
Globotruncana trinidadensis Gandolfi						
Globotruncana ventricosa White						
Rugotruncana subcircumnodifer (Gandolfi)						
Rugotruncana subpennyi (Gandolfi)		X				
Globotruncanella havanensis (Voorwijk)						
Globotruncanella petaloidea (Gandolfi)						

Table 5, faunal distribution, Henderson and Anderson Counties

	Angelina County American Liberty Co. #1-B Cameron Heirs Well sample interval 4700-30'	Trinity County Lucerne Co. #1 So. Pine Lumber Co. Well sample interval 5850-80'	 5890-910'
Globorotalia compressa (Plummer)	X		
Globorotalia pseudobulloides (Plummer)	X	X	
Globorotalia trinidadensis Bolli	X	X	
Subbotina triloculinoides (Plummer)	X		
Guembelitria cretacea Cushman			
Heterohelix glabrans (Cushman)			
Heterohelix globulosa (Ehrenberg)	X	X	X
Heterohelix navarroensis Loeblich			
Heterohelix planata (Cushman)			
Heterohelix punctulata (Cushman)	X		
Heterohelix striata (Ehrenberg)			
Heterohelix ultimatumida (White)			
Gublerina robusta de Klasz			X
Pseudoguembelina costulata (Cushman)	X		X
Pseudoguembelina excolata (Cushman)			X
Pseudoguembelina kempensis Esker			X
Pseudoguembelina palpebra Bronnimann and Brown	X		X
Pseudotextularia deformis (Kikoine)	X		X
Pseudotextularia elegans (Rzehak)			
Pseudotextularia intermedia de Klasz	X		X
Racemiguembelina fructicosa (Egger)	X		X
Planoglobulina acervulinoides (Egger)			
Planoglobulina carseyae (Plummer)			
Planoglobulina multicamerata de Klasz			
Globigerinelloides multispina (Lalicker)			
Globigerinelloides volutus (White)			
Loeblichella coarctata (Bolli)			
Loeblichella hessi (Pessagno)			
Archaeoglobigerina blowi Pessagno			
Archaeoglobigerina cretacea (d'Orbigny)			X
Rugoglobigerina hexacamerata Bronnimann	X		
Rugoglobigerina reicheli Bronnimann			
Rugoglobigerina rotundata Bronnimann	X		X
Rugoglobigerina rugosa (Plummer)	X		
Rugoglobigerina scotti (Bronnimann)	X		X
Globotruncana aegyptiaca Nakkady	X		X
Globotruncana arca (Cushman)			
Globotruncana bulloides Vogler			
Globotruncana contusa (Cushman)	X		X
Globotruncana elevata (Brotzen)			
Globotruncana fornicata Plummer	X		
Globotruncana gansseri Bolli			
Globotruncana linneiana (d'Orbigny)			
Globotruncana nothi (Bronnimann and Brown)	X		X
Globotruncana orientalis El Naggar			
Globotruncana sharawnaensis El Naggar	X		X
Globotruncana stuarti (de Lapparent)			
Globotruncana trinidadensis Gandolfi			
Globotruncana ventricosa White			X
Rugotruncana subcircumnodifer (Gandolfi)			
Rugotruncana subpennyi (Gandolfi)			
Globotruncanella havanensis (Voorwijk)	X		
Globotruncanella petaloidea (Gandolfi)			

Table 6, faunal distribution, Angelina and Trinity Counties

	Newton County Justice Mears Co. #1 Lutcher & Moore		Tyler County Pan American Oil Co. #1 Longbell
	Well sample interval		Well sample interval
	9550-80'	9580-610'	1510-40'
Globorotalia compressa (Plummer)			
Globorotalia pseudobulloides (Plummer)	X		X
Globorotalia trinidadensis Bolli			
Subbotina triloculinoides (Plummer)			
Guembelitria cretacea Cushman			
Heterohelix glabrans (Cushman)		X	
Heterohelix globulosa (Ehrenberg)		X	X
Heterohelix navarroensis Loeblich			
Heterohelix planata (Cushman)			
Heterohelix punctulata (Cushman)		X	
Heterohelix striata (Ehrenberg)			
Heterohelix ultimatumida (White)			X
Gublerina robusta de Klasz			
Pseudoguembelina costulata (Cushman)			
Pseudoguembelina excolata (Cushman)			
Pseudoguembelina kempensis Esker			
Pseudoguembelina palpebra Bronnimann and Brown		X	
Pseudotextularia deformis (Kikoine)		X	
Pseudotextularia elegans (Rzehak)		X	
Pseudotextularia intermedia de Klasz			
Racemiguembelina fructicosa (Egger)		X	
Planoglobulina acervulinoides (Egger)		X	
Planoglobulina carseyae (Plummer)			
Planoglobulina multicamerata de Klasz			
Globigerinelloides multispina (Lalicker)			
Globigerinelloides volutus (White)			
Loeblichella corretata (Bolli)			
Loeblichella hassi (Pessagno)			
Archaeoglobigerina blowi Pessagno			
Archaeoglobigerina cretacea (d'Orbigny)			
Rugoglobigerina hexacamerata Bronnimann			
Rugoglobigerina reicheli Bronnimann			
Rugoglobigerina rotundata Bronnimann			
Rugoglobigerina rugosa (Plummer)		X	
Rugoglobigerina scotti (Bronnimann)			
Globotruncana aegyptiaca Nakkady		X	
Globotruncana arca (Cushman)		X	X
Globotruncana bulloides Vogler			X
Globotruncana contusa (Cushman)			
Globotruncana elevata (Brotzen)		X	
Globotruncana fornicata Plummer			
Globotruncana gansseri Bolli			
Globotruncana linneiana (d'Orbigny)			X
Globotruncana rothi (Bronnimann and Brown)			
Globotruncana orientalis El Naggar			
Globotruncana sharaonaensis El Naggar			
Globotruncana stuarti (de Lapparent)		X	
Globotruncana trinidadensis Gandolfi			
Globotruncana ventricosa White			
Rugotruncana subcircumnodifer (Gandolfi)			
Rugotruncana subpennyi (Gandolfi)			
Globotruncanella havanensis (Voorwijk)			
Globotruncanella petaloidea (Gandolfi)			

Table 7, faunal distribution, Newton and Tyler Counties

	Houston County Shell Oil Co. #1 Darsey			Polk County Shell Oil Co. #1 Alexander		
	Well sample interval			Well sample interval		
	4120-51'	4274-306'	4306-36'	11298-330'	11330-61'	11361-91'
Globorotalia compressa (Plummer)				X	X	
Globorotalia pseudobulloides (Plummer)				X		
Globorotalia trinidadensis Bolli	X					
Subbotina triloculinoides (Plummer)						
Guembelitria cretacea Cushman						
Heterohelix glabrans (Cushman)			X			
Heterohelix globulosa (Ehrenberg)		X	X			
Heterohelix navarroensis Loeblich						
Heterohelix planata (Cushman)			X		X	
Heterohelix punctulata (Cushman)			X			
Heterohelix striata (Ehrenberg)			X		X	
Heterohelix ultimatumida (White)						
Gublerina robusta de Klasz						
Pseudoguembelina costulata (Cushman)			X			
Pseudoguembelina excolata (Cushman)			X			
Pseudoguembelina kempensis Esker			X			
Pseudoguembelina palpebra Bronnimann and Brown			X			
Pseudotextularia deformis (Kikoine)			X			
Pseudotextularia elegans (Rzehak)			X		X	
Pseudotextularia intermedia de Klasz						
Racemiguembelina fructicosa (Egger)			X			
Planoglobulina acervulinoides (Egger)						
Planoglobulina carseyae (Plummer)						
Planoglobulina multicamerata de Klasz						
Globigerinelloides multispina (Lalicker)						
Globigerinelloides volutus (White)						
Loeblichella coarctata (Bolli)						
Loeblichella hessi (Pessagno)						
Archaeoglobigerina blowi Pessagno			X			
Archaeoglobigerina cretacea (d'Orbigny)						
Rugoglobigerina hexacamerata Bronnimann						
Rugoglobigerina reicheli Bronnimann						
Rugoglobigerina rotundata Bronnimann			X			
Rugoglobigerina rugosa (Plummer)		X	X			
Rugoglobigerina scotti (Bronnimann)						
Globotruncana aegyptiaca Nakkady			X			X
Globotruncana arca (Cushman)			X		X	
Globotruncana bulloides Vogler						
Globotruncana contusa (Cushman)			X			
Globotruncana elevata (Brotzen)			X		X	
Globotruncana fornicata Plummer						
Globotruncana gansseri Bolli			X			X
Globotruncana linneiana (d'Orbigny)						
Globotruncana nothi (Bronnimann and Brown)						
Globotruncana orientalis El Naggar			X			X
Globotruncana sharawnaensis El Naggar						
Globotruncana stuarti (de Lapparent)						
Globotruncana trinidadensis Gandolfi						
Globotruncana ventricosa White						
Rugotruncana subcircumnodifer (Gandolfi)						
Rugotruncana subpennyi (Gandolfi)						
Globotruncanella havanensis (Voorwijk)						
Globotruncanella petaloidea (Gandolfi)						

Table 8, faunal distribution, Houston and Polk Counties

	San Jacinto County Humble Oil Co. #1 Ogletree				Montgomery County Phillips Oil Co. #A-1 Coal & Coke		
	Well sample interval				Well sample interval		
	11526-56'	11587-620'	11620-51'	11651-82'	13700-31'	13731-61'	13761-91'
Globorotalia compressa (Plummer)	X						
Globorotalia pseudobulloides (Plummer)	X	X			X		
Globorotalia trinidadensis Bolli		X					
Subbotina triloculinoides (Plummer)							
Guembelitria cretacea Cushman							
Heterohelix glabrans (Cushman)							
Heterohelix globulosa (Ehrenberg)							
Heterohelix navarroensis Loeblich							
Heterohelix planata (Cushman)							
Heterohelix punctulata (Cushman)				X			
Heterohelix striata (Ehrenberg)							
Heterohelix ultimatumida (White)							
Gublerina robusta de Klasz							
Pseudoguembelina costulata (Cushman)							
Pseudoguembelina excolata (Cushman)						X	
Pseudoguembelina lampensis Esker							
Pseudoguembelina palpebra Bronnimann and Brown							
Pseudotextularia deformis (Kikoine)			X				
Pseudotextularia elegans (Rzehak)				X			
Pseudotextularia intermedia de Klasz							
Racemiguembelina fructicosa (Egger)							
Planoglobulina acervulinoides (Egger)							
Planoglobulina carseyae (Plummer)							
Planoglobulina multicamerata de Klasz							
Globigerinelloides multispina (Lalicker)							
Globigerinelloides volutus (White)							
Loeblichella coarctata (Bolli)							
Loeblichella hessi (Pessagno)							
Archaeoglobigerina blowi Pessagno							
Archaeoglobigerina cretacea (d'Orbigny)							
Rugoglobigerina hexacamerata Bronnimann							
Rugoglobigerina reicheli Bronnimann							
Rugoglobigerina rotundata Bronnimann							
Rugoglobigerina rugosa (Plummer)							
Rugoglobigerina scotti (Bronnimann)							
Globotruncana aegyptiaca Nakkady			X	X		X	X
Globotruncana arca (Cushman)			X	X			X
Globotruncana bulloides Vogler							
Globotruncana contusa (Cushman)							
Globotruncana elevata (Brotzen)				X			X
Globotruncana fornicata Plummer							
Globotruncana gansseri Bolli							
Globotruncana linneiana (d'Orbigny)						X	
Globotruncana nothi (Bronnimann and Brown)							
Globotruncana orientalis El Naggar				X			
Globotruncana sharawnaensis El Naggar							
Globotruncana stuarti (de Lapparent)			X	X			
Globotruncana trinidadensis Gandolfi							
Globotruncana ventricosa White							
Rugotruncana subcircumnodifer (Gandolfi)							
Rugotruncana subpennyi (Gandolfi)							
Globotruncanella havanensis (Voorwijk)							
Globotruncanella petaloidea (Gandolfi)							

Table 9, faunal distribution, San Jacinto and Montgomery Counties

	Waller County Shell Oil Co. #1 Chapman			Austin County Mitchell Co. #1 Peschel		
	Well sample interval			Well sample interval		
	14852-81'	14881-910'	14910-42'	13060-91'	13091-123'	13123-54'
Globorotalia compressa (Plummer)						
Globorotalia pseudobulloides (Plummer)	X					
Globorotalia trinidadensis Bolli	X			X		
Subbotina triloculinoides (Plummer)						
Guembelitria cretacea Cushman						
Heterohelix glabrans (Cushman)						
Heterohelix globulosa (Ehrenberg)					X	
Heterohelix navarroensis Loeblich						
Heterohelix planata (Cushman)						
Heterohelix punctulata (Cushman)						X
Heterohelix striata (Ehrenberg)						
Heterohelix ultimatumida (White)			X			
Gublerina robusta de Klasz			X			
Pseudoguembelina costulata (Cushman)						
Pseudoguembelina excolata (Cushman)						
Pseudoguembelina kempensis Esker						X
Pseudoguembelina palpebra Bronnimann and Brown						X
Pseudotextularia deformis (Kikoine)						X
Pseudotextularia elegans (Rzehak)					X	X
Pseudotextularia intermedia de Klasz						X
Racemiguembelina fructicosa (Egger)						X
Planoglobulina acervulinoides (Egger)						
Planoglobulina carseyae (Plummer)						
Planoglobulina multicamerata de Klasz						
Globigerinelloides multispina (Lalicker)						
Globigerinelloides volutus (White)						X
Loeblichella coarctata (Bolli)						
Loeblichella hessi (Pessagno)						
Archaeoglobigerina blowi Pessagno						
Archaeoglobigerina cretacea (d'Orbigny)						
Rugoglobigerina hexacamerata Bronnimann						
Rugoglobigerina reicheli Bronnimann						
Rugoglobigerina rotundata Bronnimann						
Rugoglobigerina rugosa (Plummer)			X		X	X
Rugoglobigerina scotti (Bronnimann)						X
Globotruncana aegyptiaca Nakkady			X		X	X
Globotruncana arca (Cushman)		X	X		X	X
Globotruncana bulloides Vogler						
Globotruncana contusa (Cushman)						
Globotruncana elevata (Brotzen)			X		X	X
Globotruncana fornicata Plummer						
Globotruncana gansseri Bolli		X	X			
Globotruncana linneiana (d'Orbigny)						
Globotruncana nothi (Bronnimann and Brown)						
Globotruncana orientalis El Naggar		X	X			
Globotruncana sharaynaensis El Naggar						
Globotruncana stuarti (de Lapparent)		X				X
Globotruncana trinidadensis Gandolfi						
Globotruncana ventricosa White						
Rugotruncana subcircumnodifer (Gandolfi)						
Rugotruncana subpennyi (Gandolfi)						
Globotruncanella havanensis (Voorwijk)						
Globotruncanella petaloidea (Gandolfi)						

Table 10, faunal distribution, Waller and Austin Counties

	Bee County Shell Oil Co. #1 Roessler			De Witt County Texas Eastern Co. #1 Garbe		
	Well sample interval			Well sample interval		
	11620-50'	11650-80'	11680-710'	11780-812'	11812-43'	11875-907'
Globorotalia compressa (Plummer)						
Globorotalia pseudobulloides (Plummer)	X					
Globorotalia trinidadensis Bolli	X					
Subbotina triloculinoides (Plummer)						
Guembelitria cretacea Cushman						
Heterohelix glabrans (Cushman)						
Heterohelix globulosa (Ehrenberg)						
Heterohelix navarroensis Loeblich						
Heterohelix planata (Cushman)						
Heterohelix punctulata (Cushman)		X	X			
Heterohelix striata (Ehrenberg)						
Heterohelix ultimatumida (White)						
Gublerina robusta de Klasz						
Pseudoguembelina costulata (Cushman)						
Pseudoguembelina excolata (Cushman)			X			
Pseudoguembelina kempensis Esker						
Pseudoguembelina palpebra Bronnimann and Brown			X			
Pseudotextularia deformis (Kikoine)		X	X			
Pseudotextularia elegans (Rzehak)			X			
Pseudotextularia intermedia de Klasz						
Racemiguembelina fructicosa (Egger)						
Planoglobulina acervulinoides (Egger)			X			
Planoglobulina carseyae (Plummer)			X			
Planoglobulina multicamerata de Klasz						
Globigerinelloides multispina (Lalicker)						
Globigerinelloides volutus (White)			X			
Loeblichella coarctata (Bolli)						
Loeblichella hessi (Pessagno)						
Archaeoglobigerina blowi Pessagno						
Archaeoglobigerina cretacea (d'Orbigny)						
Rugoglobigerina hexacamerata Bronnimann						
Rugoglobigerina reicheli Bronnimann						
Rugoglobigerina rotundata Bronnimann						
Rugoglobigerina rugosa (Plummer)		X	X			X
Rugoglobigerina scotti (Bronnimann)			X			
Globotruncana aegyptiaca Nakkady			X		X	X
Globotruncana arca (Cushman)			X		X	
Globotruncana bulloides Vogler						
Globotruncana contusa (Cushman)						
Globotruncana elevata (Brotzen)			X			X
Globotruncana fornicata Plummer						
Globotruncana gansseri Bolli			X			
Globotruncana linneiana (d'Orbigny)						
Globotruncana nothi (Bronnimann and Brown)						
Globotruncana orientalis El Naggar					X	
Globotruncana sharaynensis El Naggar						
Globotruncana stuarti (de Lapparent)						X
Globotruncana trinidadensis Gandolfi						
Globotruncana ventricosa White						
Rugotruncana subcircumnodifer (Gandolfi)						
Rugotruncana subpennyi (Gandolfi)						
Globotruncanella havanensis (Voorwijk)						
Globotruncanella petaloidea (Gandolfi)						

Table 11, faunal distribution, Bee and De Witt Counties

	Lavaca County Mobil Oil Co. #1 Spanihel — Well sample interval			Milam County Placid Oil Co. #1 Smith — Well sample interval			
	11390'	11405-35'	11466-96' 11496-526'	2320-50'	2350-80'	2380-410'	2410-40'
Globorotalia compressa (Plummer)							
Globorotalia pseudobulloides (Plummer)	X			X	X		
Globorotalia trinidadensis Bolli				X	X		
Subbotina triloculinoides (Plummer)							
Guembelitria cretacea Cushman							
Heterohelix glabrans (Cushman)							
Heterohelix globulosa (Ehrenberg)							X
Heterohelix navarroensis Loeblich							X
Heterohelix planata (Cushman)			X				
Heterohelix punctulata (Cushman)							
Heterohelix striata (Ehrenberg)		X					
Heterohelix ultimatumida (White)							
Gublerina robusta de Klasz							
Pseudoguembelina costulata (Cushman)							
Pseudoguembelina excolata (Cushman)							
Pseudoguembelina kempensis Esker							
Pseudoguembelina palpebra Bronnimann and Brown		X	X			X	X
Pseudotextularia deformis (Kikoine)		X	X				X
Pseudotextularia elegans (Rzehak)		X	X			X	X
Pseudotextularia intermedia de Klasz			X				
Racemiguembelina fructicosa (Egger)							
Planoglobulina acervulinoides (Egger)		X	X				
Planoglobulina carseyae (Plummer)					X		
Planoglobulina multicamerata de Klasz							
Globigerinelloides multispina (Lalicker)							
Globigerinelloides volutus (White)							
Loeblichella coarctata (Bolli)							
Loeblichella hessi (Pessagno)							
Archaeoglobigerina blowi Pessagno							
Archaeoglobigerina cretacea (d'Orbigny)							
Rugoglobigerina hexacamerata Bronnimann							
Rugoglobigerina reicheli Bronnimann							
Rugoglobigerina rotundata Bronnimann							
Rugoglobigerina rugosa (Plummer)		X				X	X
Rugoglobigerina scotti (Bronnimann)		X					
Globotruncana aegyptiaca Nakkady			X			X	
Globotruncana arca (Cushman)		X	X				
Globotruncana bulloides Vogler							
Globotruncana contusa (Cushman)							
Globotruncana elevata (Brotzen)		X	X				X
Globotruncana fornicata Plummer							
Globotruncana gansseri Bolli							
Globotruncana linneiana (d'Orbigny)							
Globotruncana mothi (Bronnimann and Brown)							
Globotruncana orientalis El Naggar			X				
Globotruncana sharawnaensis El Naggar							
Globotruncana stuarti (de Lapparent)		X					
Globotruncana trinidadensis Gandolfi							
Globotruncana ventricosa White							
Rugotruncana subcircumnodifer (Gandolfi)							
Rugotruncana subpennyi (Gandolfi)							
Globotruncanella havanensis (Voorwijk)							
Globotruncanella petaloidea (Gandolfi)							

Table 12, faunal distribution, Lavaca and Milam Counties

	Milam County Walker Creek Locality Near Cameron		Limestone County Zephyr Oil Co. #1 M. Norris					
			Well sample interval					
	Littig Grg.	Kemp Clay	931-91'	991-1051'	1081-141'	1141-261'	1201-61'	1261-91'
Globorotalia compressa (Plummer)	X							
Globorotalia pseudobulloides (Plummer)	X		X	X	X	X	X	X
Globorotalia trinidadensis Bolli	X		X		X		X	
Subbotina triloculinoides (Plummer)	X							
Guembelitria cretacea Cushman								
Heterohelix globrans (Cushman)								
Heterohelix globulosa (Ehrenberg)					X		X	X
Heterohelix navarroensis Loeblich								
Heterohelix planata (Cushman)								
Heterohelix punctulata (Cushman)		X						
Heterohelix striata (Ehrenberg)							X	
Heterohelix ultimatumida (White)								
Gublerina robusta de Klasz								
Pseudoguembelina costulata (Cushman)								
Pseudoguembelina excolata (Cushman)		X			X			
Pseudoguembelina kempensis Esker		X						
Pseudoguembelina palpebra Bronnimann and Brown		X						X
Pseudotextularia deformis (Kikoine)		X						
Pseudotextularia elegans (Rzehak)		X						
Pseudotextularia intermedia de Klasz								
Racemiguembelina fructicosa (Egger)								
Planoglobulina acervulinoides (Egger)		X						
Planoglobulina carseyae (Plummer)		X						
Planoglobulina multicamerata de Klasz								
Globigerinelloides multispina (Lalicker)		X						
Globigerinelloides volutus (White)								
Loeblichella coarctata (Bolli)								
Loeblichella hessi (Pessagno)								
Archaeoglobigerina blowi Pessagno								
Archaeoglobigerina cretacea (d'Orbigny)							X	
Rugoglobigerina hexacamerata bronnimann								
Rugoglobigerina reicheli Bronnimann		X						
Rugoglobigerina rotundata Bronnimann		X						
Rugoglobigerina rugosa (Plummer)		X						X
Rugoglobigerina scotti (Bronnimann)		X						
Globotruncana aegyptiaca Nakkady		X					X	
Globotruncana arca (Cushman)		X						
Globotruncana bulloides Vogler								
Globotruncana contusa (Cushman)								
Globotruncana elevata (Brotzen)		X						
Globotruncana fornicata Plummer								
Globotruncana gansseri Bolli							X	X
Globotruncana linneiana (d'Orbigny)								
Globotruncana nothi (Bronnimann and Brown)								
Globotruncana orientalis El Naggar		X						
Globotruncana sharaumaensis El Naggar								
Globotruncana stuarti (de Lapparent)		X						
Globotruncana trinidadensis Gandolfi								
Globotruncana ventricosa White								
Rugotruncana subcircumnodifer (Gandolfi)								
Rugotruncana subpennyi (Gandolfi)								
Globotruncanella havanensis (Voorwijk)		X						
Globotruncanella petaloidea (Gandolfi)		X						

Table 13, faunal distribution, Milam and Limestone Counties

Limestone County
Mobil Oil Co.
#1 Brown

Well sample interval

	1270-300'	1300-30'	1330-60'	1360-90'	1390-420'	1420-50'	1450-60'	1480-510'	1510-40'	1540-70'	1570-600'	1600-30'	1630-60'	1660-90'
Globorotalia compressa (Plummer)														
Globorotalia pseudobulloides (Plummer)					X		X	X		X	X			
Globorotalia trinidadensis Bolli														
Subbotina triloculinoides (Plummer)														
Guembelitria cretacea Cushman														
Heterohelix glabrans (Cushman)												X		X
Heterohelix globulosa (Ehrenberg)	X				X	X		X	X			X	X	X
Heterohelix navarroensis Loeblich														X
Heterohelix planata (Cushman)					X		X	X			X	X	X	X
Heterohelix punctulata (Cushman)					X	X				X	X	X	X	X
Heterohelix striata (Ehrenberg)						X	X	X		X		X		X
Heterohelix ultimatumida (White)									X				X	
Gublerina robusta de Klasz														
Pseudoguembelina costulata (Cushman)												X	X	X
Pseudoguembelina excolata (Cushman)					X	X						X	X	X
Pseudoguembelina kempensis Esker												X	X	
Pseudoguembelina palpebra Bronnimann and Brown					X	X		X	X			X	X	X
Pseudotextularia deformis (Kikoine)					X	X		X		X			X	X
Pseudotextularia elegans (Rzehak)			X		X	X	X	X	X	X	X	X	X	X
Pseudotextularia intermedia de Klasz														X
Racemiguembelina fructicosa (Egger)						X							X	X
Planoglobulina acervulinoides (Egger)					X	X							X	X
Planoglobulina carseyae (Plummer)						X		X						
Planoglobulina multicamerata de Klasz								X						
Globigerinelloides multispina (Lalicker)						X	X				X	X		
Globigerinelloides volutus (White)							X				X			
Loeblichella coarctata (Bolli)												X		
Loeblichella hessi (Pessagno)					X						X	X		
Archaeoglobigerina blowi Pessagno												X	X	X
Archaeoglobigerina cretacea (d'Orbigny)										X				X
Rugoglobigerina hexacamerata Bronnimann														X
Rugoglobigerina reicheli Bronnimann					X		X			X			X	
Rugoglobigerina rotundata Bronnimann						X		X	X	X		X		
Rugoglobigerina rugosa (Plummer)					X	X	X	X	X	X	X	X		X
Rugoglobigerina scotti (Bronnimann)					X	X		X		X			X	
Globotruncana aegyptiaca Nakkady			X		X	X	X	X	X	X	X	X	X	X
Globotruncana arca (Cushman)						X	X	X	X		X	X	X	X
Globotruncana bulloides Vogler														
Globotruncana contusa (Cushman)												X	X	
Globotruncana elevata (Brotzen)	X				X	X		X	X	X		X	X	X
Globotruncana fornicata Plummer														
Globotruncana gansseri Bolli								X		X	X		X	
Globotruncana linneiana (d'Orbigny)														
Globotruncana nothi (Bronnimann and Brown)												X		
Globotruncana orientalis El Naggar						X	X			X	X	X	X	X
Globotruncana sharawnaensis El Naggar														
Globotruncana stuarti (de Lapparent)					X	X		X					X	X
Globotruncana trinidadensis Gandolfi														
Globotruncana ventricosa White														
Rugotruncana subcircumnodifer (Gandolfi)														
Rugotruncana subpennyi (Gandolfi)														
Globotruncanella havanensis (Voorwijk)														X
Globotruncanella petaloidea (Gandolfi)						X						X	X	X

Table 14, faunal distribution, Limestone County

	Leon County Daniels Oil Co. #1 Cox Est. Well sample interval		Leon County Christie et al Co. #1 Gordon Well sample interval		
	1854-84'	3920-50'	3310-40'	3340-70'	3370-400'
Globorotalia compressa (Plummer)					
Globorotalia pseudobulloides (Plummer)	X	X	X		
Globorotalia trinidadensis Bolli				X	
Subbotina triloculinoides (Plummer)					
Guembelitria cretacea Cushman					
Heterohelix glabrans (Cushman)					X
Heterohelix globulosa (Ehrenberg)					X
Heterohelix navarroensis Loeblich					
Heterohelix planata (Cushman)					X
Heterohelix punctulata (Cushman)					X
Heterohelix striata (Ehrenberg)				X	X
Heterohelix ultimatumida (White)				X	X
Gublerina robusta de Klasz					
Pseudoguembelina costulata (Cushman)					X
Pseudoguembelina excolata (Cushman)					X
Pseudoguembelina kempensis Esker				X	X
Pseudoguembelina palpebra Bronnimann and Brown					
Pseudotextularia deformis (Kikoine)				X	X
Pseudotextularia elegans (Rzehak)				X	X
Pseudotextularia intermedia de Klasz					
Racemiguembelina fructicosa (Egger)					
Planoglobulina acervulinoides (Egger)					
Planoglobulina carseyae (Plummer)					
Planoglobulina multicamerata de Klasz					
Globigerinelloides multispina (Lalicker)					X
Globigerinelloides volutus (White)					
Loeblichella coarctata (Bolli)					
Loeblichella hessi (Pessagno)					
Archaeoglobigerina blowi Pessagno				X	
Archaeoglobigerina cretacea (d'Orbigny)					
Rugoglobigerina hexacamerata Bronnimann					
Rugoglobigerina reicheli Bronnimann					
Rugoglobigerina rotundata Bronnimann					
Rugoglobigerina rugosa (Plummer)					X
Rugoglobigerina scotti (Bronnimann)					
Globotruncana aegyptiaca Nakkady				X	X
Globotruncana arca (Cushman)		X		X	X
Globotruncana bulloides Vogler				X	X
Globotruncana contusa (Cushman)					
Globotruncana elevata (Brotzen)					X
Globotruncana fornicata Plummer				X	X
Globotruncana gansseri Bolli					
Globotruncana linneiana (d'Orbigny)					
Globotruncana mothi (Bronnimann and Brown)					
Globotruncana orientalis El Naggar				X	X
Globotruncana sharawnaensis El Naggar					
Globotruncana stuarti (de Lapparent)					
Globotruncana trinidadensis Gandolfi				X	
Globotruncana ventricosa White					
Rugotruncana subcircumnodifer (Gandolfi)					
Rugotruncana subpennyi (Gandolfi)				X	X
Globotruncanella havanensis (Voorwijk)					
Globotruncanella petaloidea (Gandolfi)					

Table 15, faunal distribution, Leon County

Leon County
Smith Co.
#1 Busby

Well Sample Interval

	1683-743'	1743-804'	1804-34'	1872-933'	1926-86'	1986-2047'	2069-130'	2130-80'	2190-251'	2251-311'	2311-73'
Globorotalia compressa (Plummer)											
Globorotalia pseudobulloides (Plummer)							X				
Globorotalia trinidadensis Bolli											
Subbotina triloculinoides (Plummer)											
Guembelitria cretacea Cushman		X				X					
Heterohelix glabrans (Cushman)								X			
Heterohelix globulosa (Ehrenberg)	X										X
Heterohelix navarroensis Loeblich											
Heterohelix planata (Cushman)											
Heterohelix punctulata (Cushman)		X	X	X		X	X				
Heterohelix striata (Ehrenberg)		X				X	X	X	X		X
Heterohelix ultimatumida (White)				X		X					
Gublerina robusta de Klasz											
Pseudoguembelina costulata (Cushman)											
Pseudoguembelina excolata (Cushman)											
Pseudoguembelina lempensis Esker		X									
Pseudoguembelina palpebra Bronnimann and Brown		X									
Pseudotextularia deformis (Kikoine)	X						X				
Pseudotextularia elegans (Rzehak)				X		X			X	X	
Pseudotextularia intermedia de Klasz											
Racemiguembelina fructicosa (Egger)											
Planoglobulina acervulinoides (Egger)											
Planoglobulina carseyae (Plummer)											
Planoglobulina multicamerata de Klasz											
Globigerinelloides multispina (Lalicker)				X	X		X	X	X	X	X
Globigerinelloides volutus (White)	X	X									
Loeblichella coarctata (Bolli)											
Loeblichella hessi (Pessagno)											
Archaeoglobigerina blowi Pessagno											
Archaeoglobigerina cretacea (d'Orbigny)		X							X		
Rugoglobigerina hexacamerata Bronnimann											
Rugoglobigerina reicheli Bronnimann											
Rugoglobigerina rotundata Bronnimann											
Rugoglobigerina rugosa (Plummer)		X		X			X				
Rugoglobigerina scotti (Bronnimann)											
Globotruncana aegyptiaca Nakkady	X	X		X	X			X			
Globotruncana arca (Cushman)	X				X		X	X	X		
Globotruncana bulloides Vogler		X			X	X					
Globotruncana contusa (Cushman)											
Globotruncana elevata (Brotzen)	X							X	X	X	
Globotruncana fornicata Plummer		X		X		X			X	X	
Globotruncana gansseri Bolli										X	
Globotruncana linnaeana (d'Orbigny)					X		X		X	X	X
Globotruncana nothi (Bronnimann and Brown)									X		
Globotruncana orientalis El Naggar				X			X				
Globotruncana sharonaensis El Naggar											
Globotruncana stuarti (de Lapparent)							X				
Globotruncana trinidadensis Gandolfi						X					
Globotruncana ventricosa White		X					X				
Rugotruncana subcircumnodifer (Gandolfi)						X					
Rugotruncana subpennyi (Gandolfi)											
Globotruncanella havanensis (Voorwijk)											
Globotruncanella petaloidea (Gandolfi)											

Table 16, faunal distribution, Leon County

	Freestone County Union of Calif. Oil Co. #1 Knight — Well sample interval				Freestone County Brown Co. #1 Goolsby — Well sample interval					
	1869–1900	1900–31'	1931–62'	1962–92'	1060–90'	1090–120'	1120–50'	1150–80'	1180–210'	1270–300'	1360–90'
Globorotalia compressa (Plummer)	X									X	
Globorotalia pseudobulloides (Plummer)	X				X					X	
Globorotalia trinidadensis Bolli	X										
Subbotina triloculinoides (Plummer)											
Guembelitria cretacea Cushman											X
Heterohelix glabrans (Cushman)											
Heterohelix globulosa (Ehrenberg)							X				X
Heterohelix navarroensis Loeblich											
Heterohelix planata (Cushman)			X								
Heterohelix punctulata (Cushman)			X								
Heterohelix striata (Ehrenberg)											X
Heterohelix ultimatumida (White)											
Gublerina robusta de Klasz											
Pseudoguembelina costulata (Cushman)											
Pseudoguembelina excolata (Cushman)											
Pseudoguembelina kempensis Esker											
Pseudoguembelina palpebra Bronnimann and Brown											
Pseudotextularia deformis (Kikoine)											
Pseudotextularia elegans (Rzehak)	X	X	X				X				X
Pseudotextularia intermedia de Klasz											
Racemiguembelina fructicosa (Egger)											
Planoglobulina acervulinoides (Egger)											
Planoglobulina carseyae (Plummer)											
Planoglobulina multicamerata de Klasz											
Globigerinelloides multispina (Lalicker)											
Globigerinelloides volutus (White)											
Loeblichella coarctata (Bolli)											
Loeblichella nessi (Pessagno)											
Archaeoglobigerina blowi Pessagno		X									
Archaeoglobigerina cretacea (d'Orbigny)											
Rugoglobigerina hexacamerata Bronnimann											
Rugoglobigerina reicheli Bronnimann											
Rugoglobigerina rotundata Bronnimann											
Rugoglobigerina rugosa (Plummer)											X
Rugoglobigerina scotti (Bronnimann)											
Globotruncana aegyptiaca Nakkady	X						X				X
Globotruncana arca (Cushman)			X							X	
Globotruncana bulloides Vogler											
Globotruncana contusa (Cushman)											
Globotruncana elevata (Brotzen)											
Globotruncana fornicata Plummer											
Globotruncana gansseri Bolli			X								
Globotruncana linneiana (d'Orbigny)											
Globotruncana nothi (Bronnimann and Brown)											
Globotruncana orientalis El Naggar											
Globotruncana sharawnaensis El Naggar											
Globotruncana stuarti (de Lapparent)											
Globotruncana trinidadensis Gandolfi											
Globotruncana ventricosa White											
Rugotruncana subcircumnodifer (Gandolfi)											
Rugotruncana subpennyi (Gandolfi)								X			X
Globotruncanella havanensis (Voorwijk)											
Globotruncanella petaloidea (Gandolfi)											

Table 17, faunal distribution, Freestone County

	Freestone County Conoco Oil Co. #1 Williams			Freestone County Humble Oil Co. #1 Ball						
	Well sample interval									
	1000-20'	1040-60'	1060-80'	1576-636'	1715-75'	1775-835'	1835-95'	1925-85'	1985-2045'	2045-106'	2106-68'	2168-2230'
Globorotalia compressa (Plummer)		X										
Globorotalia pseudobulloides (Plummer)	X	X			X	X		X	X		X	X
Globorotalia trinidadensis Bolli	X	X										
Subbotina triloculinoides (Plummer)												
Guembelitria cretacea Cushman												
Heterohelix glabrans (Cushman)												
Heterohelix globulosa (Ehrenberg)				X						X	X	
Heterohelix navarroensis Loeblich												X
Heterohelix planata (Cushman)					X				X	X	X	
Heterohelix punctulata (Cushman)									X		X	
Heterohelix striata (Ehrenberg)					X		X		X		X	
Heterohelix ultimatumida (White)												
Gublerina robusta de Klasz												
Pseudoguembelina costulata (Cushman)												
Pseudoguembelina excolata (Cushman)											X	X
Pseudoguembelina kempensis Esker					X							
Pseudoguembelina palpebra Bronnimann and Brown												X
Pseudotextularia deformis (Kikoine)												
Pseudotextularia elegans (Rzehak)									X	X		
Pseudotextularia intermedia de Klasz												
Racemiguembelina fructicosa (Egger)											X	
Planoglobulina acervulinoides (Egger)										X		
Planoglobulina carseyae (Plummer)		X										
Planoglobulina multicamerata de Klasz				X					X		X	
Globigerinelloides multispina (Lalicker)												
Globigerinelloides volutus (White)												
Loeblichella coarctata (Bolli)												
Loeblichella hessi (Pessagno)												
Archaeoglobigerina blowi Pessagno												
Archaeoglobigerina cretacea (d'Orbigny)												
Rugoglobigerina hexacamerata Bronnimann												
Rugoglobigerina reicheli Bronnimann												
Rugoglobigerina rotundata Bronnimann				X					X		X	X
Rugoglobigerina rugosa (Plummer)			X						X			
Rugoglobigerina scotti (Bronnimann)											X	
Globotruncana aegyptiaca Nakkady									X	X	X	X
Globotruncana arca (Cushman)			X									
Globotruncana bulloides Vogler												
Globotruncana contusa (Cushman)									X	X		
Globotruncana elevata (Brotzen)					X							
Globotruncana fornicata Plummer										X	X	X
Globotruncana gansseri Bolli		X										X
Globotruncana linneiana (d'Orbigny)												
Globotruncana petni (Bronnimann and Brown)											X	
Globotruncana orientalis El Naggar												
Globotruncana sharsmpaensis El Naggar												
Globotruncana stuarti (de Lapparent)												
Globotruncana trinidadensis Gandolfi												
Globotruncana ventricosa White												
Rugotruncana subcircumnodifer (Gandolfi)												
Rugotruncana subpennyi (Gandolfi)												
Globotruncanella havanensis (Voorwijk)												
Globotruncanella petaloidea (Gandolfi)												

Table 18, faunal distribution, Freestone County

PLATES

EXPLANATION FOR PLATE 1

FIGURES

1 Pseudoguembelina costulata (Cushman), H.V.H. No. 8600, Kemp Clay, Walker Creek locality, near Cameron, Milam County

2 Pseudoguembelina cf. palpebra Bronnimann and Brown, H.V.H. No. 8601, Kemp Clay, Walker Creek locality, near Cameron, Milam County

3 Pseudoguembelina palpebra Bronnimann and Brown, H.V.H. No. 8602, Kemp Clay, Walker Creek locality, near Cameron, Milam County

4 Planoglobulina acervulinoides (Egger), H.V.H. No. 8603, Kemp Clay, Walker Creek locality, near Cameron, Milam County

5 Pseudotextularia elegans (Rzehak), H.V.H. No. 8604, Kemp Clay, Walker Creek locality, near Cameron, Milam County

6 Pseudotextularia deformis (Kikoine), H.V.H. No. 8605, Pan American, #1-A Parker, 2630-2660 feet

7 Pseudotextularia intermedia de Klasz, H.V.H. No. 8606, Mobil, #1 Brown, 1660-1690 feet

8 Racemiguembelina fructicosa (Egger), H.V.H. No. 8607, Kemp Clay, Walker Creek locality, near Cameron, Milam County

9, 14 Heterohelix glabrans (Cushman), H.V.H. No. 8608, Humble, #1 Surratt, 1028-1058 feet

10 Heterohelix ultimatumida (White), H.V.H. No. 8609, Pan American, #1-A Parker, 2630-2660 feet

11, 12 Planoglobulina carseyae (Plummer), H.V.H. No. 8610, Kemp Clay, Walker Creek locality, near Cameron, Milam County

13 Heterohelix punctulata (Cushman), H.V.H. No. 8611, Lucerne, #1 So. Pine Lumber Co., 5880-5910 feet

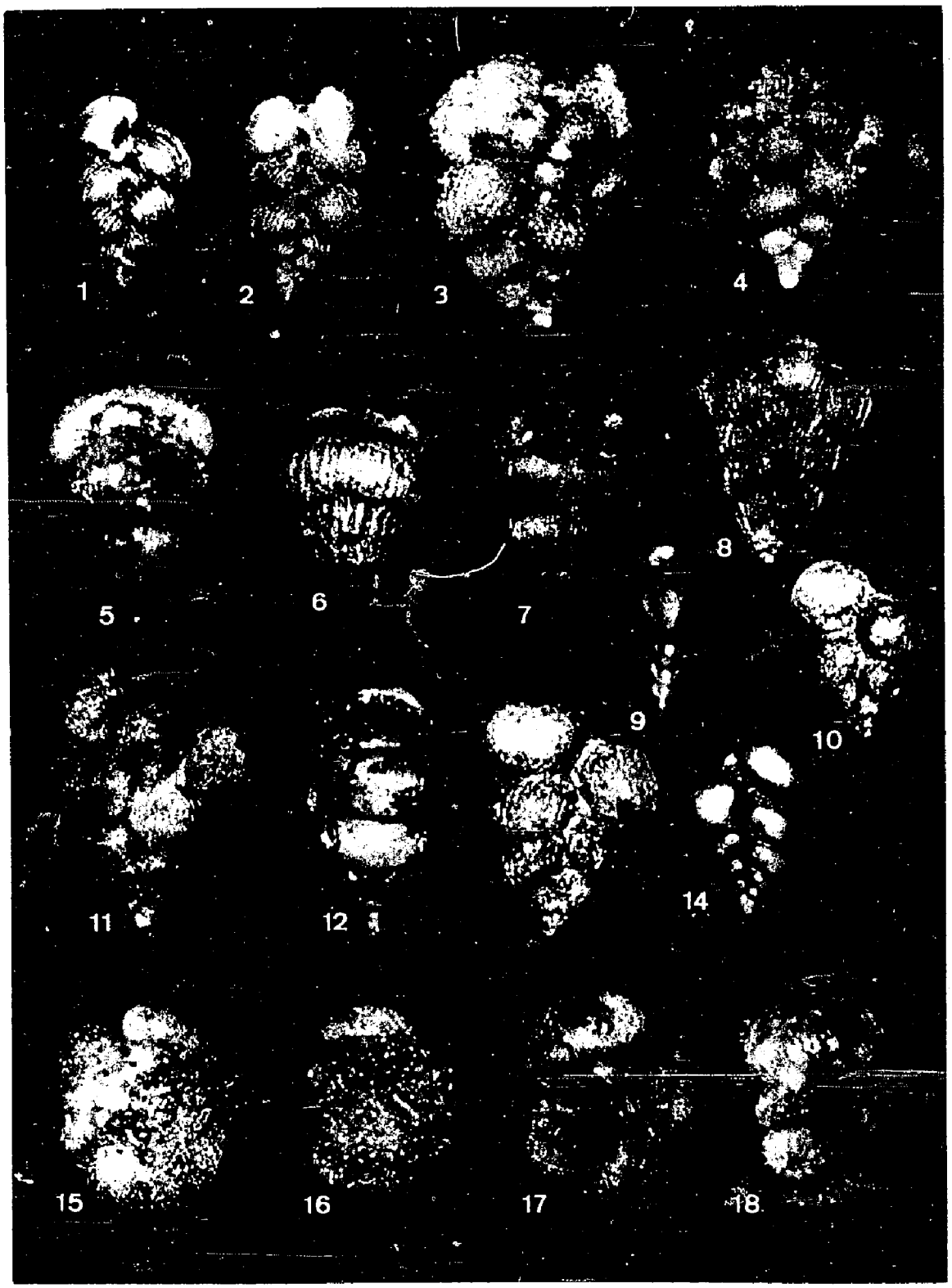
FIGURES

15, 16 Rugoglobigerina rotundata Bronnimann, H.V.H. No. 8612, Kemp Clay, Walker Creek locality, near Cameron, Milam County

17, 18 Rugoglobigerina rugosa (Plummer), H.V.H. No. 8613, Kemp Clay, Walker Creek locality, near Cameron, Milam County

All figures x80.

PLATE 1



EXPLANATION FOR PLATE 2

FIGURES

1-3 Globotruncana orientalis El-Naggar, H.V.H. No. 8614, Pan American, #1-A Parker, 2630-2660 feet

4,5 Globotruncana stuarti (de Lapparent), H.V.H. No. 8615, Pan American, #1-A Parker, 2660-2690 feet

6,10 Globotruncana fornicata Plummer, H.V.H. No. 8616, Christie et al, #1 Gordon, 3370-3400 feet

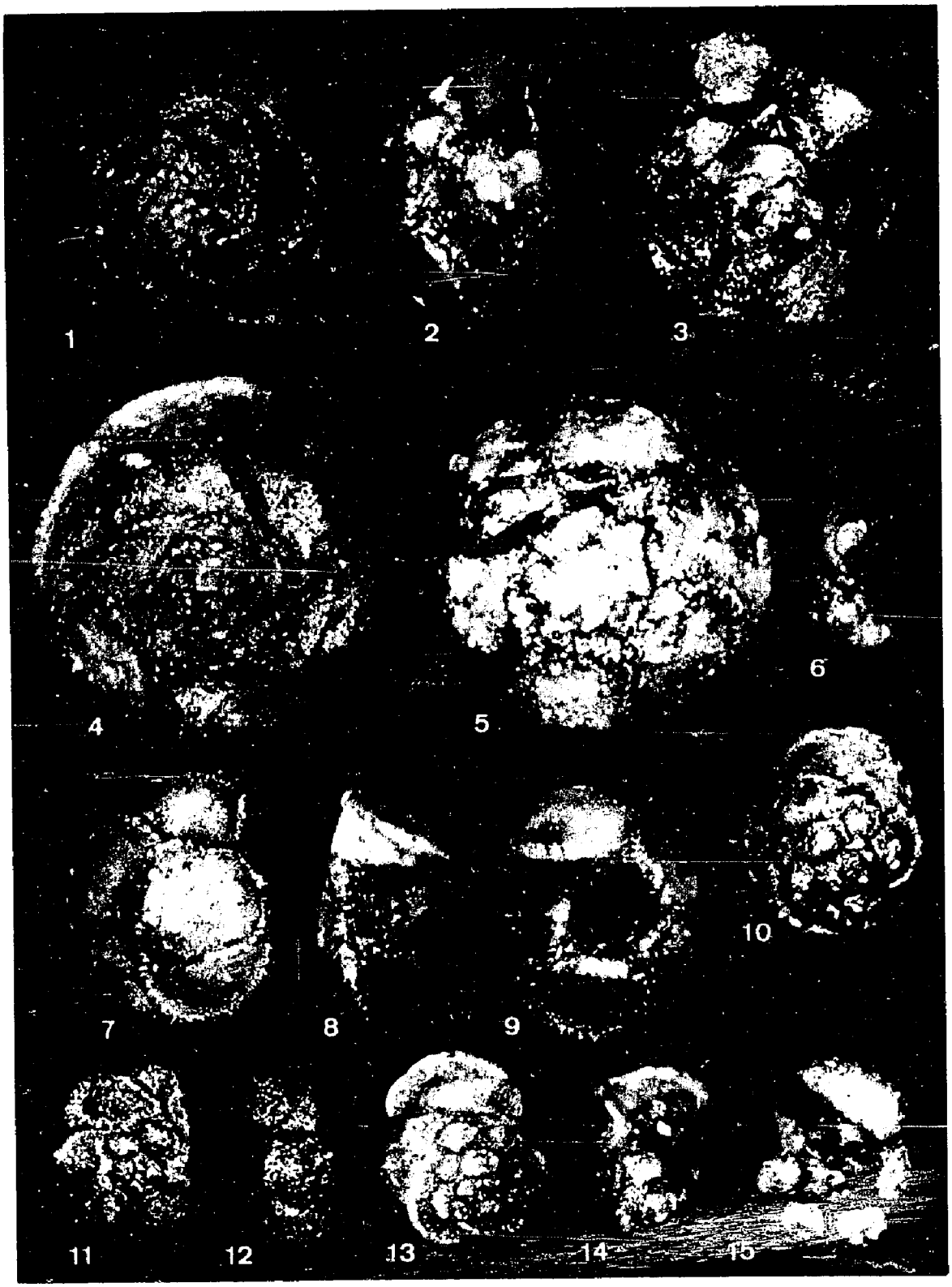
7-9 Globotruncana elevata (Brotzen), H.V.H. No. 8617, Kemp Clay, Walker Creek locality, near Cameron, Milam County

11,12 Globotruncana linneiana (d'Orbigny), H.V.H. No. 8618, Pan American, #1-A Parker, 2600-2630 feet

13-15 Globotruncana gansseri Bolli, H.V.H. No. 8619, Fain et al, #1 Yates, 3740-3770 feet

All figures x80.

PLATE 2



EXPLANATION FOR PLATE 3

FIGURES

1,2 Archaeoglobigerina blowi Pessagno, H.V.H. No. 8620, Mobil, #1 Brown, 1600-1630 feet

2,4 Archaeoglobigerina cretacea (d'Orbigny), H.V.H. No. 8621, Mobil, #1 Brown, 1660-1690 feet

5 Pseudoguembelina excolata (Cushman), H.V.H. No. 8622, Mobil, #1 Brown, 1600-1630 feet

6,7 Globotruncana bulloides Vogler, H.V.H. No. 8623, Christie et al, #1 Gordon, 3370-3400 feet

8-10 Rugotruncana subpennyi (Gandolfi), H.V.H. No. 8624, Mobil, #1 Brown, 1600-1630 feet

11 Rugoglobigerina hexacamerata Bronnimann, H.V.H. No. 8625, Mobil, #1 Brown, 1660-1690 feet

12,13 Loeblichella coarctata (Bolli), H.V.H. No. 8626, Texas, #1 Strahan, 3340-3370 feet

14 Globorotalia trinidadensis Bolli, H.V.H. No. 8627, Littig Cng., Walker Creek locality, near Cameron, Milam County

15 Rugoglobigerina reicheli Bronnimann, H.V.H. No. 8626, Mobil, #1 Brown, 1540-1570 feet

16 Guembelitria cretacea Cushman, H.V.H. No. 8629, Humble, #1 Surratt, 1028-1058 feet

17 Globorotalia pseudobulloides (Plummer), H.V.H. 8630, Littig Cng., Walker Creek locality, near Cameron, Milam County

18 Globorotalia compressa (Plummer), H.V.H. No. 8631, Union of Calif., #1 Knight, 1869-1900 feet

FIGURES

19 Subbotina triloculinoides (Plummer), H.V.H. No. 8632, Mobil, #1 Brown, 1810-1840 feet

20-22 Globotruncana aegyptiaca Nakkady, H.V.H. No. 8633, Kemp Clay, Walker Creek locality, near Cameron, Milam County

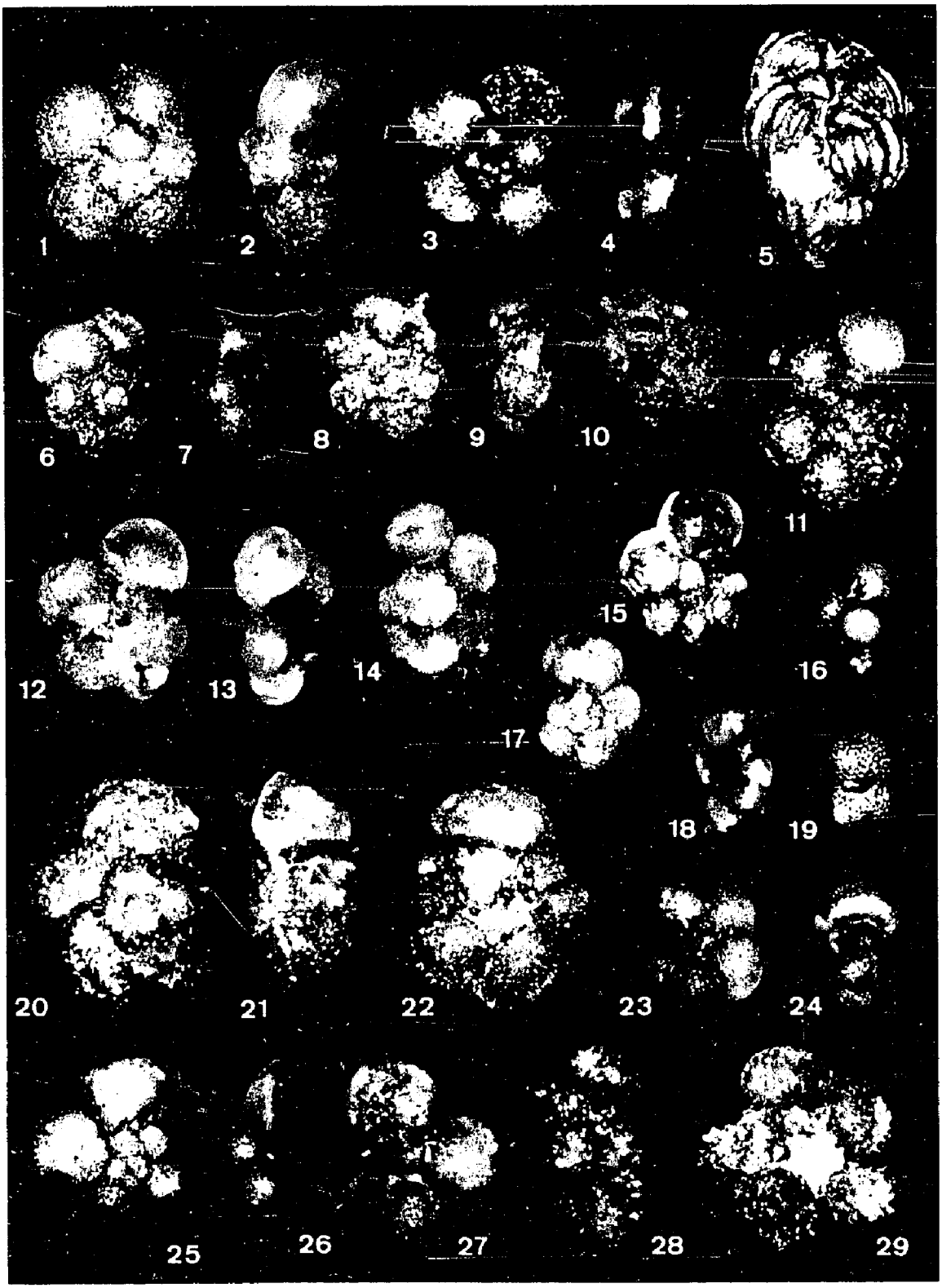
23,24 Globigerinelloides multispina (Lalicker), H.V.H. No. 8634, Mobil, #1 Brown, 1600-1630 feet

25-27 Globotruncanella havanensis (Voorwijk), H.V.H. No. 8635, Mobil, #1 Brown, 1600-1630 feet

28,29 Globotruncanella petaloidea (Gandolfi), H.V.H. No. 8636, Mobil, #1 Brown, 1600-1630 feet

All figures x80 except figures 5, 11, 15, 16, and 19 x100.

PLATE 3



EXPLANATION FOR PLATE 4

FIGURE

1, 2 Pseudoguembelina kempensis Esker, H.V.H. No. 8037, Mallard & Locke, #1 Roller Heirs, 1580-1610 feet.

3, 4 Globotruncana ventricosa White, H.V.H. No. 8038, Smith, #1 Busby, 1743-1803 feet.

5, 6 Globotruncana sharawnaensis El-Naggar, H.V.H. No. 8039, Texas, #1 Strahan, 3340-3370 feet

7 Loeblichella hessi (Pessagno), H.V.H. No. 8040, Ark-La Gas, #1 J. Davis, 860-890 feet

8, 9 Globigerinelloides volutus (White), H.V.H. No. 8041, Pan American, #1-A Parker, 2630-2660 feet

10, 16 Rugotruncana subcircumnodifer (Gandolfi), H.V.H. No. 8042, Lucerne, #1 So. Pine Lumber Co., 5880-5910 feet

11, 12 Globotruncana nothi (Bronnimann and Brown), H.V.H. No. 8043, Mobil, #1 Brown, 1600-1630 feet

13 Planoglobulina multicamerata de Klasz, H.V.H. No. 8044, Mobil, #1 Brown, 1480-1510 feet

14, 15 Globotruncana cf. trinidadensis Gandolfi, H.V.H. No. 8045, Christie et al, #1 Gordon, 3370-3400 feet

17, 18 Heterohelix navarroensis Loeblich, H.V.H. No. 8046, Humble, #1 Surratt, 1028-1058 feet

19, 20 Heterohelix planata (Cushman), H.V.H. No. 8047, Mobil, #1 Brown, 1660-1690 feet

21 Heterohelix globulosa (Ehrenberg), H.V.H. No. 8048, Humble, #1 Surratt, 1028-1058 feet

FIGURE

22, 23, 27 Globotruncana arca (Cushman), H.V.H. No. 8049, Mallard & Locke, #1 Roller Heirs, 1580-1610 feet

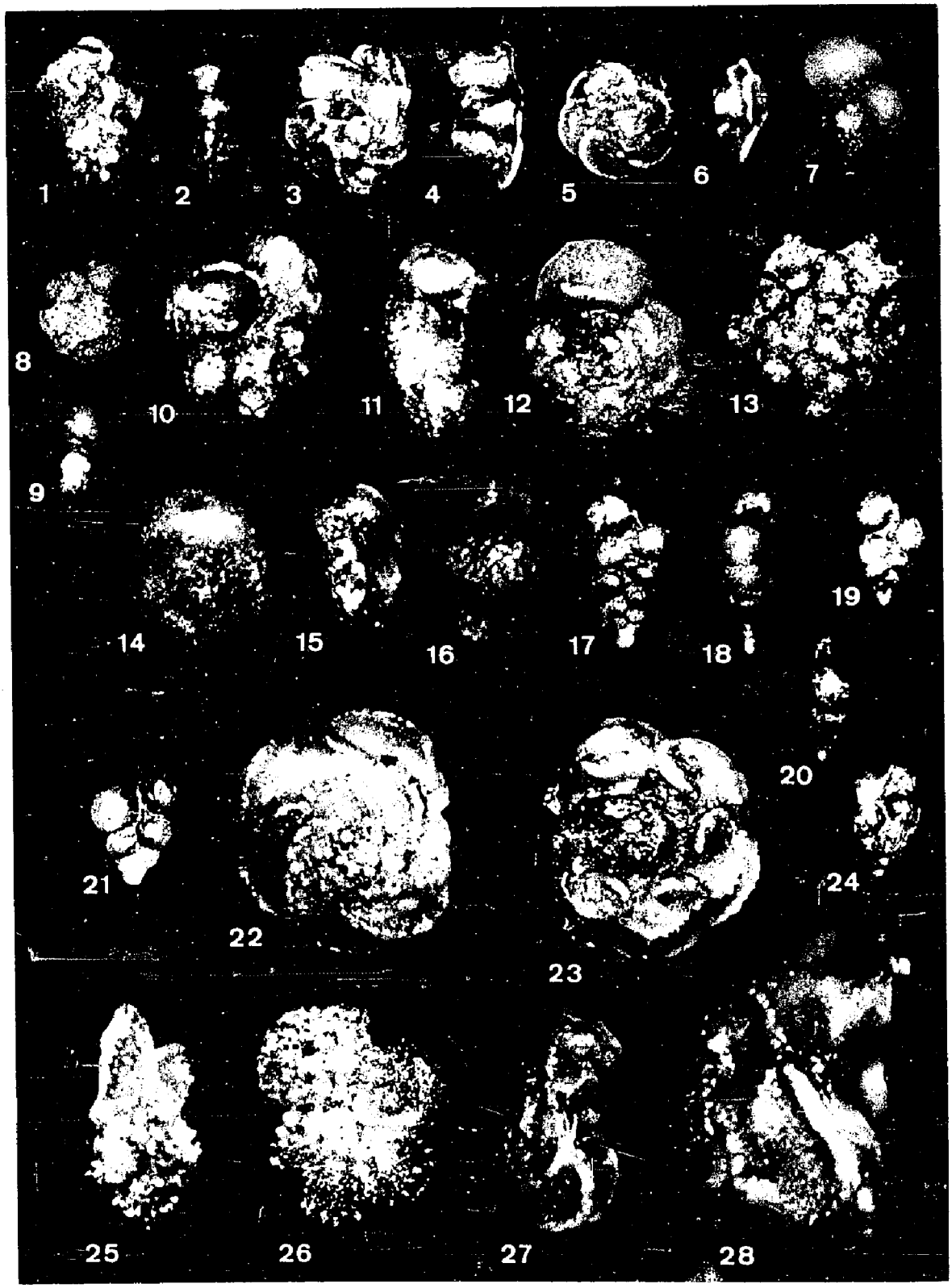
24 Heterohelix striata (Ehrenberg), H.V.H. No. 8050, Humble, #1 Surratt, 1028-1058 feet

25, 26 Rugoglobigerina scotti (Bronnimann), H.V.H. No. 8051, Kemp Clay, Walker Creek locality, near Cameron, Milam County

28 Globotruncana contusa (Cushman), H.V.H. No. 8052, Shell, #1 Darsey, 4306-4336 feet

All figures x80 except figures 3, 4, 5, 6, and 7 x60; figure 13 x40 and figure 28 x70.

PLATE 4



VITA

George C. Esker, III was born June 21, 1940 at Los Angeles, California, the son of Dr. George C. Esker, Jr. and Margaret Treacy Esker. He received his secondary education in St. Louis, Missouri. He received his B.A. degree from Washington University June, 1962 and his M.A. degree from Washington University June, 1964. From June 1964 until January 1966 he was employed by Mobil Oil International. He worked as a micropaleontologist in Tripoli, Libya during most of this period of employment. In January 1966 he began his studies at Louisiana State University for his Ph.D. degree, graduating in August, 1968.

He was a recipient of a N. A. S. A. fellowship at Louisiana State University. He is a member of Sigma Xi and the Society of Economic Paleontologists and Mineralogists.