STRATIGRAPHIC NOTES ON THE MANESS (COMANCHE CRETACEOUS) SHALE

By FRANK E. LOZO

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Stratigraphic Notes on the Maness (Comanche Cretaceous Shale)

By FRANK E. LOZO*

INTRODUCTION

In 1941, the writer was advised of the opinions of T. L. Bailey, F. G. Evans, W. S. Adkins, and other geologists of the Shell Oil Company on the stratigraphic position of the uppermost Comanche shale unit recognized in the subsurface of eastern Texas. Their studies pointed to the conclusion that this unit, now known as the Maness shale, is (1) stratigraphically younger than the subsurface Del Rio (or Grayson) shale with which it usually had been correlated, and (2) conformably overlies the Buda limestone, at this date generally misidentified as the Georgetown limestone. An investigation of the controversial sequence was made, and the confirmatory lithologic and paleontologic results, based on cores from two wells, were summarized in abstract form (Lozo, 1944) and later reported by Bailey, Evans, and Adkins (1945). A manuscript prepared by the writer in 1944 indicated the desirability of gathering additional stratigraphic information, in order better to segregate vagaries, speculation, and errors or mistakes from the rather meager factual data on hand at this date. Intermittent attention to this task has been applied and many early questions have increased in scope. It is hoped that the status of the writer's investigations here reported will stimulate others toward additional study.

STRATIGRAPHY

Historical Background on Outcrop Woodbine Basal Clays 1893-1930

Prior to the publication naming and describing the Maness shale (Bailey, Evans and Adkins, 1945), a number of microscopists examining samples from certain areas in the eastern Texas subsurface early recognized the presence of a "dark brown," "copper-colored," or "bronze" shale unit above "Lower Cretaceous," "Washita," or "Georgetown" limestone. So far as I know, the shale (when specifically identified and separated from the contiguous strata) was generally correlated with the outcrop Woodbine "Basal clay" of Taff or with the outcrop Del Rio clay of central Texas or its north Texas counterpart, the Grayson marl.

J. A. Taff (1893, p. 285) divided the "Dakota (Lower Cross Tim-

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bers) Formation" into three divisions. In descending order these were designated as the "Timber creek beds." "Dexter sand," and "Basal clay." He stated:

> Of these three beds, the first or lowest is a variable bed of impure clay, which is often lignitic and sandy, and which for convenience of study and distinct delineation, I have designated the Basal clay. (p. 285)
>
> Complete exposures of this clay have not been seen. Its thickness is estimated at ten to fifteen feet. From observations on this clay in other localities, it is believed to vary locally in thickness, structure, and lithologic character. (p. 293)

Repeated citation of a thin "greenish blue contact clay" indicates the skillful field observations of this pioneer geologist. It may be emphasized here that although this stratum (now thought to be a remnantal soil developed on the Grayson prior to Woodbine deposition) quite often was the only representative of his "Basal clay" bed, Taff explicity stated that his lowest division included strata in addition to this contact bed. Further (due to poor exposures and badly overwashed contacts south of Grayson County), most of Taff's details are based on data from the Preston anticline area. Statements to follow refer to this area and others.

R. T. Hill's (1901) monumental work on the Black and Grand prairies contains no additional data on Taff's basal clay. With full acknowledgment of Taff's stratigraphic details, Hill included the basal clay unit with the Dexter sand. A full recapitulation regarding the clay is presented by Hill under the heading "Confusion Concerning the Base of the Beds" (pp. 303-305).

Until the publication of W. M. Winton's bulletin on the geology of Denton County in 1925, discussions of the Woodbine basal clay generally followed the pattern presented by Hill. Examples are the University of Texas bulletins of Udden, Baker and Böse (1916), Dumble (1920), Winton and Adkins (1920), and Winton and Scott (1922).

Cores from borings by the Tarrant County Water Improvement District No. 1 in 1925 provided additional material for statements on the Woodbine basal clay. A boring on the south bank of the West Fork of Trinity River was called "Trinity No. 1." Cores from this test hole and others were examined in considerable detail by Winton and staff at Texas Christian University, Fort Worth.

The data pertinent to the Woodbine, as interpreted in the "Trinity No. 1," were first reported in Winton's "Geology of Denton County." He stated (1925, p. 36) that "near the base [of the Woodbine] are some shales very rich in delicate fossils." W. L. Moreman, in a chapter on "Micrology of the Woodbine, Eagle Ford and Austin Chalk," gave a brief summary of the fossils obtained from the Woodbine washed sample residues, figured three species of Ostracoda and listed six genera of Foraminifera. Although the Comanche Cretaceous aspect was readily apparent to these workers, no precise statement to this effect was made.

Gayle Scott, on sabbatical leave from Texas Christian University in 1925 for advanced graduate study in France, was absent from Texas during the preparation of the Denton County bulletin. In his paper "The Woodbine Sand of Texas Interpreted as a Regressive Phenomenon," Scott (1926, p. 616) reported, after study of the "Trinity No. 1" Woodbine cores, that:

> A number of fossils, all indeterminate specifically, have been picked from some of the cores, and show, particularly in the case of the ammonites, a marked Washita complexion.

C. I. Alexander (1929, p. 35), a member of Winton's staff in 1925, prepared a doctorate thesis on north Texas Cretaceous Ostracoda and concisely summarized the status of the data and ideas derived from the "Trinity No. 1" basal clay and shale of the Woodbine.

> The author's studies have added a number of species of ostracods from samples of the basal clay and shale members of the formation in the core of the Tarrant County Water Improvement District's well at Arlington, Texas. All species of ostracods found in these basal Woodbine shales at Arlington have also been recognized in the upper beds of the underlying Grayson formation. It is important to note, further, that many species of foraminifera, too, are common to the two formations.
>
> The compact, black, laminated shales from which the above-mentioned samples were taken, agree exactly with numerous descriptions of the shales that have been regarded by various authors as the basal beds of the Woodbine at other localities and differ radically from any Grayson clays that the writer has ever seen, or of which he has been able to find descriptions. In the cores they are easily differentiated from the yellowish clays of the Grayson.
>
> The lack of faunal breaks in the meager amount of material available for study suggests that in Tarrant County, at least, sedimentation must have been almost, if not quite, continuous through the time period during which the upper Grayson clays and these basal black shales of the Woodbine were deposited. On account of the paucity of the macrofauna, the solution of the problem of the origin and time relationships of the Woodbine formation throughout its areal extent will perhaps be reached through a careful study of the microfossils. The author plans to make a series of careful collections along this much-disputed contact of the Woodbine with the Comanche formations, in an attempt to gather evidence which will establish whether the Woodbine is actually transgressive in Oklahoma and Arkansas, or whether the regression postulated by Scott simply began earlier in that area. Collections from several arenaceous and lignitic clay layers throughout the Woodbine formation have so far failed to produce any microfossils.
>
> Concentrates from the basal shale layers from the Arlington drill core contained, besides numerous ostracods and foraminiferans, a quantity of molluscan fragments, a small amount of echinoid material, some sand, and varying quantities of pyrite.

References to Subsurface Clays at Base of Woodbine 1931-1944

Drilling in the East Texas Basin in the early 1930's resulted in recognition of the brownish-red, fossiliferous clay at the base of the Woodbine section. At a meeting of the Dallas Petroleum Geologists in 1931, Gayle Scott, F. B. Plummer, and others discussed this subsurface clay (since named the Maness) and possible outcrop correlatives. A mimeographed transcript of their remarks was distributed under the title "A Discussion of the Producing Sands of East Texas." A brief notation on the lithology of the basal clay is also presented in

Plummer and Sargent's study of Woodbine underground waters and subsurface temperatures (1931).

Adkins' (1933) report on the Mesozoic geology of Texas summarized the references to the various "Woodbine basal clays" through 1932, and added new paleontologic data by L. F. Spath, Gayle Scott, Helen J. Plummer, and himself. He named the Pepper shale as a distinct basal Gulf Cretaceous unit south of the Brazos River, avoided any categorical reference of the Pepper to either the Woodbine or the Eagle Ford, and stressed the uncertainty of any identification of the outcrop Pepper shale with the subsurface Woodbine basal clay (Maness).

Discovery of oil in the Woodbine on the Boggy Creek salt dome, Anderson and Cherokee counties, in 1927; on the Van dome, Van Zandt County, in 1929; and the wildcat discovery of the great East Texas field by C. M. Joiner in 1930, led to the drilling of many prospects in the East Texas Basin. Knowledge of the character and distribution of the subsurface clay at the base of the Woodbine increased and reports soon appeared in the literature.

Denison, Oldham, and Kisling (1933), reporting on the Kelsey anticline, Upshur County, indicated the Maness as Washita shale on cross-sections, and provisionally correlated the unit with the Del Rio shale of central Texas on paleontologic evidence by N. L. Thomas and Harold Herndon. With regard to the upper contact, the following statement was made (p. 663):

> Although elsewhere, as on the Sabine uplift, there is a notable erosion interval between the Gulf and Comanche series, the Woodbine in this locality merges gradually into the Washita shale without evidence of unconformity.

A month later, and unaware of the manuscript contemporaneously prepared on the Kelsey anticline, Minor and Hanna's (1933) paper on the East Texas oil field appeared. They discussed the same lithologic interval at the base of the Woodbine, noted the occurrence of Lower Cretaceous fossils, and indicated the shale unit on cross-sections. Their conclusion on the nature of the contact between the shale and overlying sand section was stated thus (p. 776):

> An unconformity has been postulated at the base of the clay section below the main sand zone and above the Washita limestone section. Sufficient evidence is not at hand to determine positively that no such unconformity exists, but the presence of Lower Cretaceous fossils suggests that it is not present. It is believed that no prominent unconformity, if any, exists between this clay zone and the sands deposited immediately above, suggesting that Scott's contention of a regressive period of deposition is correct for the lower part of the Eagle Ford-Woodbine group of beds.

R. A. Liddle's (1936) excellent and detailed report on the Van field contains slightly variable summaries on the copper-colored shale at Van plus additional remarks on the shale in the East Texas field:

> At Van fossiliferous copper-colored Lower Cretaceous shales averaging about 15 feet thick overlie gray Comanche limestone. Between the

> copper-colored shales and the Woodbine is a variable thickness (4 to 15 feet) of gray shale or gray sandy shale, carrying re-worked Comanche Foraminifera where the shales are not sandy. It appears to be a transition zone between the Lower and Upper Cretaceous. At the south end of the East Texas field the gray Comanche limestone is overlain by fossiliferous copper-colored Comanche shales which in turn are overlain by gray shales and gray sandy shales that grade upward into unquestionable Woodbine. Here also there are re-worked Comanche Foraminifera in the gray shales where they are not sandy. [Excerpt from "Geologic Notes," Plate 3.]
>
> The Washita and Fredericksburg have not been subdivided in the Van field.... At the top of the Comanche are copper-colored fossiliferous shales from 5 to 30 feet thick which grade up into gray sandy shales averaging about 10 feet thick. These in turn grade into basal Woodbine without noticeable lithologic break. There seems to be no thinning of the Fredericksburg and Washita over the Van uplift. [Excerpt from "Geologic Notes," Plate 9.]

The Buffalo dome in Leon County, essentially a Woodbine gas field, was discovered in 1933. Several early wells were cored almost continuously through the Woodbine and underlying shale and penetrated into the Washita (Buda) limestone. Data on the post-Buda Comanche shale by J. B. Dorr and Jerome Sasse of the Shell Oil Company were reported in the Leon County geological bulletin by H. B. Stenzel (1939). Buda limestone was still unrecognized in the central portion of the East Texas Basin and Stenzel followed others in identifying the Maness as Grayson, the Buda as Georgetown. It is pertinent to add that this bulletin contains a stratigraphic section (Fig. 56, p. 220) from southern Johnson County into northern Bell County by W. S. Adkins from outcrop data gathered several years previously.

Stratigraphic studies initiated in the East Texas Basin in 1938 by Bailey, Evans, and Adkins resulted, two years later, in realization of the identity of the Buda limestone and the hitherto false correlation of the overlying shale with the Grayson or Del Rio. In 1941, during a period of summertime employment with the Shell Oil Company in Houston, the writer examined cuttings from the Texas Co., Scritchfield No. 1, Smith County, and cores from the Shell Oil Co., Stephens No. 1, Henderson County, for faunal data. This investigation was under the direction of Adkins at the request of Bailey. The post-Buda Maness shale, then informally called "Scritchfield," "Stephens," or "La Rue," was provisionally distinguished paleontologically and lithologically from the pre-Buda Grayson shale.[1] Cores from the Shell Oil Co., Maness No. 1, Cherokee County, and cuttings from a number of other wells were later examined and the results incorporated in a summary Shell report (Lozo, 1942).

R. W. Imlay, in Texas during the early 1940's on an assignment for the United States Geological Survey's oil and gas investigation project, was informed of the stratigraphic developments under discussion. In the three publications resulting from this assignment,

[1]Written communication, F. E. Lozo to T. L. Bailey, Aug. 4, 1941.

Imlay (1944, 1945a, 1945b) indicated the position of the Maness shale on a correlation table as "un-named beds."

Including the writer's (1944) abstracted paleontologic note previously mentioned, the above paragraphs summarize fairly completely the stratigraphic information on the Maness known to the writer prior to publication by Bailey, Evans, and Adkins (1945).

References to the Maness Shale 1945-1950

The scope of the original paper describing and naming the Maness shale is adequately presented in the authors' abstract (Bailey, *et al.*, 1945, p. 170):

> The subsurface Lower Cretaceous (Comanche) of the East Texas basin is divided into formations by electric logs and microfossils. The Maness shale, post-Buda age and highest known Comanche formation, is described. It occurs near the center of the basin and is unknown at the outcrop. Beneath it is the Buda limestone, which is thin or absent at the outcrop in northeast Texas, except at a few localities where it is present as outliers. A Buda outlier is described on the Hill-Johnson County line and another outlier in Denton County contains *Budaiceras* and other fossils so far known only from the Buda. The beveled top of the Comanche in this area constitutes a widespread unconformity, which is definite near the east, north, and west margins of this basin, but near the center of the basin the existence of an unconformity is unproved. The overlying basal Woodbine ("Dexter beds" of R. T. Hill) contains ammonites none of which is known in the Lower Cretaceous (Comanche).

Publications since 1945 have indicated the presence or absence of the Maness in local oil producing areas, on regional cross-sections, or referred to the Maness in discussions of outcrop areas. A. R. Loeblich (1946) described a fauna of arenaceous Foraminifera from the type locality of the Pepper shale and discussed evidence in support of Wooodbine age correlation. The Maness shale is recognized in the Hawkins field, Wood County, Texas (Wendlandt, Shelby, and Bell, 1946). The formation is reported absent by post-Comanche erosion in the Quitman field, Wood County (E. R. Scott, 1948), and Talco field, Franklin and Titus counties, Texas (Wendlandt and Shelby, 1948). In November, 1948, a nonserialized printing was issued in Tyler, Texas, and New York of the abstract and lantern-slide illustrations used in oral presentations of a paper on the outcrop Woodbine. A down-dip stratigraphic section from Dallas County into Henderson County, Texas, presented the writer's interpretation of the Maness-Woodbine contact in Kaufman and Henderson Counties along the line of section (Lozo, 1948).

The concept of the Maness shale as a basal portion of the South Tyler formation (introduced in a correlation table, page xvi, of the Shreveport Geological Society's "1945 Reference Report on certain Oil and Gas Fields . . ," vol. 1, 1946) was expressed by Hazzard, Blanpied, and Spooner (1947, p. 476) in these words:

> The term "South Tyler Formation" is applied to the sand and mottled red and gray shale sequence which intervenes between the base of the Dexter and the top of the Buda Limestone. It includes, at its base, the Maness or copper colored shale of Comanche age. The South Tyler formation is named after the South Tyler field in Smith County, Texas, in the wells of which are found typical developments. In the Phillips Petroleum Company No. 1 Mrs. W. T. McMinn well in the M. M. Long survey, discovery well of the South Tyler Field, the South Tyler formation is defined as the interval between depths of 5675 and 6065 feet.
>
> The South Tyler formation is considered to represent the deposits laid down during the regression of the late Comanche Sea in the East Texas basin. The authors' interpretation involves the concept that a period of sub-aerial erosion intervened between the deposition of the regressive South Tyler formation and the onset of the Dexter transgression, the basal deposits of the latter being characterized by coarse sands and gravelly sands far out into the basin.

Three stratigraphic sections (pls. 10-12) graphically present the above authors' interpretation of the relationship of the South Tyler formation over much of the East Texas Basin.

In 1949, the results of H. R. Bergquist's detailed mapping and stratigraphic studies of the outcrop Woodbine in Cooke, Grayson, and Fannin counties, Texas, were published in summarized form. A wealth of closely controlled data, both lithologic and faunal, resulted from his work; the stratigraphic data will be incorporated in L. W. Stephenson's monograph on the larger fossils of the Woodbine, now in press. Relevant to the subsurface Maness and South Tyler formations, Bergquist mapped and secured faunal data from several isolated exposures of dark, fissile shale and fossiliferous glauconitic or sandy clay at the base of the mappable Woodbine section. This "unnamed shale and sandy clay (post-Grayson)" was suggested to be the age equivalent of the Buda limestone on the basis of exogyras and other pelecypods. Under a discussion of these beds, he stated:

> The base of the Woodbine formation apparently lies unconformably on the Washita group and older beds of the Comanche series at most places, but in some exposures in Grayson County the Grayson marl appears to grade upward into the Woodbine and it is difficult to determine where the unconformity occurs. At these places the Woodbine appears to be conformable with fossiliferous shale and clay younger than the Grayson marl of the Washita group.... Whether or not these beds are correlative with the recently described South Tyler formation cannot be determined at present because of insufficient data in the area between the Tyler Basin and the Red River region [text on sheet 2].

Stratigraphic Speculations, Facts, and Statements

Taff's outcrop Woodbine basal clay. Until the field work of Bergquist in the Red River Region, 1945-1948, inclusive, and the intermittent work of Adkins and Lozo, 1944-1948, all statements concerning the identity and correlation of Taff's basal clay may be regarded as speculation based on hypotheses forced to conform to weakly supported stratigraphic postulations. It is now known that various stratigraphic horizons at different localities were identified or correlated as the same "basal clay." Uplift of the Preston anticline and depression of the flanking synclinal areas during late Comanche-early

Gulf Cretaceous time, demonstrable local erosion of the Grayson, isolated occurrences of post-Grayson Washita shale, and the strong probability of local overlap in the base of the overying sand and shale section may all be cited as factual evidence in support of the initial statement.

It is here stated that the exposures of the post-Grayson clay or shale of Bergquist in Grayson County at Pawpaw Branch and along Rock Creek in the northwestern portion of the county, near the Pottsboro cut-off railroad underpass of the M. K. & T., at the type locality of the foraminifera *Flabellammina denisonensis* in the city of Denison, and in the branch of Choctaw Creek north of Cherry Mound, northeastern Grayson County, are believed by the writer to be essentially contemporaneous and as such will be informally called the "Cherry Mound shale." Evidence in manuscript preparation indicates that this shale is Buda equivalent; generally contains an impoverished arenaceous foraminiferal fauna very similar to the Pepper shale, excepting the occurrence of *Flabellammina denisonensis;* and may be conformable, gradational, or interbedded at either contact, or disconformable and sharply limited at either contact dependent upon the locality.

"Trinity No. 1" Woodbine basal clay. Data, principally paleontologic, from this near-outcrop core-test were often cited in the 1925-1933 period in support of a Comanche age determination for basal Woodbine clays. These data were projected to outcrop localities to the north (some of which, insofar as the writer can determine, were actually in the Pawpaw clay), and later were confused with similar data from the Maness. Suffice it to state that at least one location given for the core-test is erroneous, an inaccuracy which incidentally led to the restudy of the 1925 stratigraphic data; the original stratigraphic determinations are in part mistakes of fact; and the basic data, i.e. the precisely labeled core itself and samples cut therefrom, are no longer available.

The facts of true location and original stratigraphic determinations are indicated on Figs. 1, 2, and 3. The corrected stratigraphic determinations are shown on Fig. 4. These Washita units have been precisely correlated with the outcrop area to the west by means of other electric logs, core-test data, and nearby detailed outcrop sections. It may be noted that the correct identifications of the Denton and Pawpaw shales, as shown, are at variance with the identifications in present general use in the east Texas subsurface (Bailey, *et al.*, 1945; and others).

The writer is in full agreement with the paleontologic identifications reported from the 1925 "Woodbine." These Grayson fossils are actually from the Grayson. From portions of cores preserved because of the larger fossils, and presumably correctly labeled as to depth, the fauna mentioned by Moreman (1925) and Alexander (1929) has been re-obtained. Sixteen samples between the depths of 58 to 93 feet

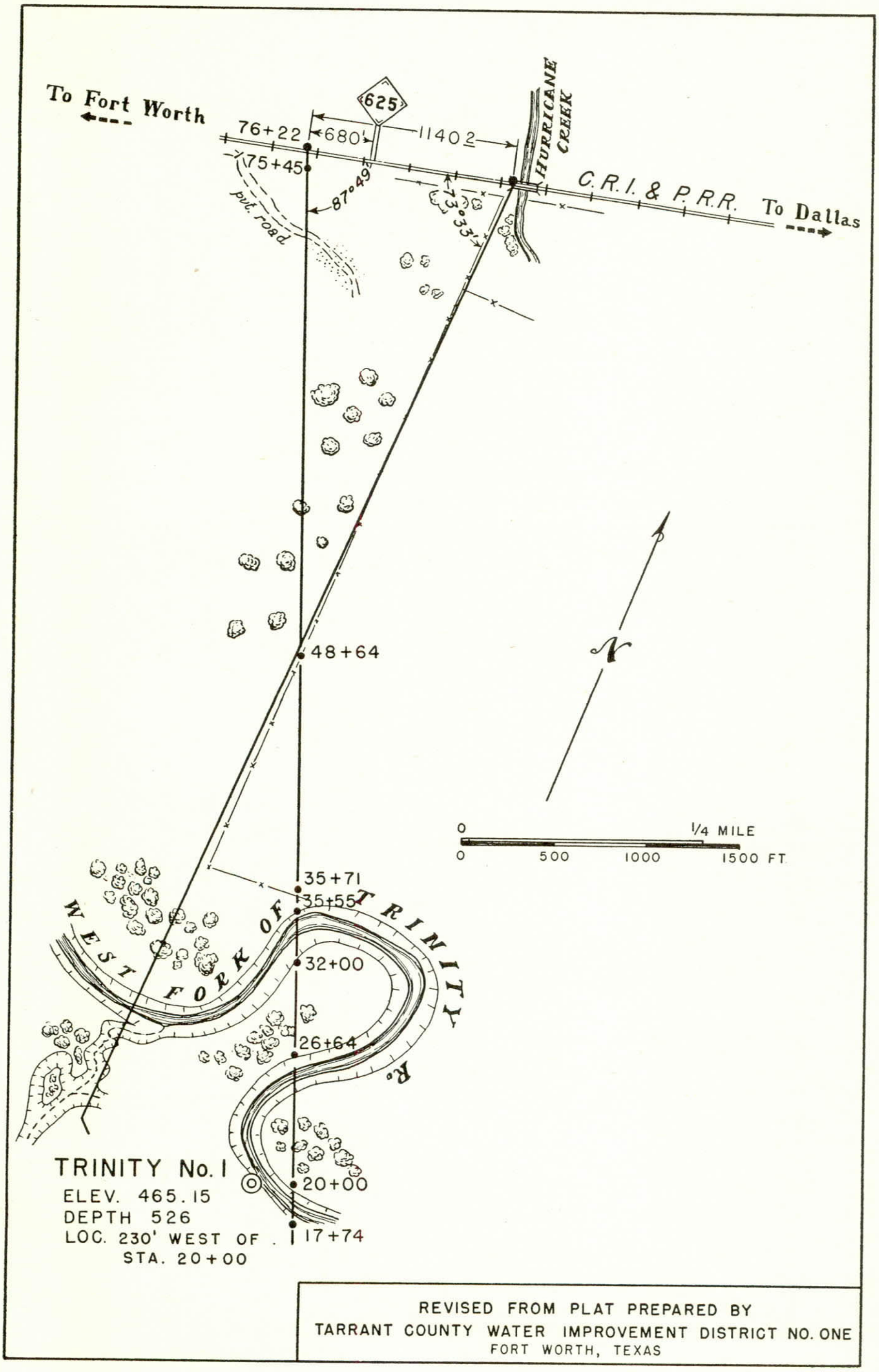


Fig. 1. Plat of location of "Trinity No. 1" core test, Tarrant County, Texas.

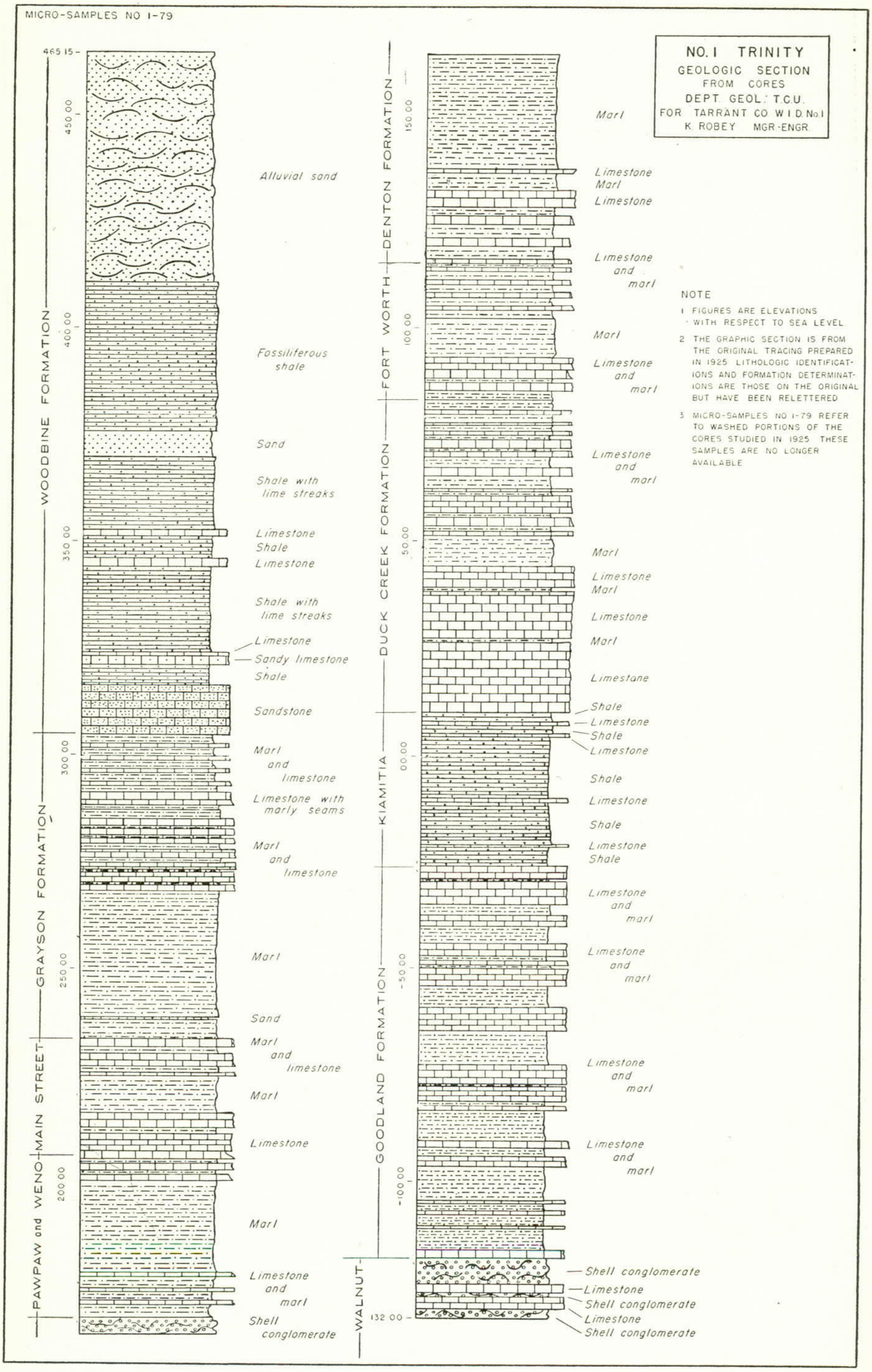


Fig. 2. Graphic log and 1925 stratigraphic determinations, "Trinity No.1" core test.

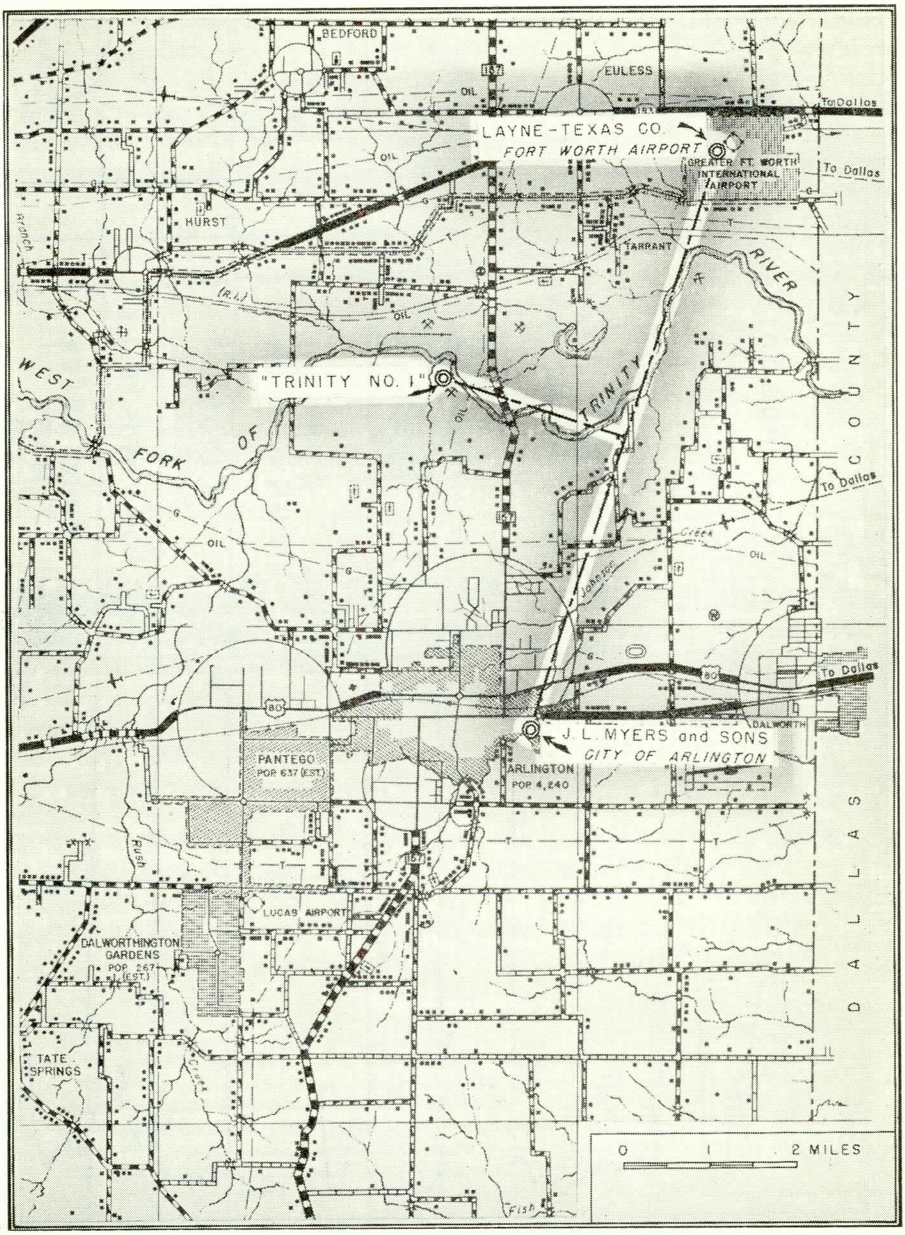


Fig. 3. Regional map of Arlington-Euless area, Tarrant County, Texas, with line of section of Fig. 4.

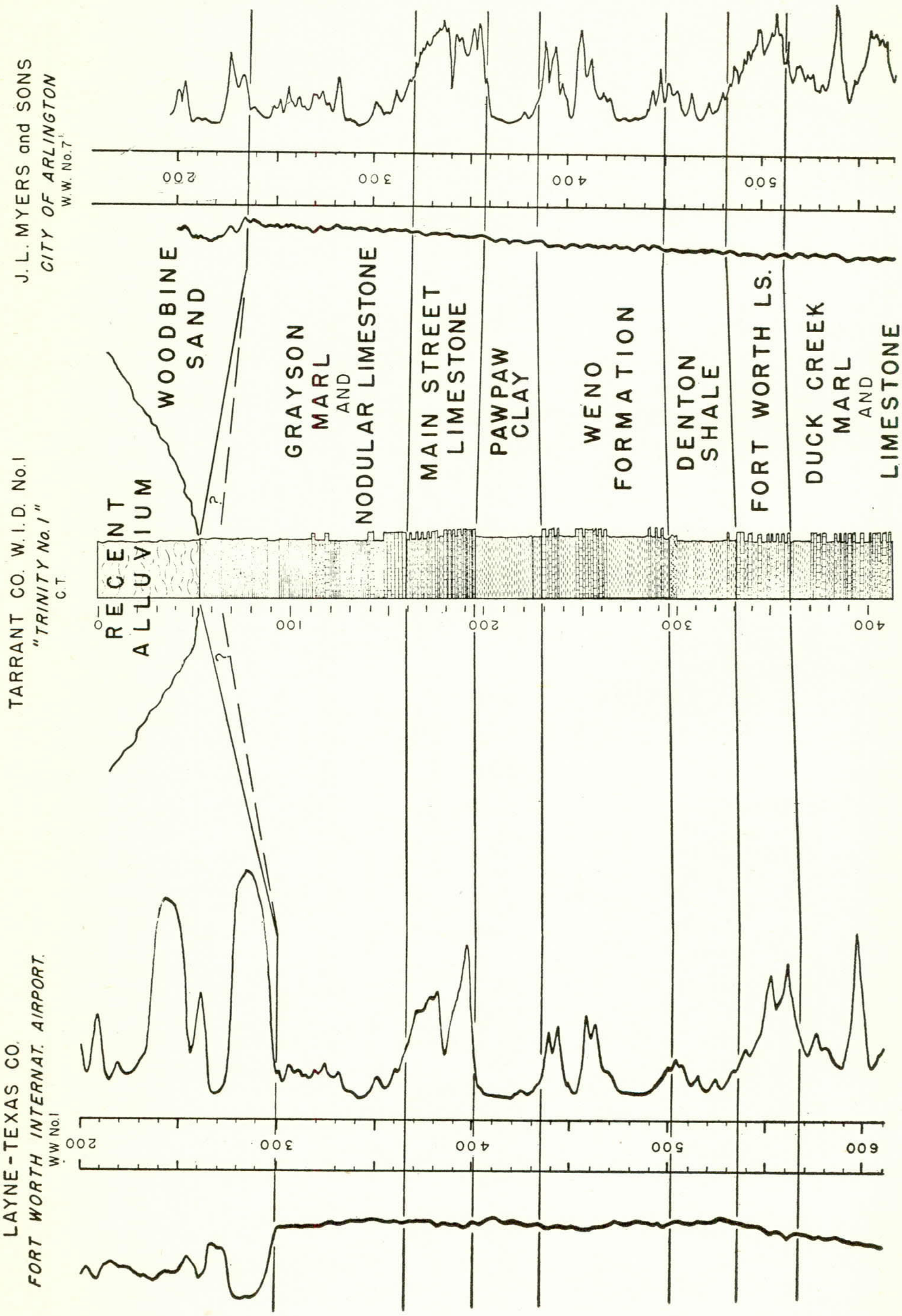


Fig. 4. Stratigraphic section, Euless vicinity to Arlington, showing stratigraphic revision of "Trinity No. 1."

(elevations +407 to +372 feet) were examined for microfossils. All fossils recovered were those common to the Grayson.

No explanation is available for the 6 feet of sand logged from depths 87 to 93 feet (elevations +378 to +372 feet) or the 12 feet of sandstone from depths 148 to 160 feet (elevations +317 to +305). A core labeled "about 91 feet" contained no sand and washed down to a typical fossiliferous Grayson marl residue.

The apparently excessive Grayson interval of 107 feet, as determined by the writer, may include a few feet of black fissile shale at the top. At a nearby outcrop north of Handley, there are exposed a few feet of post-Grayson shale with indigenous? Washita fossils. Adjacent to this exposure a trench silo cut exposed a few feet of black shale with indigenous Woodbine fossils resting upon eroded Grayson limestones. In the Handley-Arlington-Grand Prairie area, the Grayson interval, as measured in outcrops and interpreted in wells, varies from 75 to 100 feet. This difference is due in some degree to demonstrable post-Grayson erosion.

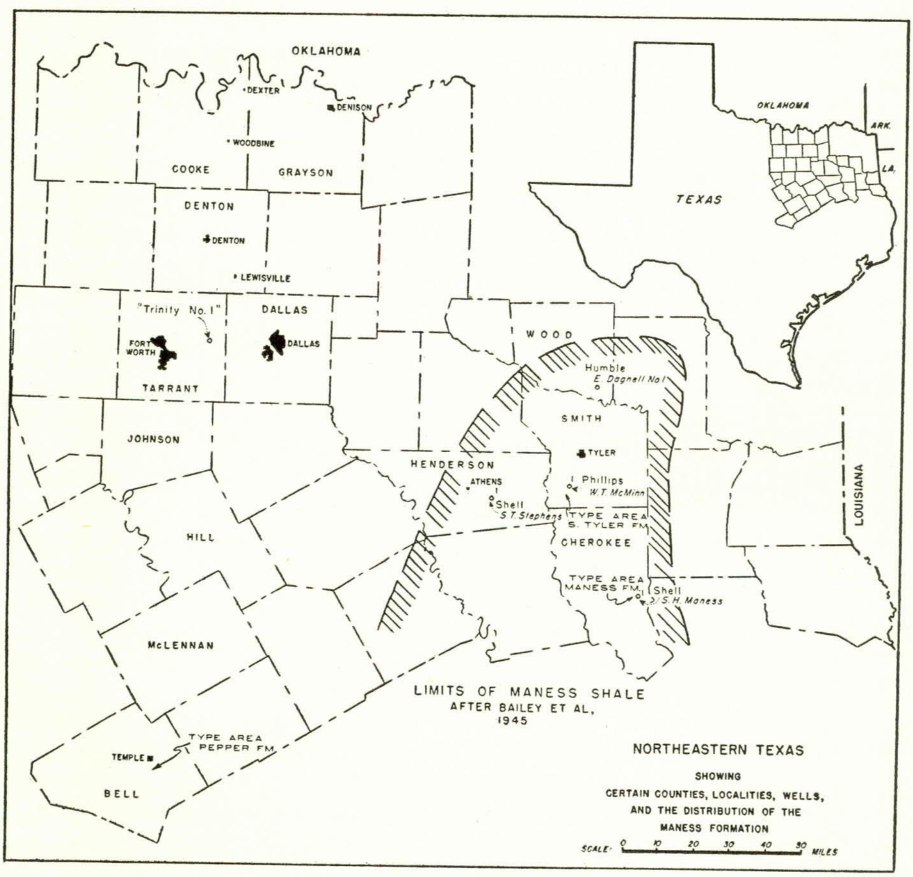


Fig. 5. Index map of a portion of northeastern Texas.

Basal Gulf Cretaceous Pepper shale. Although the Pepper shale has an interesting history of identification with the Eagle Ford and then with the Woodbine, there have been few printed statements that this shale is correlative with the Maness. The present writer is aware, however, that such speculation has occurred. It is conceivable that in the southern part of the East Texas Basin where there is an interval of a hundred or more feet of unidentified black shale above Buda limestone, that some of this shale could be of outcrop Pepper facies and indistinguishable from the surface shale. It is also conceivable that some of this shale is a black shale facies of the bronze-colored Maness shale to the north and east. Stratigraphic studies of the outcrop and near-outcrop Pepper shale indicate that it is probably correlative into upper Woodbine. Similar studies on the Maness in the subsurface suggest that this shale is absent by erosion on the west margin of the East Texas Basin.

Maness shale and the South Tyler formation. Much speculation exists as to the nature, significance, and precise position of the upper contact of the Maness. At least some of the confusion arises from the fact that reasonable interpretations in one area are forced into dissimilar situations in another area. Such action does not strengthen the hypothesis applicable in the known area and is against the better principles of stratigraphy. For example, the recognition on a structure of presumably re-worked fossils in the overlying beds with possible shortening of the underlying section may be interpreted as an unconformable relationship. It is well known that structures in the East Texas Basin formed at different times; therefore, their episodic growth would result in different positions of unconformities. On a regional basis, unconformities and resultant overstep or overlap on an eroded or beveled surface are generally assumed to decrease in magnitude in some direction. These examples are sufficient to indicate that categorical references as to the nature and significance of many contacts, including those of the Maness, are but dogmatic statements when extended beyond the area of controlled data.

It is generally conceded that the Maness-Buda contact is conformable and transitional by gradation. Differences of opinion exist on the nature of the upper contact of the Maness, i.e., conformability versus unconformability with the overlying sandy shale and sand section. Solution of this question is dependent upon a closely controlled history of the Sabine Uplift and the basins adjacent. Until more data are fitted into the proper regional relationship, the writer does not propose to add to the confusion already existing.

Special mention is here made of the concept of the South Tyler formation of Hazzard and others. To the writer the unit seems valid in the area from which it was originally described. Inasmuch as the Maness is consigned to the basal portion, evidence is present for the Comanche age of the lower portion of the South Tyler. In certain areas of Wood County, an expanded Buda limestone may prove to be the lateral replacement of the Maness and some of the overlying sand section. This hypothesis remains to be proved. If correct, an additional middle section of the South Tyler would probably be assigned Comanche age on the basis of fossil remains (not yet known) from the expanded Buda. The upper shale portion is placed in the South Tyler on the basis of conglomerates in the base of the overlying sand. The lateral continuity of these conglomerates remains to be demonstrated and evaluated as indicative of the basal transgression of the Gulf Cretaceous. Evidence regarding these conglomerates appears strongest in the northeastern portion of the basin. Conversely, much evidence supporting the concept is less satisfactory progressively southwestward. In conclusion, the writer believes that critical study of the South Tyler concept will add much to the geologic history of the controversial Comanche-Gulf Cretaceous boundary problem.

PALEONTOLOGY

General Statement

With the exception of indeterminate fragments of echinoderms, molluscs, and fish remains, the larger fossils of the Maness are essentially unknown. A specimen of *Budaiceras* was recovered from a core in the basal portion of the formation in the Humble, F. K. Stephens No. 1, Hawkins field, Wood County. Undetermined gastropods, clams, and a crustacean chela have been observed in cores of the formation in the Humble, E. Dagnell No. 1, also in the Hawkins field. A pecten was reported in a core of the Shell, S. H. Maness No. 1, Cherokee County. From cores of the probable Maness in the Buffalo field, Leon County, several molluscan genera were reported.

An idea of the fragmentary nature and relative abundance of the fossils in the Maness may be obtained from the photomicrographs of thin-sections of the shale (Pl. 1). For contrast, views of the underlying Buda limestone are included.

Ostracoda

The ostracods are comparatively rare, and as a result of adhering matrix, coloration, or other factors of preservation, are identified with uncertainty. This is particularly true of those species with reticulate or granulose surface ornamentation. Tentative identifications based on the collections from the Shell, Stephens No. 1 and the Shell, Maness No. 1 indicate the presence of the following species:

Bairdia harrisiana Alexander
Cythereis nuda (Jones and Hinde)
Cythereis roanokensis Alexander
Cythereis triplicata (F. A. Roemer) Alexander
Cythereis sp.
Cytherella comanchensis Alexander

Cytherelloidea granulosa (Jones)
Paracypris alta Alexander

These species have been recorded by Alexander (1929) from outcrop Grayson.

FORAMINIFERA

Occurrence diagrams. An indication of the faunal composition and relative abundances may be obtained from the occurrence diagrams of species observed in the Stephens and Maness cores (Figs. 6 and 7). With one exception, all species listed are known to occur in outcrop Washita.

Description of certain species, by A. R. Loeblich and Helen Tappan. A. R. Loeblich and Helen Tappan (Mrs. A. R. Loeblich) have contributed greatly to knowledge of Mesozoic Foraminifera and have assisted the writer over the years in many ways. Plate 2 was prepared by Helen Tappan in 1945 for the author's use in an intended manuscript describing some new species. This paper never materialized and in later studies some of these species were described from outcrop localities. The following descriptions of two new species and notations on 6 others were prepared at the writer's request for inclusion in this publication.

DESCRIPTION OF FORAMINIFERA

Family TEXTULARIIDAE

Genus TEXTULARIA DeFrance, 1824

Textularia losangica Loeblich and Tappan, n. sp.

Plate 2, figures 4, 5.

Textularia washitensis TAPPAN. 1943 (not Carsey, 1926), Jour. Paleontology vol. 17, p. 486, pl. 78, figs. 5a-9.

Test large, broad, elongate, biserial throughout, thickest at the central zigzag suture between the two series of chambers so that the test has a diamond-shaped cross section, periphery subacute; chambers numerous, increasing rapidly in breadth so that the test is flaring, well developed specimens having sides subparallel in the later portion, chambers gently convex or flattened, occasionally collapsed and concave; sutures distinct, slightly depressed, so that periphery is somewhat lobulate, but when chambers are collapsed the sutures may appear to be slightly raised; wall finely arenaceous, surface smoothly finished; aperture a low arch at the base of the last formed chamber.

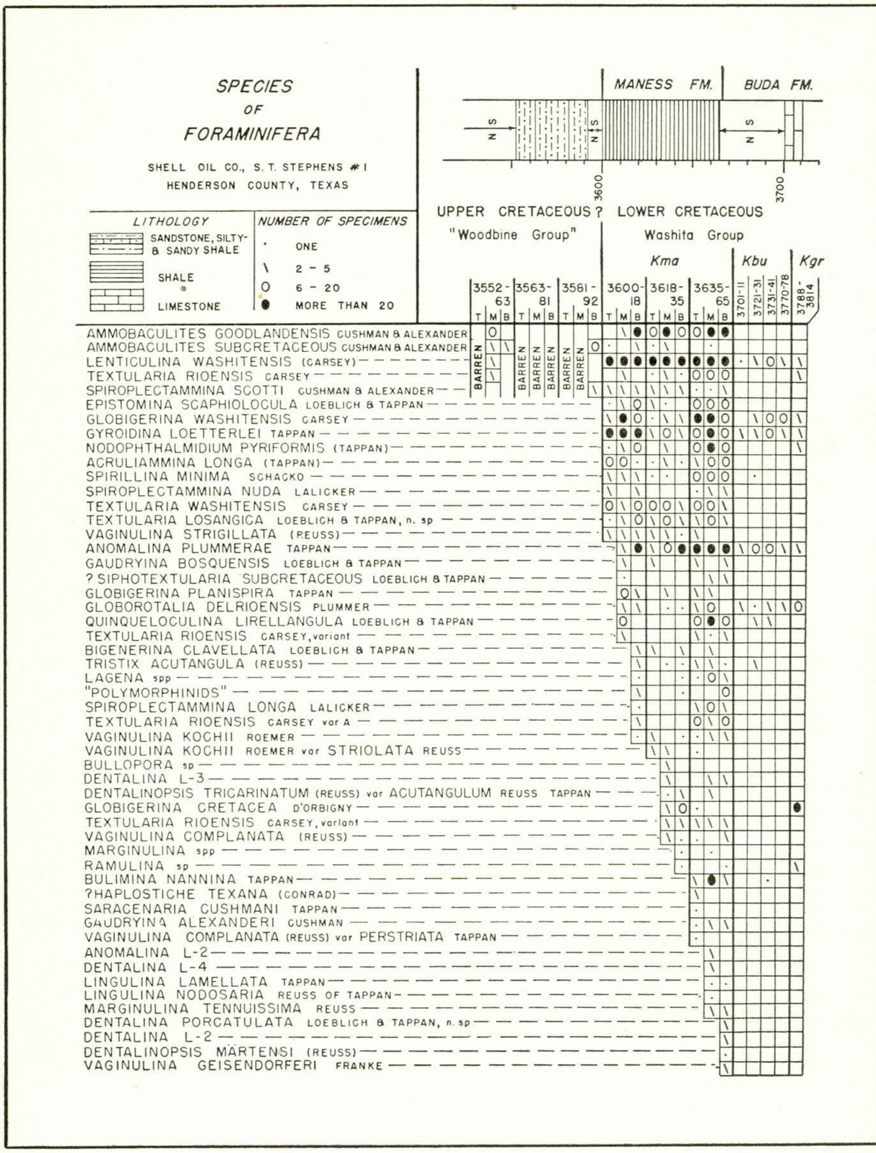
Length of holotype (Tappan, 1943, pl. 78, figs. 5a-c) 1.21 mm., greatest breadth 0.54 mm., greatest thickness 0.29 mm. Length of figured Maness paratype 0.65 mm., breadth 0.48 mm., greatest thickness 0.16 mm.

Remarks. Tappan (1943, p. 486) noted the following differences between the Duck Creek specimens and typical *Textularia washitensis* Carsey:

> ... specimens from the lower Washita, as in the Duck Creek, are perhaps better developed than later forms, as the specimens are unusually long and broad. Also the tests generally show less collapse of the chambers and have depressed sutures, a more flaring test and a more angular periphery. Those in the upper Washita [*T. washitensis*] show definitely collapsed chambers and the resultant higher sutures and a more parallel-sided test and blunt periphery.

The lower Washita specimens belong to the present new species *T. losangica*. The present species is rhomboid in section and *T. washitensis* is rectangular in section. The Maness forms are similar in all respects to those from the Duck Creek formation, although as is true of the majority of species in the Maness, none of the extremely large specimens are found in the subsurface. The holotype from the Duck Creek is approximately twice the length of the Maness paratype figured, although smaller forms also occur in the Duck Creek formation.

Types and occurrence. Holotype (U.S.N.M. No. P. 5) (Tappan, 1943, pl. 78, figs. 5a-c) and paratype (U.S.N.M. No. P. 6) (Tappan, 1943, pl. 78, fig. 8) from the Duck Creek formation, top 10 feet exposed, in a road cut on the east side of U.S. Highway 77, just south of the bridge across the Red River in Cook County, Texas. Paratypes (U.S.N.M. No. P. 7a) (Tappan, 1943, pl. 78, fig. 6) and (U.S.N.M. No. P. 7b) (Tappan, 1943, pl. 78, fig. 9) from the Duck Creek formation, 18 to 24 feet above the base of the exposure, on the west bank of the Red River, in the SW ¼, Sec. 22, T. 8 S., R. 2 E., on the southwest side of Horseshoe Bend, Love Co., Oklahoma. Paratype (U.S. N.M. No. P. 8) (Tappan, 1943, pl. 78, fig. 7) from the upper Duck Creek formation in a three-foot section exposed in a low, north facing bank of Hickory Creek, 150 feet north of where the road leading northwest from Krum to Trinity Farms crosses the creek, 8 miles northwest of Krum, Denton Co., Texas. Unfigured paratypes (U.S. N.M. No. P. 9) from the Duck Creek formation, 15 feet below the top of the exposure in a tributary to Kansas Creek, flowing N. 25° W., in the NW ¼ sec. 25, T 5 S, R 7 E, on the farm of Mr. Joe Brown, approximately two miles southeast of the abandoned Fort Washita, in northwestern Bryan County, Oklahoma. Unfigured paratypes (U.S.N.M. No. P. 11) from a 5-foot zone from 5 to 10 feet above the base of the exposure, paratypes (U.S.N.M. No. P. 12) from 13 to 16 feet above the base, paratypes (U.S.N.M. No. P. 13) from a six-inch marl bed at the top of the exposure, all from the Fort Worth formation, in a deep road cut on the west side of the Denison-Durant road, 1000 feet north of Calvary Cemetery, and 1.6 miles north of Main Street in Denison, Grayson County, Texas. Unfigured paratypes (U.S.N.M. No. P. 19) from a 2½-foot sample, five feet above the base of the exposure of the Fort Worth formation, in a creek bank just north of a small concrete bridge where the road crosses the tributary to Hickory Creek, 1½ miles northwest of Krum, Denton County, Texas. Unfigured paratypes (U.S.N.M. No. P. 10) from the lower 10 feet of the Fort Worth exposure in a road cut in the 1700

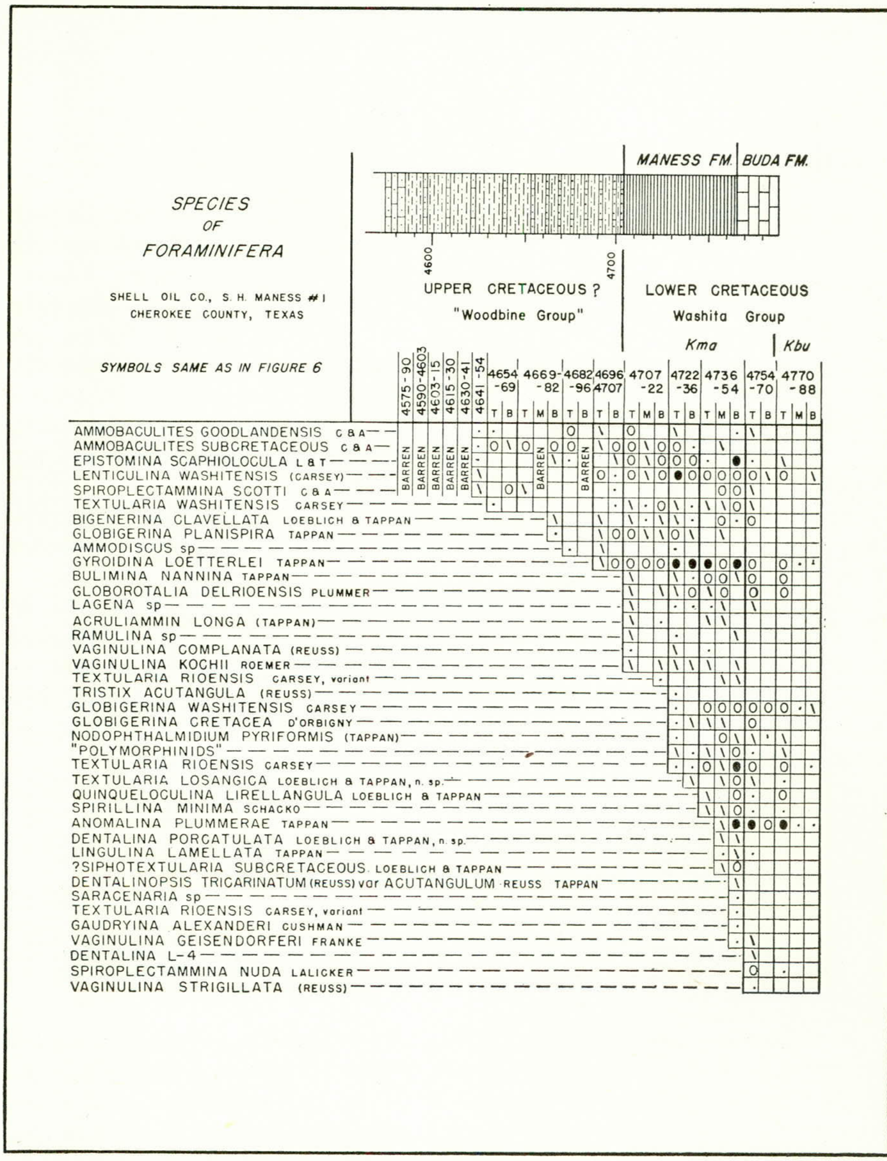


F. E. Lozo

Fig. 6. Occurrence diagram of Foraminifera in the Shell, S. T. Stephens No. 1, Henderson County, Texas.

block of East Lancaster Street, on the Fort Worth-Dallas highway (Highway 80) in eastern Fort Worth, Tarrant County, Texas.

Figured paratype (Plate 2, figures 4, 5), U.S.N.M. No. P. 20, from the Maness formation, in a core at 3635 to 3665 feet, unfigured paratypes (U.S.N.M. No. P. 17) from the top of the same core, unfigured paratypes (U.S.N.M. No. P. 14) from the middle portion of



F. E. Lozo

Fig. 7. Occurrence diagram of Foraminifera in the Shell, S. H. Maness No. 1, Cherokee County, Texas.

the core, and unfigured paratypes (U.S.N.M. No. P. 16) from the bottom of the same core; unfigured paratypes (U.S.N.M. No. P. 18) from the bottom of the core at 3600 to 3618 feet, unfigured paratypes (U.S.N.M. No. P. 15) from the bottom of the core at 3618-3635 feet, all from the Shell Stephens No. 1 well, Henderson County, Texas.

TEXTULARIA RIOENSIS Carsey
Plate 2, figures 6-9.

Textularia rioensis CARSEY, 1926, Texas Univ. Bull. 2612, p. 24, pl. 7, fig. 12; PLUMMER, 1931, Texas Univ. Bull. 3101, p. 128, pl. 8, fig. 6; TAPPAN, 1940, Jour. Paleon., vol. 14, no. 2, p. 98, pl. 15, figs. 1, 2; TAPPAN, 1943, Jour. Paleon., vol. 17, no. 5, p. 485, pl. 78, figs. 1-4; LOZO, 1944, Amer. Mid. Nat., vol. 31, no. 3, p. 551, pl. 3, figs. 7, 9.

In addition to the typical forms of *Textularia rioensis* Carsey, many variants are found in the Maness formation, as in the outcrop Washita group. A few of these are illustrated, figures 6 and 7 being an elongate, somewhat compressed form, and figures 8, 9 an elongate, tapering form which is rounded in section. The typical forms are shorter and more inflated, but all gradations are found between the typical forms and these variants. Some of the variants also resemble *T. washitensis* Carsey, in being compressed. However, they are more ovoid in section, the test flares more rapidly and the sutures are not thickened and elevated.

Length of hypotype in figures 6, 7 is 0.80 mm., greatest thickness 0.24 mm. Length of hypotype in figures 8, 9 is 0.73 mm., breadth 0.38 mm., greatest thickness 0.305 mm.

Types and occurrence. Hypotype of figures 6, 7 (U.S.N.M. No. P. 21) and hypotype of figs. 8, 9 (U.S.N.M. No. P. 22) from the Maness formation from the upper part of the core from 3635 to 3665 feet, in Shell Stephens No. 1 well, Henderson County, Texas. The species was originally described from the Del Rio formation and has been recorded throughout the Fredericksburg and Washita groups.

Family VERNEUILINIDAE
Genus GAUDRYINA d'Orbigny, 1893
GAUDRYINA ALEXANDERI Cushman
Plate 2, figures 12, 13.

Gaudryina alexanderi CUSHMAN, 1936, Cushman Lab. Foram. Res. Spec. Pub. 6, p. 6, pl. 1, figs. 13 a, b; TAPPAN, 1943, Jour. Paleon., vol. 17, no. 5, p. 488, pl. 78. figs. 22-27.

The Maness specimens show no biserial stage, but closely resemble the young triserial stage of *Gaudryina alexanderi* topotypes with which they have been compared. Many of the topotypes also show only the triserial stage and these are quite similar in size, outline and angularity in section. Because of the absence of the biserial stage in the Maness specimens and the presence of the terminal aperture it could well be referred to *Tritaxia*. However, it seems conspecific with *Gaudryina alexanderi* and occasional topotype specimens of *G. alexanderi* show a uniserial development (Tappan, Jour. Paleontology, vol. 17, pl. 78, figs. 22, 26 and 27). As the typical form and by far the majority of specimens show only the biserial stage it has been left in the genus *Gaudryina* and the uniserial development is considered only as showing an evolutionary pattern.

Length of figured hypotype 0.68 mm., greatest breadth 0.39 mm.

Types and occurrence. Figured hypotype (U.S.N.M. No. P. 1) and unfigured hypotypes (U.S.N.M. No. P. 2) from the Maness formation in a core at 3635-3665 feet in Shell Stephens No. 1 well, Henderson Co., Texas. *G. alexanderi* has not previously been recorded above the Duck Creek formation on the surface. In the subsurface it has been found in the Maness and the Buda formations, but is so rare that it will probably be of minor use for zonation purposes in cuttings and cores.

GAUDRYINA BOSQUENSIS Loeblich and Tappan
Plate 2, figures 10, 11.

Gaudryina bosquensis LOEBLICH and TAPPAN, 1946, Jour. Paleon., vol. 20, no. 3, p. 245, pl. 35, figs. 12a-13b, text figs. 3a-c.

The Maness specimens have been compared to the original types of this species. The figured specimen is a megalospheric individual. The Maness specimens are very similar to the average outcrop specimen, although a few of the paratypes attain a length twice that of the Maness specimens. This is the same form referred to *Gaudryina gradata* Berthelin by Plummer, but Berthelin's species is actually a *Dorothia* and the Texas form is not conspecific.

The triserial stage is much reduced in *G. bosquensis* and in some megalospheric forms from the Maness it is apparently entirely absent. This bears out a theory expressed by Cushman (Cushman Lab. Foram. Res. Spec. Pub. 7, p. 31) where he suggests that "It is probable that through acceleration of development the early triserial stage may be greatly reduced and even become wanting in the megalospheric form."

Length of figured hypotype 0.62 mm., breadth 0.35 mm., greatest thickness 0.29 mm.

Types and occurrence. Figured hypotype (U.S.N.M. No. P. 3) and unfigured hypotypes (U.S.N.M. No. P. 4) from the Maness formation in a core at 3635-3665 feet (bottom) in the Shell Stephens No. 1 well, Henderson County, Texas. The holotype was described from the Del Rio formation and it was also recorded by Loeblich and Tappan from the Weno and Pawpaw formations.

Family LAGENIDAE
Genus NODOSARIA Lamarck, 1812
NODOSARIA ? sp.
Plate 2, figure 14.

This species is extremely fragile and no specimens of more than a single chamber have been recovered. The specimens closely resemble a *Lagena,* but examination reveals the broken extremities of the majority of specimens, showing that the globular chambers represent merely a portion of an elongate test with greatly constricted sutures. This species is closely similar to *Nodosaria paupercula* Reuss of Tappan, 1941, which differs from Reuss's form in having more numerous and coarser ribs. It has probably been confused in some Washita occurrences with *Lagena sulcata* (Walker and Jacob). Because no complete tests have been found, the form is not specifically identified. It is common in Upper Washita outcrop material, particularly from the Grayson formation.

Length of figured specimen 0.23 mm., breadth 0.18 mm.

Types and occurrence. Figured specimen (U.S.N.M. No. P. 27) and unfigured specimens (U.S.N.M. No. P. 28) from the Maness formation in a core at 3635 to 3665 feet in Shell Stephens No. 1 well, Henderson County, Texas.

Genus DENTALINA d'Orbigny, 1826

Dentalina porcatulata Loeblich and Tappan, n. sp.

Plate 2, figures 15, 16.

Test small, elongate, rectilinear, ovate in cross-section; chambers few in number, inflated, proloculus globular, later chambers somewhat longer than broad; sutures distinct, constricted, oblique, at an angle of about 30° from the horizontal, highest at the ventral side; wall calcareous, surface ornamented with low longitudinal costae, about six visible in side view; aperture terminal, on a short neck.

Length of holotype 0.71 mm., thickness through proloculus 0.18 mm., thickness through final chamber 0.17 mm.

Remarks. This species superficially resembles the associated *Marginulina tenuissima* Reuss, but differs in its larger size, in the absence of an early coil, in having fewer but larger and more inflated chambers and a comparatively larger proloculus. It differs from *Dentalina crassula* Reuss, from the Upper Cretaceous of Poland, in being about half as large (comparing tests of equal development), in having more continuous ribs and more oblique sutures, and in lacking the apical spine on the proloculus.

Types and occurrence. Holotype (U.S.N.M. No. P. 23) and paratypes (U.S.N.M. No. P. 24) from the Maness formation, in the mid portion of a core at 3635 to 3665 feet in Shell Stephens No. 1 well, Henderson County, Texas.

Genus TRISTIX Macfadyen, 1941

TRISTIX ACUTANGULA (Reuss)

Plate 2, figures 17, 18.

Rhabdogonium acutangulum REUSS, 1862, Sitz. k. Akad. Wiss. Wien., vol. 46, p. 55, pl. 4, fig. 14.

Dentilinopsis excavata (Reuss) PLUMMER, 1931, Texas Univ. Bull. 3101, p. 187, pl. 11, figs. 11, 12. (Not *Rhabdogonium excavatum* Reuss, 1862.)

Dentalinopsis excavata (Reuss) TAPPAN, 1940, Jour. Paleon., vol. 14, no. 2, p. 118, pl. 18, figs. 10a, b; 1943, Jour. Paleon., vol. 17, no. 5, p.509, pl. 81, fig. 22.

Tristix acutangulum (Reuss) TEN DAM, 1948, Jour. Paleon., vol. 22, no. 2, p. 181, pl. 32, figs. 9, 10.

Tristix cf. *acutangulum* (Reuss) TEN DAM, 1950, Mem. Soc. Geol. France, n. ser., vol. 29, fasc. 4, mem. 63, p. 46, pl. 2, fig. 21.

Not *Rhabdogonium tricarinatum* var. *acutangulum* CHAPMAN, 1894. Roy. Micr. Soc. Jour., p. 159, pl. 4, figs. 8a, b.

Not *Dentalinopsis tricarinatum acutangulum* TAPPAN, 1940, Jour. Paleon., vol. 14, no. 2, p. 119, pl. 18, figs. 13a-3; 1943, Jour. Paleon., vol. 17, no. 5, p. 510, pl. 81, figs. 29a-c.

Chapman, Plummer and Tappan apparently confused this species with *Tristix excavata* (Reuss). Comparison of Maness, outcrop Washita and Gault specimens shows that both species are represented, but the larger form with more flaring and compressed flanks belongs in *T. excavata,* and the narrower and more elongate and parallel-sided form should be referred to *T. acutangula.*

Length of figured hypotype 0.39 mm., greatest breadth 0.18 mm.

Types and occurrence. Figured hypotype (U.S.N.M. No. P. 29) and unfigured hypotypes (U.S.N.M. No. P. 30) from the Maness formation, from the mid portion of the core at 3535 to 3565 feet, in Shell Stephens No. 1 well, Henderson County, Texas.

Tristix acutangula occurs throughout the Washita group, from the Duck Creek through the Grayson formation in outcrops, and in the Maness formation in the subsurface.

Family ROTALIIDAE

Genus EPISTOMINA Terquem, 1883

EPISTOMINA SCAPHIOLOCULA Loeblich and Tappan

Plate 2, figs. 1-3.

Epistomina scaphiolocula LOEBLICH and TAPPAN, 1946, Jour. Paleon., vol. 20, no. 3, p. 256, pl. 37, figs. 18a-c.

This biconvex species has the 2½ whorls clearly visible dorsally, with about seven chambers in the final whorl, the sutures strongly raised and thickened and the chambers sunken between the sutures. The surface of the chamber walls has a granular appearance. The Maness specimens appear slightly more compressed than the types from the Pawpaw formation, but this may be due to the preservation.

Figured hypotype is 0.91 mm. in greatest diameter, least diameter 0.77 mm., greatest thickness 0.34 mm.

Types and occurrence. Figured hypotype (U.S.N.M. No. P. 25) and unfigured hypotypes (U.S.N.M. No. P. 26) from the Maness formation from the mid portion of a core at 3635 to 3665 feet in Shell Stephens No. 1 well, Henderson County, Texas. The species was originally described from the Pawpaw formation of Texas and was recorded from the Fort Worth, Denton and Weno formations.

SUMMARY

Lithologic and faunal evidence from cores and cuttings indicate that the Maness formation overlies Buda limestone of Comanche Cretaceous age and underlies "Woodbine" sandy shale and sand of questionable age in the subsurface type area of eastern Texas. The Maness, Buda, and Grayson formations have been identified on the basis of lithology, fauna, and stratigraphic position. On known faunal affinity, the Maness shale is Washita Comanche in age.

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PLATE 1

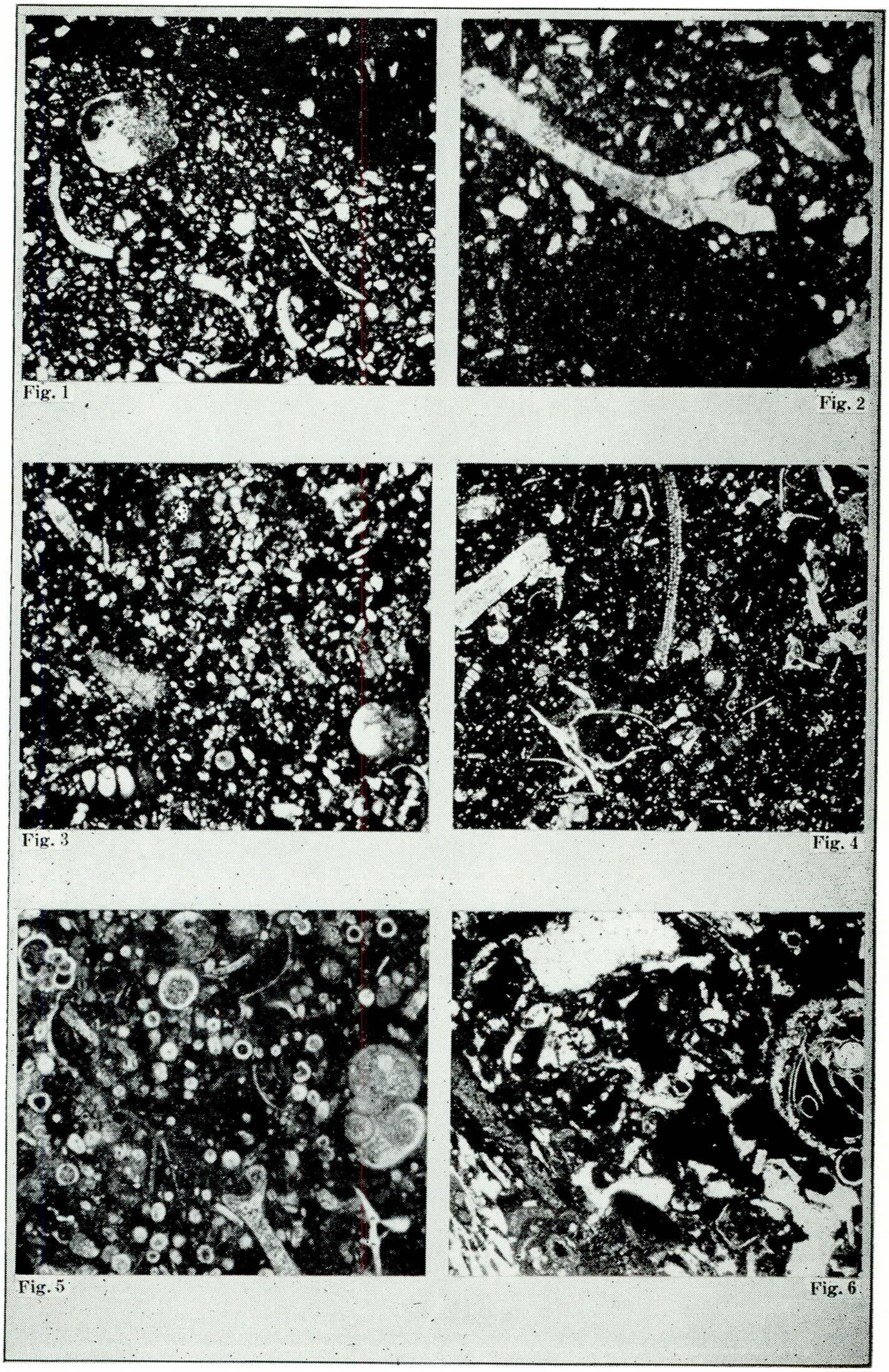
PHOTOMICROGRAPHS OF MANESS SHALE AND BUDA LIMESTONE

(Magnifications approximate)

Figure

1. Maness shale, Humble, E. Dagnell No. 1, Wood County, Texas, 4436—40 core. Sideritic silt and very fine calcareous sandstone. x20.
2. Maness shale. Humble, E. Dagnell No. 1, 4457 core. Silty sideritic shale with fossil fragments and sideritic concretions. x35.
3. Maness shale. Shell, S. T. Stephens No. 1, Henderson County, Texas, 3635—65 (bottom) core. Fossiliferous silty argillaceous limestone. x40.
4. Maness shale. Humble, E. Dagnell No. 1, 4485—90 core. Fossiliferous calcareous shale. x45.
5. Buda limestone. Shell, S. T. Stephens No. 1, 3721—31 core. Very fossiliferous dense micro-oolitic limestone. x40.
6. Buda limestone. Muckleroy, J. Rabel No. 1, Caldwell County, Texas, 1891 core. Fossiliferous dense limestone. x40.

Photomicrographs by Bruce Gray



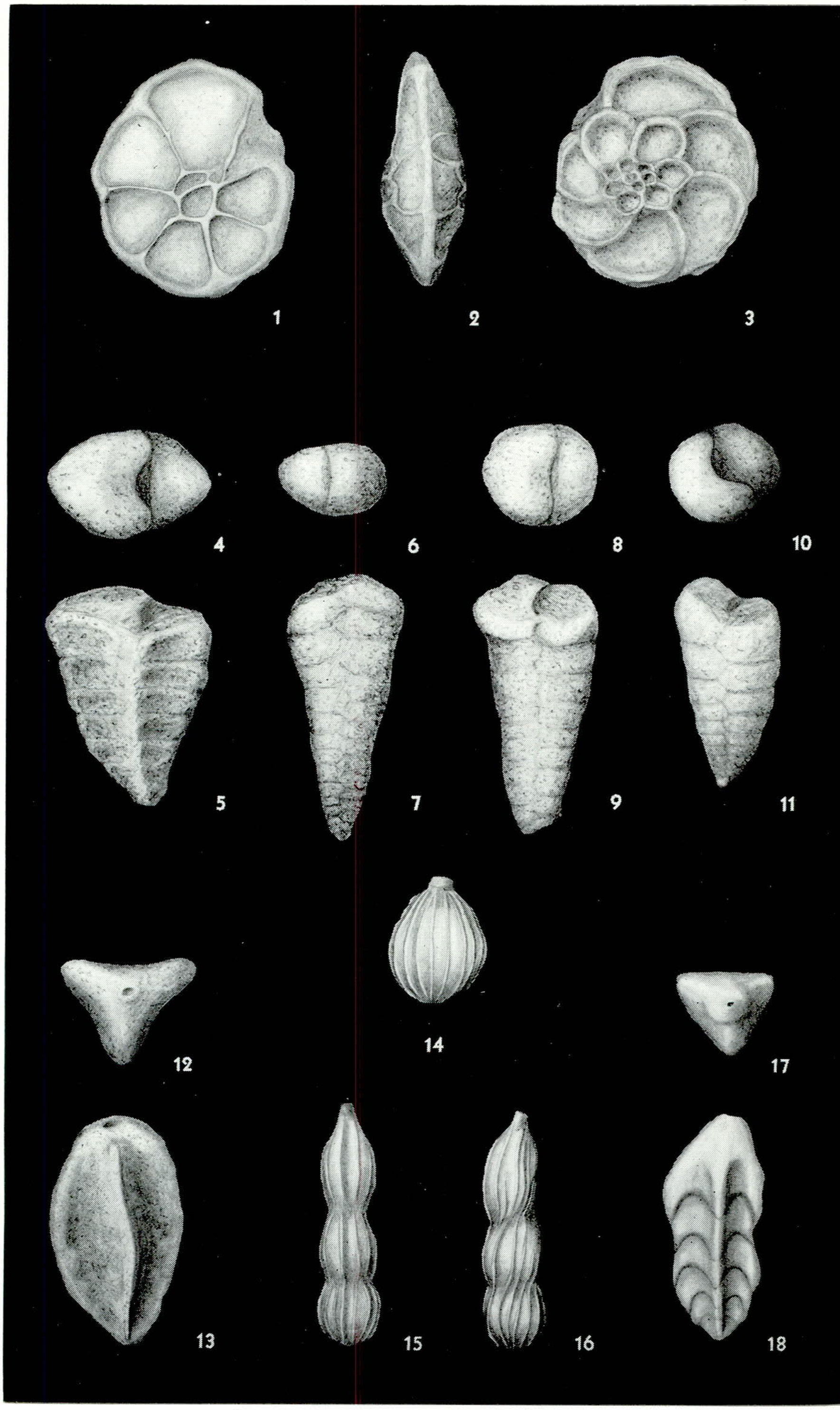
PHOTOMICROGRAPHS OF MANESS SHALE AND BUDA LIMESTONE
(Magnifications approximate)

PLATE 2

MANESS (COMANCHE CRETACEOUS) FORAMINIFERA

Figures		Page
1- 3.	*Epistomina scaphiolocula* Loeblich and Tappan. Ventral, edge, and dorsal views of hypotype (U.S.N.M. No. P. 25). x36	89
4- 5.	*Textularia losangica* Loeblich and Tappan, n. sp. Top and side views of paratype (U.S.N.M. No. P. 20). x48	82
6- 9.	*Textularia rioensis* Carsey. 6 and 7, top and side views of hypotype (U.S.N.M. No. P. 21) ; 8 and 9, top and side views of hypotype (U.S.N.M. No. P. 22). x48	86
10-11.	*Gaudryina bosquensis* Loeblich and Tappan. Top and side views of hypotype (U.S.N.M. No. P. 3). x48	87
12-13.	*Gaudryina alexanderi* Cushman. Top and side views of hypotype (U.S.N.M. No. P. 1). x48	86
14.	*Nodosaria?* sp. Side view (U.S.N.M. No. P. 27). x79	87
15-16.	*Dentalina porcatulata* Loeblich and Tappan, n. sp. Face and side views of holotype (U.S.N.M. No. P. 23). x48	88
17-18.	*Tristix acutangula* (Reuss). Top and side views of hypotype (U.S.N.M. No. P. 29). x79	88

Illustrations drawn by Helen Tappan



MANESS (COMANCHE CRETACEOUS) FORAMINIFERA