OKLAHOMA GEOLOGICAL SURVEY
CARL C. BRANSON, *Director*

BULLETIN 104

BIOSTRATIGRAPHY AND RUGOSE CORALS OF THE LOWER PENNSYLVANIAN WAPANUCKA FORMATION IN OKLAHOMA

by

CHARLES L. ROWETT AND PATRICK K. SUTHERLAND

The University of Oklahoma
Norman
March 1964

CONTENTS

ILLUSTRATIONS

FIGURES

Plates

TABLES

Biostratigraphy and Rugose Corals of the Lower Pennsylvanian Wapanucka Formation in Oklahoma

Charles L. Rowett* and Patrick K. Sutherland†

ABSTRACT

The Wapanucka Formation is a fossiliferous limestone and shale sequence of Lower Pennsylvanian age (Morrow Series) that is exposed in the Arbuckle Mountains region in south-central Oklahoma and in the frontal belt of the Ouachita Mountains in southeastern Oklahoma. A biostratigraphic study of this formation has been based on (1) description of the physical stratigraphy, (2) description of the rugose coral faunas and recognition of the zonal distribution of some species, (3) a preliminary petrographic study of the carbonates, and (4) evaluation of faunal and lithologic associations.

Solitary rugose corals are common and in general are well preserved in the Wapanucka Formation. Nineteen species are described and are referred to nine genera: *Empodesma, Stereocorypha, Amplexocarinia, Lophophyllidium, Leonardophyllum, Amplexizaphrentis, Barytichisma, Koninckophyllum* and *Dibunophyllum.* Two new species, *Koninckophyllum oklahomense* and *Leonardophyllum morrowense*, are described. The two distinct faunal zones recognized are the *Barytichisma* zone in the lower part and the *Koninckophyllum* zone in the upper part of the formation.

Comparison of the coral fauna of the Wapanucka Formation to the described faunas of the Marble Falls Formation of central Texas and the Hale and Bloyd Formations of northeastern Oklahoma suggests partial equivalence to these formations, but more precise correlations must await detailed biostratigraphic study in those areas.

The history of deposition of the Wapanucka Formation in the Arbuckle Mountains area is outlined in three stages: (1) early development of a carbonate shelf, (2) culmination of shelf development, and (3) marine erosion and dissection of shelf carbonate muds and deposition of oölites. The deposition of the Wapanucka Formation was followed in this area by emergence, erosion, and slight tilting eastward, succeeded by transgression to the west and deposition of the Atoka Formation.

*University of Alaska.
†The University of Oklahoma.

STRATIGRAPHY

Introduction.—The Wapanucka Formation is a fossiliferous limestone and shale sequence of Early Pennsylvanian age (Morrow Series) that is exposed in the Arbuckle Mountains and in the frontal belt of the Ouachita Mountains in south-central and southeastern Oklahoma. This report has as its primary objectives the description of the rugose-coral fauna of this formation, a description of the physical stratigraphy, and a biostratigraphic evaluation of the faunal and lithologic associations.

The Wapanucka Formation contains, in addition to the species of rugose corals described herein, a large and varied assemblage of tabulate corals, brachiopods, crinoids, mollusks, and several minor faunal elements. Preliminary identification of 67 genera and more than 100 species have been made, exclusive of the rugose corals. The rugose-coral fauna includes 9 genera and 19 species, and provides a basis for both the biostratigraphic zonation of the Wapanucka and correlation with rocks of Morrowan age in northeastern Oklahoma and in central Texas.

Stratigraphic relations and distribution.—Surface exposures of the Wapanucka Formation are limited to two general areas: (1) outcrops along the northeastern and eastern flanks of the Arbuckle Mountains, in Pontotoc, Coal, and Johnston Counties, Oklahoma (fig. 1), and (2) exposures along the frontal belt of the Ouachita Mountains in Atoka, Pittsburg, and Latimer Counties, Oklahoma.

In the Arbuckle Mountains region the Wapanucka Formation is underlain by calcareous shales of the Springer Formation, but the contact between the two formations is covered in all exposures studied and the depositional relationship of the two formations could not be determined. In this region the Wapanucka Formation is overlain unconformably by conglomerate, shale, and sandstone of the Atoka Formation. The Wapanucka Formation in this area consists of a shale and limestone sequence that shows marked lateral variations in facies and local intraformational unconformities. Regional stratigraphic relations are summarized on the ribbon

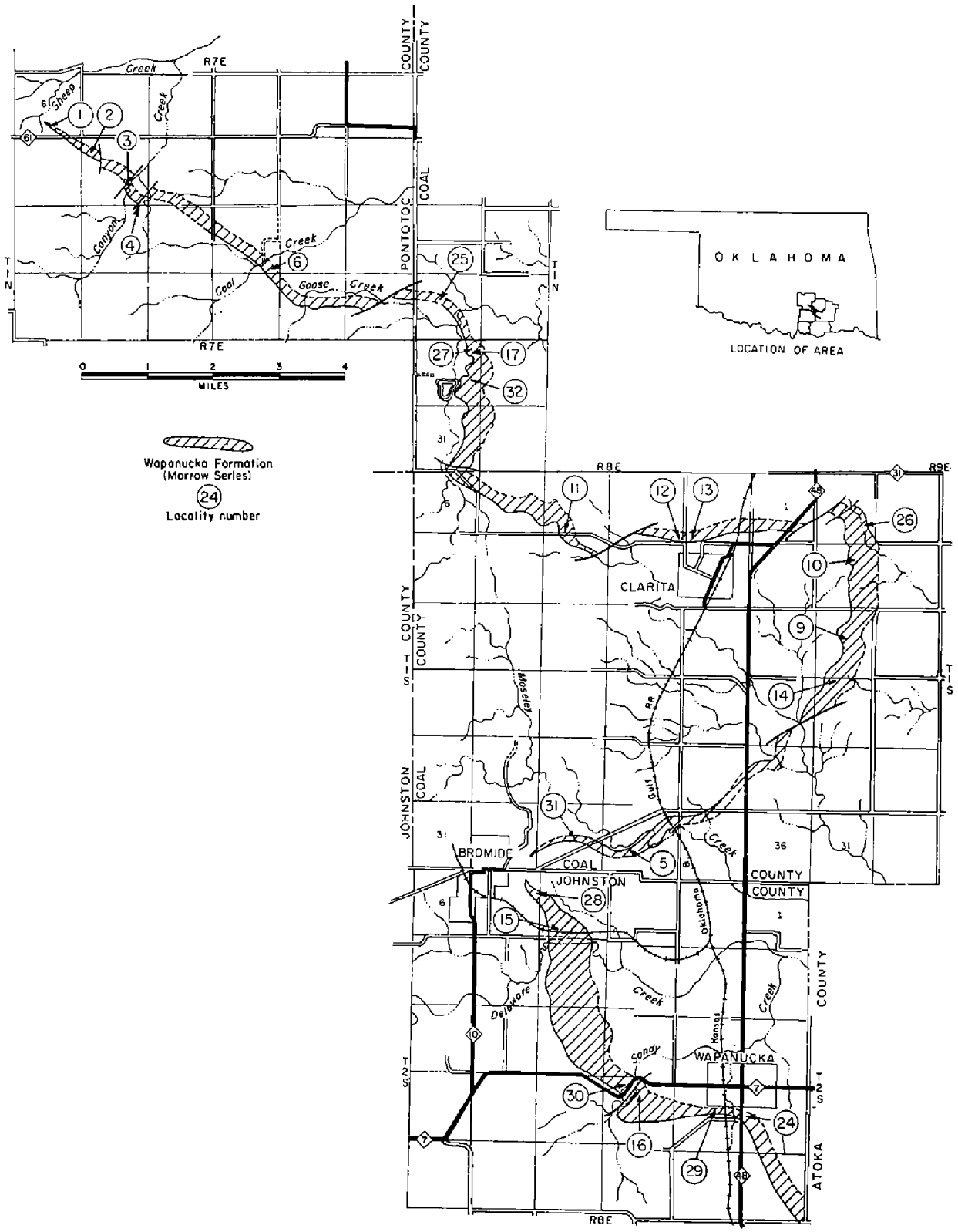


Figure 1. Index map of the Wapanucka Formation in the eastern Arbuckle Mountains region showing coral localities.

diagram, figure 2, and the detailed stratigraphic sections on which this diagram is based are included in appendix I. In the northwesternmost exposures of the formation in the Arbuckle Mountains area (locs. 3, 4, Pontotoc County), the formation consists of highly fossiliferous calcareous shales, darker unfossiliferous shales, and thin argillaceous bioclastic limestones. This facies interfingers to the southeast with a lower sequence of shales and thin limestones, an intermediate sequence of bioclastic and cherty limestones, and an upper oölitic limestone member. The maximum observed thickness of the Wapanucka Formation in the Arbuckle region is 181 feet, at locality 3 in Pontotoc County.

In the western frontal belt of the Ouachita Mountains the Wapanucka consists of a lower sequence of interbedded spiculites and spiculiferous shales and an upper sequence of cherty, oölitic, bioclastic, and microcrystalline limestones. The maximum thickness recorded in this facies is 356 feet at Limestone Gap (loc. 18) in Atoka County. Northeastward, along the frontal belt of the Ouachitas, the upper limestones are gradually replaced by lenticular sandstones and unfossiliferous shales, a transition which takes place primarily in southern Pittsburg County. The entire section thickens to more than 450 feet in Latimer County, and in Le Flore County, near the Arkansas state line, Wapanucka equivalents cannot be clearly distinguished. The Wapanucka Formation throughout the Ouachita region is intensely deformed and is faulted into imbricate strike ridges which commonly expose near-vertical strata. The formation is underlain by spiculiferous shales of the "Pennsylvanian Caney" formation, which are similar in gross features to those in the lower part of the Wapanucka Formation. At present no satisfactory criteria are available for establishing the base of the Wapanucka Formation in the frontal Ouachita area. In this region the formation is apparently in fault contact at all localities studied with shale and sandstone of the overlying Atoka Formation.

Original definition and historical review.—The Wapanucka Formation was first described by Taff (1901) from exposures near the settlement of Wapanucka, in Johnston County, Oklahoma. This formation was further defined by Wallis (1915), who divided the Wapanucka in the Ouachita region into eight lithologic members and the exposures in the Arbuckle region into several less well-defined members. Subdivisions and restrictions of the formation made by Harlton (1938) have not been supported by detailed field

investigations, and the boundaries of the Wapanucka Formation as originally defined by Taff in 1901 are followed here. Studies in which the Wapanucka Formation is briefly discussed but not described in detail include those by Morgan (1924), Hollingsworth (1933), Harlton (1934), Kuhleman (1948), Barker (1950), and Cline (1960). Recent investigations of the Wapanucka Formation, including both petrographic and biostratigraphic studies, have been made by Rowett (1959, 1962, 1963a and 1963b).

Rugose corals and biostratigraphic zonation.—Colonial rugose corals are absent in the Wapanucka Formation. Tabulate corals are common, and collected material has been identified as species of *Michelinia, Striatopora, Acaciapora,* and *Cladochonus.* Solitary rugose corals occur at several horizons in the Wapanucka and are herein described as species of *Empodesma, Stereocorypha, Amplexocarinia, Lophophyllidium, Leonardophyllum, Amplexizaphrentis, Barytichisma, Koninckophyllum,* and *Dibunophyllum.* Some species show no clear evidence of zonal distribution, and several species occur sporadically throughout the formation. An example is *Lophophyllidium idonium,* a species which at several localities can be collected from both the basal shales and the upper oölitic limestones. Several coral species are uncommon in the Wapanucka Formation, such as species of *Empodesma, Stereocorypha,* and *Amplexizaphrentis.* These forms occur in small numbers at isolated, widely spaced localities, and their biostratigraphic distribution in the formation cannot be evaluated.

Two distinct faunal zones, based on the occurrence of rugose corals (fig. 3), have been recognized in the Wapanucka Formation.

The *Barytichisma* zone is a lower zone characterized particularly by a zaphrentid coral, *Barytichisma callosum.* This species occurs in calcareous shales and thin bioclastic limestones in the lower part of the formation throughout the Arbuckle region. In the northwesternmost exposures of the formation, in Pontotoc County, in the lower calcareous shale facies of that area (fig. 2), the zone also includes *Leonardophyllum morrowense* and *Lophophyllidium minutum.* The *Barytichisma* zone has not been recognized in the Ouachita region where the lower part of the Wapanucka Formation consists of spiculites and spiculiferous shales which contain few corals.

The *Koninckophyllum* zone is an upper zone characterized by

the aulophyllid corals, *K. nitellus, K. oklahomense,* and *K. simplex.* This zone has been recognized in both the Arbuckle and Ouachita regions. In the Arbuckle area, the zone occurs in argillaceous bioclastic limestones and calcareous shales in the northwesternmost exposures and in bioclastic and cherty limestones in the upper-middle part of the formation below the upper oölitic limestones in the southeast. In the frontal belt of the Ouachitas, the zone occurs in a variety of limestone types, including bioclastic, cherty, oölitic, and microcrystalline limestones but invariably is restricted to a stratigraphic interval of 6 to 10 feet in the upper part of the formation. The *Koninckophyllum* zone in the Arbuckle region is characterized by *K. nitellus* and *K. oklahomense*; in the Ouachita region it is characterized by *K. simplex, K. nitellus,* and *Amplexocarinia corrugata. K. oklahomense* and *K. simplex* are similar but distinctive species, which are geographically separated but occur at approximately the same stratigraphic horizon.

It will be noted that species of the *Koninckophyllum* zone occur in rocks of several different lithologic types. This would appear to indicate a wide environmental tolerance. In contrast, the species of the *Barytichisma* zone, although stratigraphically restricted, occur only in calcareous shales and associated thin bioclastic limestones.

History of deposition.—The biostratigraphic study of the Wapanucka Formation described in this paper reflects the distribution and migration of several lithotopes during Morrowan time in the Arbuckle region. The resulting stratigraphic and facies relations are shown on the ribbon diagram (fig. 2). The history of deposition of this formation in the Arbuckle area can be described in three stages:

(1) An early phase was characterized by the deposition of silt, clay, and lime mud under uniformly low-energy conditions. The depositional strike during this time was approximately NW-SE, and the offshore direction was to the east or northeast. This general trend was maintained throughout all depositional stages of the formation in the Arbuckle region. These initial deposits are preserved as interbedded calcareous shales and argillaceous limestones near the base of the formation. A sequence composed predominantly of shale in Pontotoc and Johnston Counties (loc. 3, unit A; loc. 4, unit A; and loc. 16, units A-D) grades eastward into calcar-

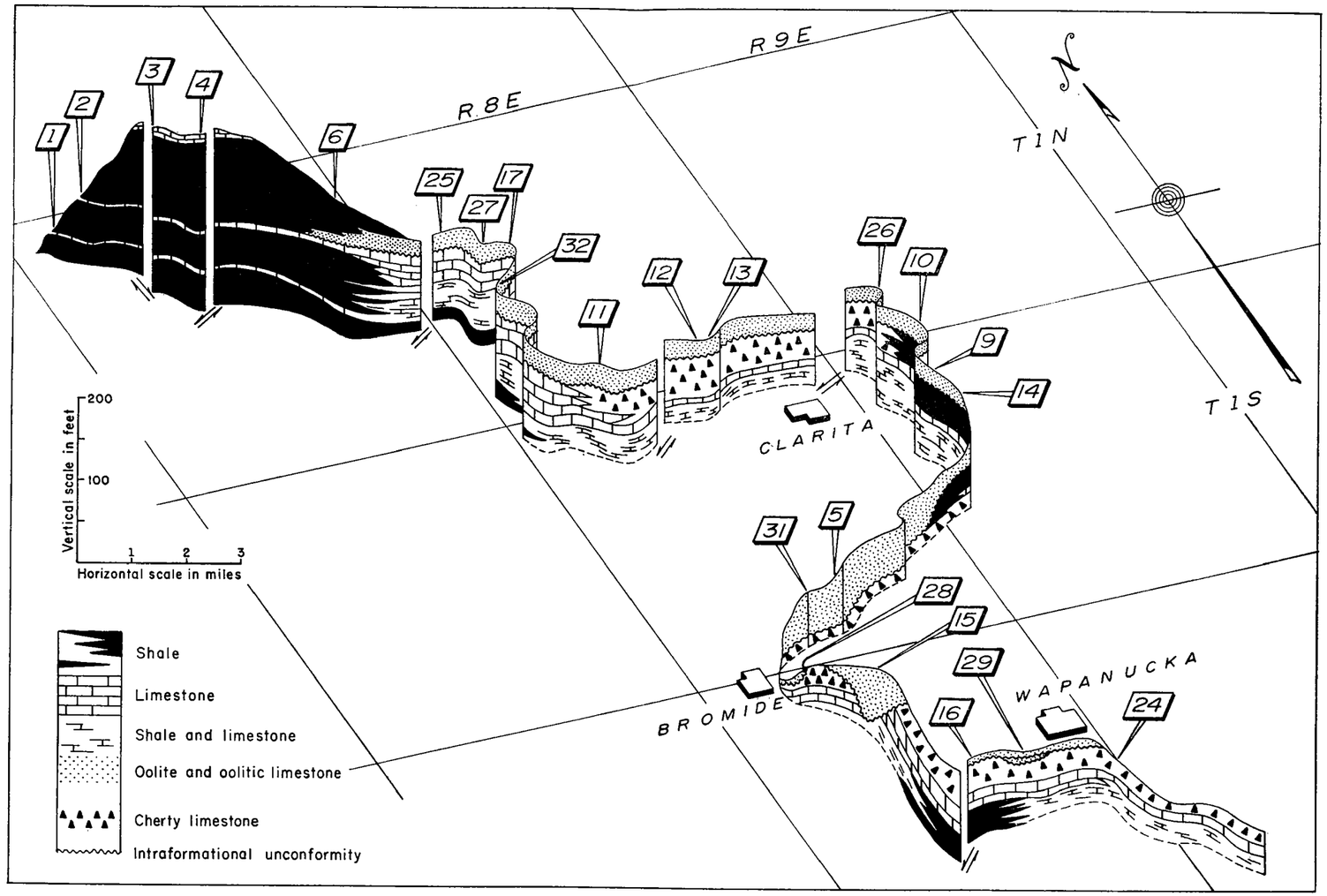


Figure 2. Ribbon diagram of the Wapanucka Formation in the Arbuckle Mountains region. The base of the diagram approximates the present outcrop, and the top indicates the unconformable contact with the Atoka Formation. Vertical breaks indicate major faults.

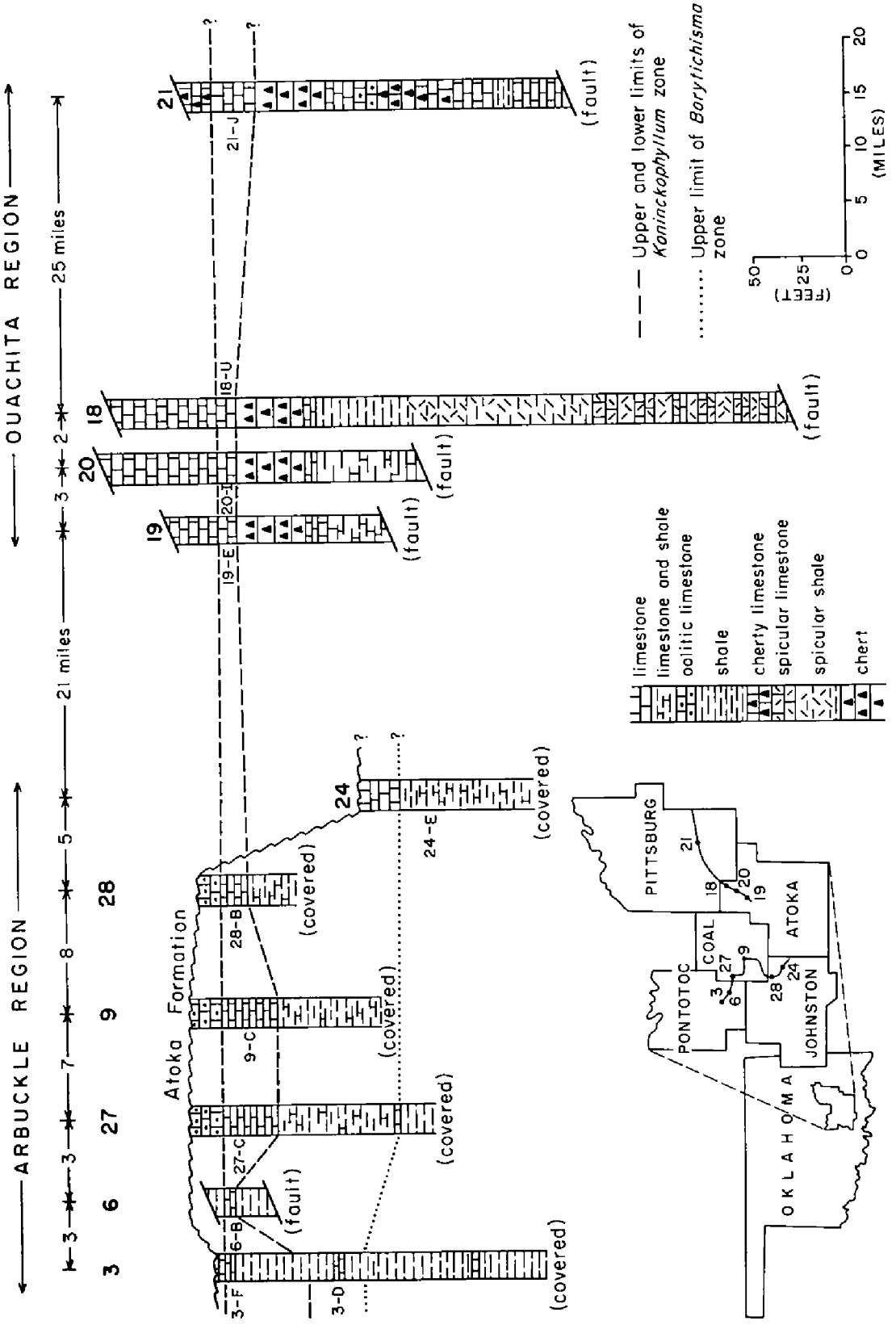


Figure 3. Distribution of coral zones in representative sections of the Wapanucka Formation in the Arbuckle and Ouachita Mountains regions, Oklahoma.

eous shale and thin bioclastic limestones. The zaphrentid coral *Barytichisma* is common in these rock types (*Barytichisma* zone).

(2) The second recognized phase was characterized by an increase in the deposition of lime muds on an offshore shelf and the appearance of restricted lagoonal areas on the landward (westward) side of these deposits. The lagoonal deposits are preserved as thick poorly fossiliferous dark-gray shales in Pontotoc County (loc. 3, unit E). Oölitic and bioclastic sediments periodically were washed into this area from the offshore shelf (loc. 3, units D, F) and are interbedded with the poorly fossiliferous shales. Coral species of the *Koninckophyllum* zone are characteristic of this depositional phase.

(3) A third phase in the depositional history resulted in the shallow-marine erosion of the semiconsolidated carbonate muds of the shelf area. Locally channels were cut through these sediments, and the relief on this surface in some areas was considerable. Shallowing and increased wave activity produced conditions that were favorable for the formation of oölites, and a blanket of oölites was distributed over most of the area (fig. 2, upper oölitic limestones). Large channels in northern Johnston County were filled with strongly cross-bedded oölites, and, in one such channel (loc. 15), cross-bedded units are up to 8 feet thick and have an aggregate thickness of more than 70 feet. The fauna of the oölite consists principally of brachiopods, mollusks, and crinoids. Only a few coral species have been found.

The Wapanucka Formation is unconformably overlain by limestone conglomerate, sandstone, and shale of the Atoka Formation. Study of the composition of the basal limestone conglomerates in the Atoka Formation (Rowett, 1963a) demonstrated that they were derived almost entirely from erosion of the limestones of the subjacent Wapanucka Formation. Erosion to a depth of at least 30 feet is indicated in Johnston County. The conglomerate contains reworked corals from the Wapanucka Formation, including species of *Koninckophyllum, Stereocorypha,* and *Michelinia.* Analysis of the petrofabrics of the conglomerate suggests that it was deposited as a beach gravel. These observations provide evidence for prolonged emergence and slight eastward tilting of the Wapanucka Formation prior to deposition of the Atoka Formation in the Arbuckle Mountains region.

Age and correlation.—In all published references to the Wapanucka Formation it is considered to be Morrowan in age and equivalent to some part of the Hale and Bloyd Formations in northeastern Oklahoma and to some part of the Marble Falls Formation in central Texas. This study supports these general correlations.

Most of the coral species here described have been previously described by Moore and Jeffords (1945) from the Marble Falls Formation or from the Hale and Bloyd Formations. However, most of their descriptions of species are based on small numbers of specimens from isolated localities. Little information is available at present regarding the stratigraphic relations of these exposures or the geographic distribution of the described species.

In central Texas, Plummer (1945, p. 65) divided the Marble Falls Formation into a lower Sloan Member, an intermediate Big Saline Member, and an upper Lemons Bluff Member. Plummer also recorded his interpretation of the occurrence of the corals described by Moore and Jeffords in the same publication. The two coral zones which occur in the Wapanucka Formation appear to be recognizable in the Marble Falls Formation. *Barytichisma,* which characterizes the lower faunal zone of the Wapanucka, was reported by Plummer as occurring primarily in the Sloan Member in the lower part of the Marble Falls Formation. Similarly, species of *Koninckophyllum* (described as *Neokoninckophyllum* by Moore and Jeffords) and *Amplexocarinia* occur primarily in the upper Lemons Bluff Member of the Marble Falls; these forms characterize the upper coral zone in the Wapanucka Formation. However, more recent field studies of the physical stratigraphy of the Marble Falls Formation by Bell (1957, p. 2; personal communication, 1962) suggest that Plummer's lithologic divisions were not well founded and are partial lateral equivalents. This faunal correlation with the Marble Falls Formation is therefore tentative, pending the results of future biostratigraphic studies of the Marble Falls Formation.

In northeastern Oklahoma the regional biostratigraphic relations of the Hale and Bloyd Formations are not yet established. A majority of the corals described by Moore and Jeffords (1945) from this area were based upon specimens collected from a locality below the dam at Greenleaf Lake. These strata are assigned in their publication to the Hale Formation, but Huffman (1958, pl. 4) mapped

this area as part of the Bloyd Formation. In view of this disagreement, references in the present study to the Greenleaf Lake locality are designated as Hale (or Bloyd?) Formation.

More precise biostratigraphic correlations between the coral faunas here described from the Wapanucka Formation and those of central Texas and northeastern Oklahoma must await comprehensive zonal studies of the faunas in those areas.

PALEONTOLOGY

Introduction.—A primary objective of this study has been to evaluate the nature and extent of the variability within the coral species described. Some morphological characters in rugose corals lend themselves to quantitative treatment, including those features that can be counted, measured precisely, or computed. These include number of septa at a given diameter; number, attitude, and spacing of tabulae; and size and spacing of dissepiments. It is unfortunate that several other characters which must be used in the description of species cannot readily be quantified. Examples are the shape and character of the axial structure and variations in the shape and development of the cardinal fossula and alar pseudofossulae. We consider the degree of internal thickening by secondary deposits of skeletal tissue to be less important genetically than other factors, but this feature is likewise difficult to express quantitatively. Thus any discussion of variability in coral species can be based partly upon quantitative methods but must also be based partly on those characters that cannot be precisely measured.

Statistical methods are employed in this study primarily to express the expected limits of variability in certain morphological characters in the described species. Statistical discrimination of species has been attempted in only one case, that of *Leonardophyllum morrowense,* forms A and B. Good discussions of biometrical methods in zoology and paleontology are given by Burma (1948), Imbrie (1956), and Simpson and others (1960).

The assumption is here made that all individuals appearing to belong to a particular species that occur at a single locality and within a limited stratigraphic interval constitute a sample of a fossil "population." However, the recognition of indigenous faunas is difficult in paleontology, and the degree of correspondence of fossil "populations" to living biological populations is therefore conjectural.

Statistical notations.—The following characters have been treated quantitatively. All measurements were made with a micrometer caliper or with a calibrated ocular in the binocular microscope.

alar diameter (d)—diameter of corallite, measured along a line perpendicular to the cardinal-counter plane

tabularium diameter (d^t)—diameter of tabularium, measured in same section and along same line as the alar diameter

height (h)—linear distance between proximal end of corallite and axis of corallite at any stage of growth

dissepimentarium diameter (d^d)—diameter of dissepimentarium, calculated from $\frac{1}{2}$ ($d-d^t$)

number of major septa (n)—direct count of the number of major septa, made in transverse section from which corresponding diameter is recorded

septal ratio (n/d)—number of major septa per 1 mm diameter

sample size (N)—number of individual measurements

observed range (O.R.)—statement of the largest and smallest values recorded for each variate

mean (M)—arithmetic mean, given by $\frac{\Sigma\chi}{N}$ where $\Sigma\chi$ is equal to the sum of all variates

standard deviation (S. D.)—a measure of the absolute variation in a given sample; given by $\sqrt{\frac{\Sigma(d^2)}{N-1}}$ where $\Sigma(d^2)$ represents the sum of the squares of the deviations of each variate from the sample mean

coefficient of variation (C.V.)—standard deviation expressed as a percentage of the mean; given by $\frac{100\ (S.D.)}{M}$

standard error of the mean (S. E.M)—a measure of the reliability of the mean as an estimate of the true mean; given by $\frac{S.\,D.}{\sqrt{N}}$

Measurements of diameter, septal count, height, and septal ratio are recorded for all specimens, and measurements of tabular ium diameter and dissepimentarium diameter are recorded where appropriate in appendix II. The observed variation in diameter and septal ratio has been computed for species where sufficient numbers of specimens are available to be significant. These calculations are included in tables 1-12.

Biometrical methods.—The most frequently treated morphological character in recent quantitative studies of corals has been the septal ratio, which is an expression of the number of major septa occurring per 1 mm diameter (Chilingar, 1956; Rozkowska, 1957; Oliver, 1960). In these studies, the number of septa was commonly plotted against the corresponding diameter of the corrallite, which provides, in most species, an easily obtained means of evaluating the factor of increase in septal number throughout growth. This method has the advantage of being useful in the study of fragmentary material. The relationship of septal ratio to height was not recorded in studies of the above-cited authors.

The solitary rugose corals from the Wapanucka Formation in general are well preserved, and many specimens are complete and weather free from the rock matrix. This circumstance offered the possibility of utilizing the added factor of height in relation to septal ratio. We believe this provides a more meaningful basis for the evaluation of septal insertion. A careful record, therefore, was made of the height above the proximal end at which all transverse sections were taken, and septal ratios have been plotted against height (figs. 4-11, 13). It should be noted that these figures do not depict true ontogenetic development because there is no evidence that a linear relationship exists between the height of a corallite and time (Burma, 1948, p. 742). Although it is undoubtedly true that the over-all height of corals is related to their span of life, the effect of local environments on morphology and growth rates in the extinct coral species studied cannot be evaluated. It also seems likely that growth rates may have been accelerated during the early ontogeny.

The distinction of the ephebic stage (mature or adult stage of growth) from the earlier neanic stage (juvenile) cannot be made objectively. A continuous growth series offers no more possibility of objective subdivision into parts than does any continuum. A subjective judgment, therefore, was made of the height at which fully mature characters were present for each species studied. In this study the mean septal ratio was calculated for successive stages of growth by class groups of from 4 to 16 mm, depending upon the size of the corallites and the availability of data. Deviation of each variate from the sample mean (M) was computed, and a measure of the absolute variation present in the sample was obtained (standard deviation, S.D.). The standard deviation in the adult stages of

growth with respect to septal ratio, diameter, and tabularium ratio is shown for most species (tables 1-12). The expected limits of variation in the septal ratio were calculated as equalling M±3S.D., and are also given for most species (figs. 1-11, 13). It is possible that multivariate analysis would approach the actual limits of variability more closely, but lack of data did not permit the use of this method. The limits of variability established by the method used should include about 99 percent of the variability actually present and are generally considered adequate (Burma, 1948, p. 729).

In *Leonardophyllum morrowense,* new species, slight differences in septal ratio were observed to correspond to the degree of complexity of the axial structure. The differences in septal ratio were evaluated by means of a standard formula for the statistical discrimination of samples (Simpson and others, 1960, p. 176) and were found not to be significant. Nevertheless this slight difference, related as it is to the complexity of the axial structure, should be recorded. These two groups of corals are therefore treated informally as form A and form B in the description of this species.

The over-all differences in the diameters of the tabularium and dissepimentarium in *Koninckophyllum oklahomense* and *K. simplex* are shown graphically (fig. 12). This diagram is based upon the computed mean values for the diameters of the tabularium (d^t) and the dissepimentarium (d^d) by class intervals through all stages of growth.

General procedures.—The type specimens for most of the species described in this study and for many related species of Lower Pennsylvanian corals described by Jeffords (1942) and by Moore and Jeffords (1945) were borrowed from The University of Texas (Bureau of Economic Geology) and from the University of Kansas. Unfortunately these type specimens consist of disarticulated, unpolished, and saw-marked chips that cannot be adequately studied. In most cases longitudinal cuts have partially destroyed transverse surfaces, from which no thin sections were made. Virtually nothing can be determined from the cut surfaces in early growth stages of most of these specimens because of the close spacing of the septa. The unfortunate condition of this material is attributable to the illustrative technique used by Moore and Jeffords in these studies. It consisted of photographing transverse cut surfaces, enlarging the photographs, and inking on them the interpreted structural features.

The photographic emulsion was then bleached to leave a black-line drawing. They then made longitudinal cuts of the specimen and followed the same procedure. This method of illustration is not recommended for type specimens.

Unretouched photographs of thin sections are used to illustrate species in the present study. Specimens to which University of Oklahoma catalog numbers have been assigned are designated by the prefix OU; University of Kansas types by the prefix KU; and University of Texas types by the prefix TU.

In describing the number and distribution of major septa, we have followed the septal notation method used by Moore and Jeffords (1945, p. 83). For example, K 4 A 3 C 3 A 4 K indicates counter septum, 4 metasepta, alar septum, 3 metasepta, cardinal septum, 3 metasepta, alar septum, 4 metasepta, and counter septum again. Counts are made in a clockwise direction in transverse sections (viewed from above), and minor septa are not included. Total number of septa in the above example is 18.

Morphological terms were used in this study as defined by Moore, Hill, and Wells (*in* Hill, 1956, p. 245). Generic diagnoses are given, but we have followed the family designations as outlined by Hill (1956) in *Treatise on Invertebrate Paleontology*.

Partial or total recrystallization has obscured or destroyed the septal microstructure in many of the coral specimens available for study from the Wapanucka Formation. Statements concerning septal microstructure are recorded in the systematic section in those species descriptions where a positive observation can be made.

CORAL DESCRIPTIONS

Order RUGOSA

Family METRIOPHYLLIDAE Hill, 1939

Remarks.—Hill (1956, p. 257) stated that members of Metriophyllidae have the cardinal fossula on the convex side of the corallite. However, at least two of the genera she included in this family do not meet this requirement. The type species of *Empodesma* shows a variable position of the fossula in relation to curvature (Moore and Jeffords, 1945, p. 90), and Hill stated that the genus *Stereocorypha* has the cardinal fossula on the concave side of the corallite.

Genus *EMPODESMA* Moore and Jeffords, 1945

Type species.—*Empodesma imulum* Moore and Jeffords, 1945; Lower Pennsylvanian, Marble Falls Formation, central Texas.

Diagnosis.—Solitary corallites with long and thick protosepta in the proximal region and the cardinal and counter septa joined axially for some distance vertically from the proximal end. The cardinal septum is commonly shortened in adult stages and a fossula is developed. Major septa are amplexoid and dissepiments are absent.

Empodesma cf. *E. imulum* Moore and Jeffords, 1945

Plate 1, figure 1

Empodesma imulum Moore and Jeffords, 1945, p. 90, text-figs. 10-14.

Description.—The single ceratoid corallite here described is curved slightly in a plane between the cardinal and an alar septum and has the cardinal fossula offset from the concave side of the corallite. Complete height is estimated to have been more than 45 mm. The calice is crushed. The epitheca is 1.3 mm thick at the calice and is marked externally by shallow septal grooves and low interseptal ridges.

Major septa number 24 at a diameter of 6.0 mm (septal ratio,

4.0) and increase to an observed maximum of 32 at a diameter of 15.0 mm (septal ratio, 2.1). Septa are irregularly amplexoid. At the base of the calice in adult stages, major septa are long and are uniform in thickness in the cardinal quadrants and shorter and unequal in length in the counter quadrants (pl. 1, fig. 1b). In early growth stages, all major septa are long and the cardinal and counter septa join axially (pl. 1, fig. 1d). The cardinal septum becomes irregularly shortened and thins distally. It occupies a prominent fossula marked in the axial region by downbent tabulae. Alar septa are distinctly longer than adjacent major septa in the counter quadrants. The septal formula in the ephebic stage is K 9 A 5 C 5 A 9 K. No axial structure or minor septa are present.

Tabulae are complete, subhorizontal, and downbent near the periphery of the corallite and at the margin of the cardinal fossula. From 5 to 7 complete tabulae occur per 10 mm vertically. Dissepiments are absent.

Discussion.—Empodesma imulum, as defined by Moore and Jeffords (1945, p. 89), is characterized by the obliquity of the calice floor and by the junction in the early stages of the cardinal and counter septa. These features are present in the single corallite here described. Also in agreement are the irregularity of position of the cardinal fossula in relation to the plane of curvature, the number and attitude of tabulae, the development of the cardinal fossula, and the amplexoid nature of the septa. The septa of the holotype, as illustrated by Moore and Jeffords (1945, p. 91, fig. 10), are thicker than those of the corallite here described and have a tendency to be irregularly rhopaloid, but their illustrations of paratypes (1945, figs. 11, 12) are variable in these respects.

Range and distribution.—Empodesma imulum was described by Moore and Jeffords from the Marble Falls Formation of Lampasas County, Texas. This genus has not previously been reported from the Wapanucka Formation. It has been found at one locality in the Arbuckle region only.

Material and occurrence.—One specimen from locality 24-E.

Genus *STEREOCORYPHA* Moore and Jeffords, 1945

Type species.—Stereocorypha annectans Moore and Jeffords, 1945; Lower Pennsylvanian, Marble Falls Formation, central Texas.

Diagnosis.—Solitary corallites with long major septa, most of which join axially, but an independent axial structure not developed. The cardinal septum is commonly shortened in late growth stages and occupies an obscure fossula. Dissepiments are absent.

Stereocorypha cf. *S. spissata* Moore and Jeffords, 1945
Plate 1, figure 2

Stereocorypha spissata Moore and Jeffords, 1945, p. 88, text-figs. 7, 8.

Description.—The single trochoid corallite here described is curved slightly in the cardinal-counter plane. The cardinal fossula is on the concave side of the corallite. The incomplete height is 27 mm; diameter at the calice is 15.2 mm. The corallite is imbedded in limestone and the epitheca is not observable.

Major septa number 36 at a diameter of 11.0 mm (septal ratio, 3.2) and increase to 39 at a diameter of 15.2 mm (septal ratio, 2.6). Major septa are thin, straight, nonrhopaloid, and are united axially by skeletal tissue in the immature stages of growth. The cardinal septum is one-third to one-half the width of other septa and extends into the axial region in early growth stages. It becomes shortened in the ephebic stages and occupies a distinct cardinal fossula. Alar pseudofossulae are narrow but well developed. The septal formula at the base of the calice is K 11 A 6 C 6 A 11 K. Axial ends of major septa coalesce in immature stages, but a true axial column is not developed. Minor septa and dissepiments are absent.

Tabulae appear in transverse sections to be thin and widely spaced.

Discussion.—Moore and Jeffords (1945, p. 88) based their description of *Stereocorypha spissata* on two specimens from Limestone Gap (loc. 18, this report). Only the holotype is illustrated (1945, text-figs. 7, 8). The description here given of this species is based on a single fragmentary specimen, which is also from Limestone Gap (loc. 18). It is smaller than the holotype (KU 7060-22a), with which it has been compared, and has somewhat less sclerenchyme in the axial region. The specimen here described is interpreted as an immature individual which belongs to this species. Oblique transverse cuts through three additional specimens from the same locality indicate that they also may belong to *S. spissata.* However, these specimens show considerable variation in the amount of axial thickening. More material representative of this uncommon

species is needed to evaluate the marked degree of variability that is suggested by the available material.

The holotype of *Stereocorypha annectans* (TU P-11931c), described by Moore and Jeffords (1945, p. 86) from the Marble Falls Formation of Texas, has also been examined. This species differs from *S. spissata* in having a significantly lower septal ratio and stronger acceleration of septal insertion in the cardinal quadrants.

Range and distribution.—Upper part of the Wapanucka Formation at one locality in the Ouachita area.

Material and occurrence.—Four fragmentary specimens from locality 18-U.

Family LACCOPHYLLIDAE Grabau, 1928

Genus *AMPLEXOCARINIA* Soshkina, 1928

Type species.—*Amplexocarinia muralis* Soshkina, 1928; Lower Permian, Russia.

Diagnosis.—Small cylindrical corallites with the amplexoid major septa shortened in adult growth stages. No fossulae are developed. Tabulae are flat axially but are inclined downward at the periphery. Dissepiments and an axial structure are absent.

Remarks.—Uncertainty exists as to the generic assignment of the small Pennsylvanian amplexoid corals here assigned to the genus *Amplexocarinia.* Hill (1956, p. 258) stated that this genus occurs only in the Permian of Europe and listed no genus in the family Laccophyllidae as occurring in the Pennsylvanian System. At present it seems advisable to follow Moore and Jeffords (1945, p. 140) in using this generic name for Lower Pennsylvanian species with characters which appear to be similar to the Permian species described by Soshkina as the type species for *Amplexocarinia.*

Amplexocarinia corrugata (Mather), 1915
Plate 1, figures 3-5

Amplexus corrugatus Mather, 1915, p. 90, pl. 1, figs. 7-10.
Amplexocarinia corrugata (Mather), Moore and Jeffords, 1945, p. 142, text-figs. 129-140.

Description.—The corallites here described are small, cylindrical, or scolecoid; heights of available specimens range from 13 to 32

mm, and diameters range up to 5.5 mm. The epitheca is marked externally by narrow septal grooves and broad, low interseptal ridges. Small, radiciform processes are present at the proximal ends of complete corallites.

Major septa number about 16 at a diameter of 3.4 mm (septal ratio, 4.7) and increase to 22 at a diameter of 5.0 mm (septal ratio, 4.4). Major septa extend to the axis of corallites only within a few millimeters of the proximal end (pl. 1, fig. 3d); distally, septa withdraw to produce an open axial area. Septa are amplexoid in mature growth stages and range in length from one-half the radius immediately above tabulae to about one-third the radius immediately below tabulae. The cardinal and counter septa commonly extend as much as 1 mm into the open axial area. Alar septa are not identifiable in the ephebic stages of growth. The septal formula of a typical corallite (ephebic stage) is K 6 A? 3 C 3 A? 5 K. Minor septa, dissepiments, and an axial column are absent.

Tabulae are complete, horizontal in the axial region, and number from 3 to 4 per 10 mm vertically. They are distinctly downbent near the periphery of the corallites at angles approaching 90 degrees and may be subparallel to the corallite wall for several millimeters (pl. 1, fig. 4b).

Discussion.—The corals here described from the Wapanucka Formation agree closely to those described by Mather (1915, p. 90) as *Amplexus corrugatus* and subsequently described by Moore and Jeffords (1945, p. 142) as *Amplexocarinia corrugata* (Mather). The diagnostic features of this species are its small size, cylindrical to scolecoid form, short amplexoid septa, and complete horizontal tabulae, which are inclined steeply downward at their peripheral margins.

Range and distribution.—Amplexus corrugatus was described by Mather from units which he designated as the Brentwood Limestone Lentil of the Bloyd Formation of northwestern Arkansas and from the Morrow formation near Fort Gibson, in northeastern Oklahoma. Corals described as *Amplexocarinia corrugata* by Moore and Jeffords were collected from what these authors considered to be the Hale Formation in northeastern Oklahoma. Moore and Jeffords also assigned two specimens from the lower Marble Falls Limestone of central Texas to this species. *Amplexocarinia corrugata* has not previously been reported from the Wapanucka Formation

and has been found only in the Ouachita Mountains region in the *Koninckophyllum* zone in the upper part of the formation.

Material and occurrence.—Our description is based upon four corallites from locality 18-U. This species also occurs at localities 19-E, 20-I, and 21-J.

Family LOPHOPHYLLIDIIDAE Moore and Jeffords, 1945

Genus *LOPHOPHYLLIDIUM* Grabau, 1928

Type species.—*Cyathaxonia prolifera* McChesney, 1860; Upper Pennsylvanian, Illinois.

Diagnosis.—Solitary corallites with a simple columella which is formed by an expansion of the axial end of the long counter septum, from which it may be separated in adult stages. Other major septa, with the exception of the cardinal septum, are long and are commonly rhopaloid. Tabulae are tent-shaped, and dissepiments are absent.

Remarks.—The taxonomic history of the lophophyllidid corals was reviewed by Jeffords (1942, 1947) and will not be repeated here. However, we cannot agree with restriction by Jeffords (1947, p. 21) of the genus *Lophophyllidium* "to species having a relatively large axial column that contains radiating laminae" and the erection of a new genus *Stereostylus* for species in which the columella is relatively thin and lacks radiating laminae. Jeffords also stated that *Lophophyllidium* differs from *Stereostylus* in having a thicker epitheca and extensive internal deposits of sclerenchyme. These features, as well as the thickness of the columella, are determined primarily by the addition of skeletal tissue to the internal skeletal elements. The degree of internal thickening is highly variable, even within a single species, and there appears to be continuous gradation between the two species groups represented. We do not consider it possible to separate *Stereostylus* from *Lophophyllidium* consistently, and we consider this genus to be a junior synonym of *Lophophyllidium*. The genetic significance of the thickening of skeletal elements in these corals is not known. Some variation in this factor may represent responses of individual corals to environment and may have no consistent genetic significance.

Jeffords' argument that *Stereostylus* "can be distinguished generally from *Lophophyllidium* by examination of external features of the corallite" (Jeffords, 1947, p. 38) is shown to be tenuous by a comparison of his illustrated exteriors of representatives of the two groups (compare Jeffords' pl. 10 with pl. 20 and fig. 6 with fig. 7).

Lophophyllidium idonium Moore and Jeffords, 1945
Plate 1, figures 6-9; plate 2, figure 1

Lophophyllidium idonium Moore and Jeffords, 1945, p. 96, text-figs. 25-28.

Description.—The corallites here described are small, steeply trochoid, and straight or slightly curved. The position of the cardinal fossula in relation to curvature could not be determined.

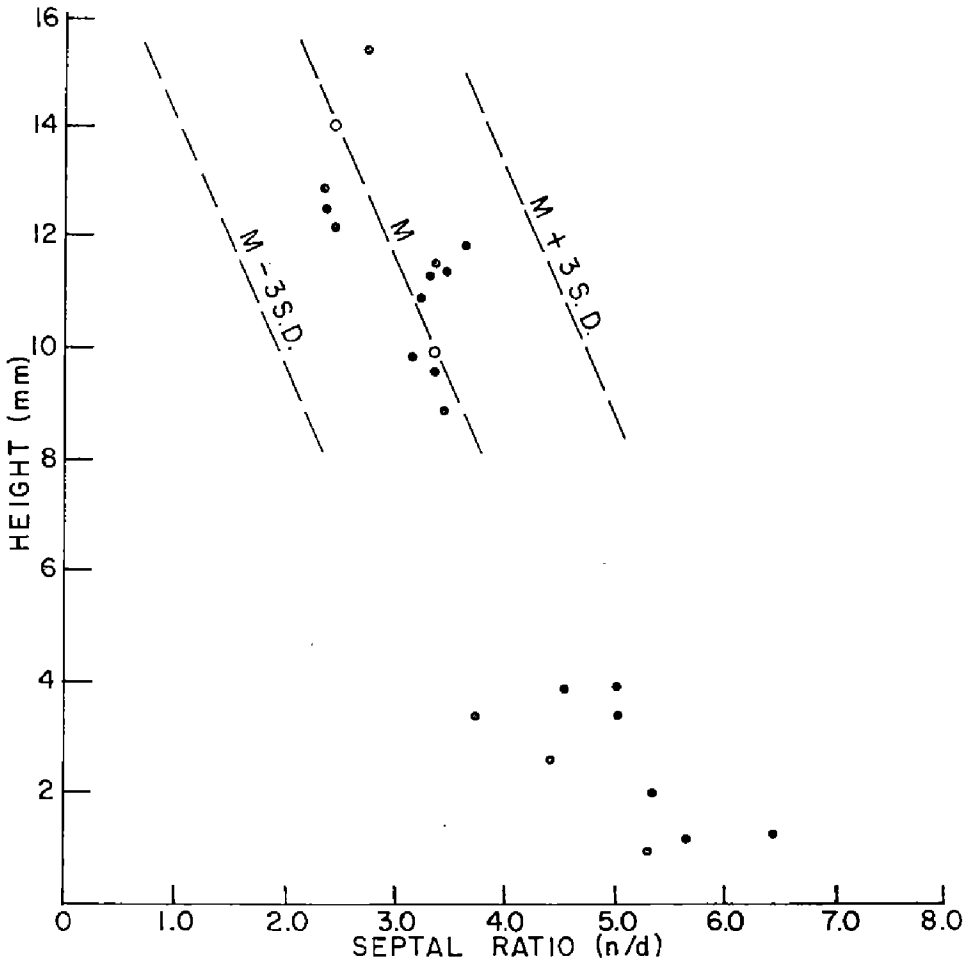


Figure 4. Relationship of height to septal ratio (n/d) in *Lophophyllidium idonium*, based upon specimens from all localities. Circles indicate mean values (M) for n/d, computed by classes (class intervals, 4 mm). Outer lines indicate expected limits of variability in n/d (based upon 3 standard deviations) for all stages of growth at heights greater than 8 mm.

Heights of complete specimens range from 18.3 to 36.5 mm and maximum diameters from 9.7 to 16.0 mm. A prominent calicular boss commonly extends as much as 5 mm above the calice floor. The epitheca is 1 mm or less thick in adult stages and is marked externally by narrow septal grooves and interseptal ridges. Transverse rugae and growth lines are faint.

Major septa number about 14 at a diameter of 2.2 mm (septal ratio, 6.4) and increase to an observed maximum of 28 at 12.0 mm (septal ratio, 2.3). The expected limits of variability in septal ratios in relation to height are shown in figure 4. It will be noted that the septal ratio decreases uniformly throughout the upper part of the corallites. Typically 24 to 28 major septa are at the base of the calice in mature individuals. Major septa are markedly rhopaloid. Their axial ends are united by skeletal tissue in quadrants (pl. 1, figs. 7c, 8) and are commonly united to the columella. The cardinal septum is less than 2 mm long in neanic and ephebic growth stages and occupies a narrow open or closed fossula, which narrows axially. Metasepta adjacent to the cardinal fossula are not appreciably deflected toward it. The counter septum is expanded axially to produce an elongate, lathlike columella which lacks radial elements. Interseptal spaces between the counter and counter-lateral septa are commonly slightly wider than other interseptal spaces. Alar pseudofossulae are narrow. A typical septal formula in the ephebic stage is K 8 A 4 C 4 A 8 K (pl. 1, fig. 8). Minor septa are rudimentary.

Tabulae are complete, steeply inclined upward axially, and are widely spaced. They number 1 or 2 per 10 mm. Tabulae cannot be distinguished in the proximal one-quarter of the corallite where internal skeletal elements are thickened. Dissepiments are absent.

TABLE 1.—VARIATION IN *Lophophyllidium idonium*

All measurements taken in growth stages higher than 8 mm from proximal end. Specimens from all localities are included.

	Diameter	*Septal Ratio*
N.	12	12
O.R.	6.1-12.0	2.3-3.6
M.	8.7	3.0
S.D.	2.09	0.469
C.V.	24.0	15.6
$S.E._M$	0.6	0.1

Discussion.—Comparison of topotypes to the holotype (KU 7151-21a) shows only slight interspecific variation. *L. idonium* appears to be closely related to *L. confertum* Jeffords (1942, p. 221), based upon specimens from the Lester Formation near Ardmore, Oklahoma. It differs from that species primarily in having a higher septal ratio and in being less cylindrical in shape. From the specimens described in this paper as *L.* cf. *L. angustifolium,* this species differs in having fewer tabulae and in having much more internal thickening which results in a thicker columella, more rhopaloid septa, and thicker septa in the early stages. From *L. minutum* this species differs in being of distinctly larger size, in having less prominent alar pseudofossulae, and in the absence of marked curvature in the early stages of the corallite.

The observed variation in diameter and septal ratio has been computed for this species (table 1).

Range and distribution.—Lophophyllidium idonium was described from the Wapanucka Formation by Moore and Jeffords (1945, p. 96) on the basis of three specimens from a locality which corresponds to locality 16-D of this report. This species occurs in several stratigraphic intervals in the Wapanucka Formation in the Arbuckle region only.

Material and occurrence.—Eighteen corallites; five specimens, including two figured specimens (pl. 1, figs. 7, 8), are topotypes. Material collected from localities 3-D, 4-A, 16-D (type locality), 24-E, 26-A, and 27-A.

Lophophyllidium minutum Jeffords, 1942, emended Rowett and Sutherland

Plate 2, figures 2-6

Lophophyllidium minutum Jeffords, 1942, p. 246, pl. 7, figs. 2-4.
Lophophyllidium minutum, Moore and Jeffords, 1945, p. 107, text-fig. 54.

Description.—The corallites here described are small, trochoid to ceratoid, and straight or curved near the proximal end only. Curvature, when present, is in the cardinal-counter plane with the cardinal fossula located on the convex side. Observed heights of complete specimens range from 9.0 to 16.5 mm and maximum diameters from 4.8 to 9.7 mm. The epitheca is thick, relative to the small size of this species, and is in excess of 1 mm at the calice of

mature specimens. The epitheca is marked externally by narrow septal grooves and rounded interseptal ridges. The calice contains a prominent calicular boss. Rugae and growth lines are faint.

Major septa number about 8 at a diameter of 1.5 mm (septal ratio, 5.3) and increase to an observed maximum of 24 at a diameter of 8.0 mm (septal ratio, 3.0). The expected limits of variability in septal ratios in relation to height are shown in figure 5. The septal ratio decreases slightly throughout the ephebic stages. Typically 20 to 24 major septa are at the base of the calice in mature specimens. The major septa are rhopaloid in the ephebic stages and are joined axially to the columella by skeletal tissue. In the proximal one-third of the corallite the septa are thick and are closely spaced. The cardinal septum is less than 1.5 mm long in neanic and ephebic stages of growth and occupies a well-developed, closed fossula, which narrows axially. The counter septum is thickened axially to form a lathlike columella, which lacks internal radial elements. Alar pseudofossulae are narrow but distinct. Typical septal formulae in the ephebic stages are K 6 A 4 C 4 A 6 K and K 5 A 4 C 4 A 5 K. Minor septa are absent.

As many as 2 or 3 thin tabulae are visible in the upper two-thirds of many of the corallites studied (pl. 2, figs. 6a, 6b). In specimens in which they are present, tabulae rise steeply (50 to 60 degrees) toward the columella. Tabulae appear to be absent in the remaining specimens. Tabulae may be present in the lower one-third of the corallites but are obscured by close spacing of the thick septa in this region.

Discussion.—In Jeffords' original description of *Lophophyllidium minutum* (1942, p. 246) and in Moore and Jeffords' redescription (1945, p. 107), tabulae were stated to be absent in this small species. Tabulae clearly are present, however, in 14 of 30 corallites assigned to this species from the Wapanucka Formation. These corallites are otherwise completely indistinguishable from those which apparently have no tabulae. Because all specimens were collected from the same locality and interval in the Wapanucka, it is concluded that they possibly represent a single-species population. It is possible that tabulae are present in the early growth stages of material described by Jeffords (1942) but are obscured by the internal thickening characteristic of this species. We have examined the holotype (KU 7385-21c) and tabulae appear to be present but confirmation is prevented because no thin sections of the holotype

are available. One illustration of this species by Jeffords (1942, pl. 7, fig. 2a) suggests the presence of tabulae.

Two corallites from the Wapanucka Formation figured by Moore and Jeffords (1945) as *Lophophyllidium minutum* do not clearly belong to this species. On the basis of their illustrations of a specimen from Limestone Gap, their figures 56a and 56b (p. 105) possibly represent an immature specimen of *Stereocorypha,* and the specimen with an enlarged columella (fig. 55, p. 105) probably belongs to some other species of *Lophophyllidium.*

The diagnostic features of this species are (1) small size, (2) well-developed alar pseudofossulae, (3) rhopaloid septa, (4) thick epitheca, and (5) presence of a few tabulae in most specimens. It is possible that tabulae are altogether absent in some individuals, but this could not be confirmed.

Lophophyllidium minutum does not closely resemble other

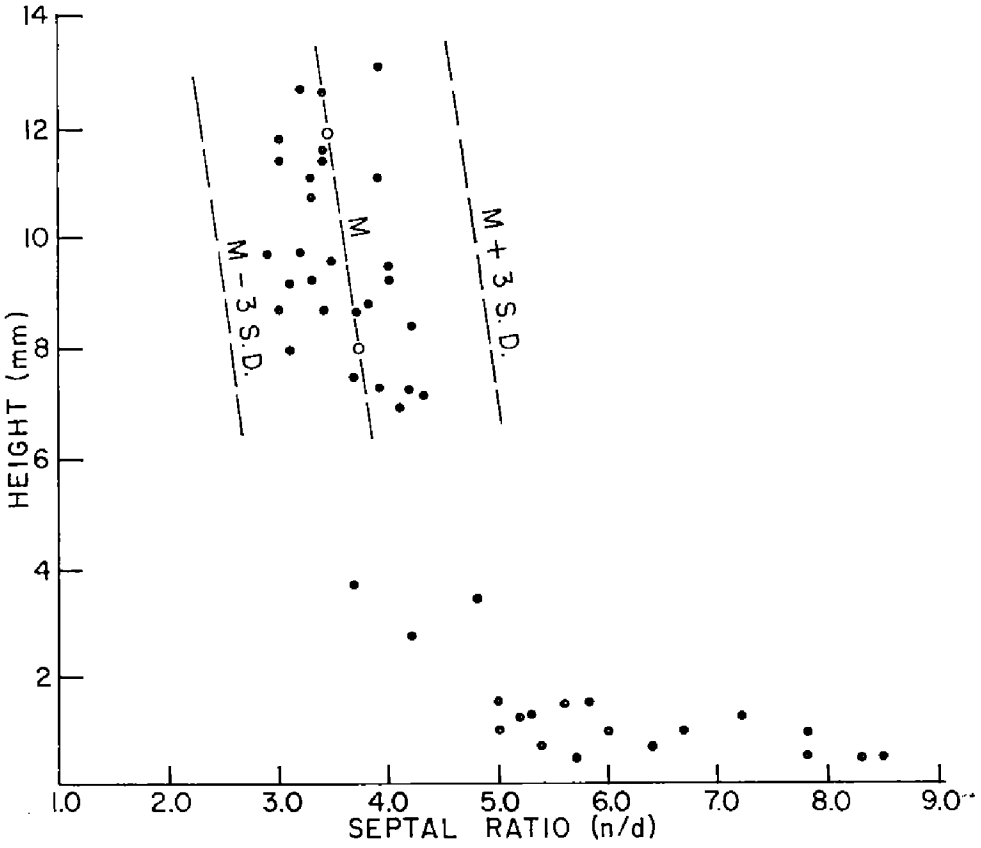


Figure 5. Relationship of height to septal ratio (n/d) in *Lophophyllidium minutum,* based upon a population from locality 4. Circles indicate mean values (M) for n/d, computed by classes (class intervals, 4 mm). Outer lines indicate expected limits of variability in n/d (based upon 3 standard deviations) for all stages of growth at heights greater than 6 mm.

TABLE 2.—VARIATION IN *Lophophyllidium minutum*

All measurements taken in growth stages higher than 6 mm from proximal end. All specimens are from one locality and stratigraphic interval (4-A).

	Diameter	*Septal Ratio*
N.	32	32
O.R.	6.0-8.0	2.9-4.3
M.	5.9	3.6
S.D.	0.79	0.41
C.V.	13.4	11.4
$S.E._M$	0.14	0.07

species of lophophyllidid corals from the Wapanucka Formation or from rock of equivalent age elsewhere.

The observed variation in diameter and septal ratio has been computed for this species (table 2).

Range and distribution.—Lophophyllidium minutum was originally described by Jeffords (1942, p. 246) from the Hale (or Bloyd?) Formation at Greenleaf Lake in northeastern Oklahoma and also from the Otterville Formation (Lower Pennsylvanian) in the Ardmore area of southern Oklahoma. The species is here recorded from the lower part of the Wapanucka Formation, near the westernmost exposure of the formation in the Arbuckle Mountains region. It has not been found in the Ouachita area.

Material and occurrence.—Thirty corallites are from locality 4-A.

Lophophyllidium ignotum Moore and Jeffords, 1945, emended Rowett and Sutherland

Plate 2, figures 9-14

Lophophyllidium ignotum Moore and Jeffords, 1945, p. 108, text-figs. 57, 58.

Description.—The corallites here described are trochoid, uncurved, or slightly curved approximately in the plane of an alar septum. Observed heights of nearly complete specimens range from approximately 18 to 34 mm and maximum diameters from 9.9 to 18.0 mm. The epitheca is thick and forms a distinctive peripheral stereozone, which is as much as two-fifths the radius in some specimens. The epitheca is marked externally by shallow septal grooves and low interseptal ridges. Growth lines and rugae

are inconspicuous. The calice contains a spikelike calicular boss. Small radiciform processes are preserved at the proximal ends of several corallites.

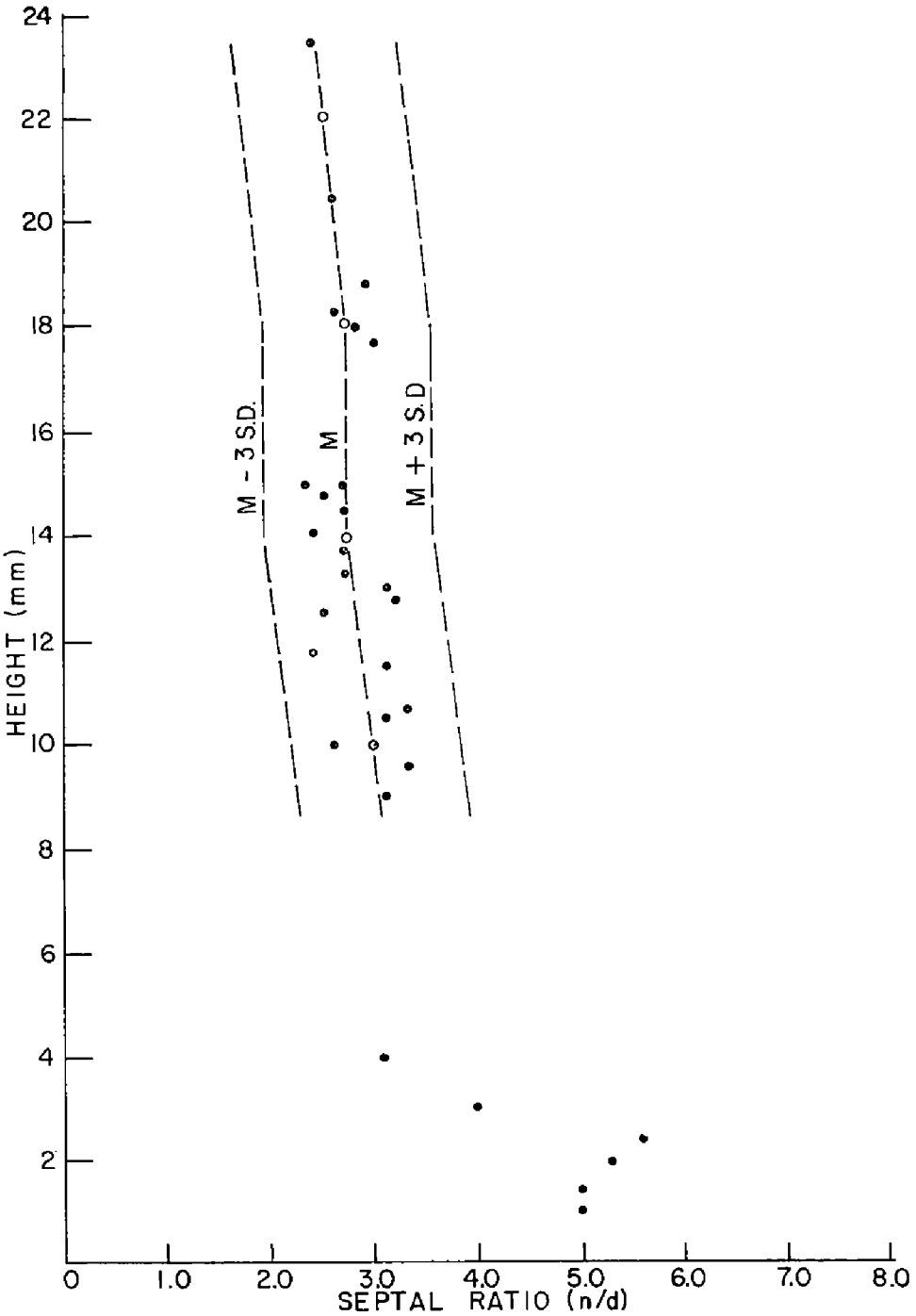


Figure 6. Relationship of height to septal ratio (n/d) in *Lophophyllidium ignotum*, based upon specimens from all localities. Circles indicate mean values (M) for n/d, computed by classes (class intervals, 4 mm). Outer lines indicate expected limits of variability in n/d (based upon 3 standard deviations) for all stages of growth at heights greater than 8 mm.

Major septa number about 10 at a diameter of 2.0 mm (septal ratio, 5.0) and increase to an observed maximum of 29 at a diameter of 12.0 mm (septal ratio, 2.4). The expected limits of variability in septal ratios in relation to height are shown in figure 6. It will be noted that septal ratio decreases only slightly throughout the ephebic stages of growth. Typically 22 to 26 major septa are at the base of the calice in mature specimens. Major septa are subequal in length, radially arranged, commonly slightly rhopaloid, and are united to the axial structure by skeletal tissue except in the late ephebic stage, in which they are shortened. The cardinal septum is variable in length and tends to shorten in the ephebic stage, in which it is less than one-third the length of adjacent metasepta. The cardinal fossula is distinct and narrows axially. In neanic and early ephebic stages the axial structure consists of a lathlike columella formed from the swollen axial edge of the counter septum. In the ephebic stage sporadic, irregular radial lamellae commonly develop as part of the axial structure and produce an irregular radiating structure. In late ephebic growth stages concentric secondary layers of skeletal tissue may surround the lamellae to produce an axial structure that is oval, subrounded, or irregular in cross section. The axial structure persists as an independent structure into the calice. Alar pseudofossulae are not developed. The septal arrangement in typical corallites (ephebic stage) is K 7 A 3 C 3 A 7 K (pl. 2, fig. 9a) and K 8 A 4 C 4 A 9 K (pl. 2, fig. 14b). The marked acceleration of septal insertion in the counter quadrants is characteristic. Minor septa are rudimentary and are commonly obscured by the peripheral stereozone.

Tabulae are complete and are widely spaced. In one corallite, tabulae are more numerous than is typical, and a transverse section

TABLE 3.—VARIATION IN *Lophophyllidium ignotum*

All measurements taken in growth stages higher than 8 mm from proximal end. All specimens are from one locality and stratigraphic interval (23-B).

	Diameter	*Septal Ratio*
N.	23	23
O.R.	6.9-12.0	2.3-3.3
M.	6.7	2.8
S.D.	1.41	0.28
C.V.	16.7	10.0
$S.E._M$	0.3	0.06

of this specimen (pl. 2, fig. 10b) intersects approximately five tabulae. Structural features in the proximal one-quarter to one-third of a corallite tend to be obscured by the closely spaced, thick septa and by deposits of skeletal tissue. Dissepiments are absent.

Discussion.—The above description is based upon topotype material of *Lophophyllidium ignotum* which has been compared with the holotype (KU 7134-21b). Moore and Jeffords' statement (1945, p. 108) that the cardinal septum in this species "remains distinctly shortened throughout growth" is incorrect. Their figured paratype shows a long cardinal septum in what presumably is the early ephebic stage (1945, text-fig. 58a). Compare their figure to that of our figured topotype (pl. 2, fig. 9b), which shows the same development. The cardinal septum becomes shortened in the later ephebic stages. Moore and Jeffords did not give the location of the cardinal fossula in relation to curvature for their figured type specimens. In those of our specimens which are curved, the fossula is not in the cardinal-counter plane but corresponds approximately to the plane of an alar septum.

The axial structure in *L. ignotum* is markedly variable, both ontogenetically and among individuals of equivalent growth stage. The variability of the axial structure in this species is due primarily to irregularity in number and arrangement of septal lamellae and to differing amounts of secondary skeletal tissue added to the column.

Lophophyllidium ignotum differs from other lophophyllidid corals from the Wapanucka Formation in the character of the axial structure and in its marked radial symmetry. In addition this species differs from *L. angustifolium* and *L. blandum* Moore and Jeffords (1945) in having a more prominent axial structure, thicker septa, and a peripheral stereozone. *L. extumidum* Moore and Jeffords (1945) also is characterized by internal thickening, but it has more numerous tabulae, a thinner wall, and more distinctly rhopaloid septa than are found in *L. ignotum.*

The observed variation in diameter and septal ratio has been computed for this species (table 3).

Range and distribution.—The original description of *Lophophyllidium ignotum* by Moore and Jeffords (1945, p. 108) was based on two corallites from the Wapanucka Formation at a locality which corresponds to loc. 23 of this report. Our topotype specimens came from the lower part of the Wapanucka Formation at this

locality, and we have not found this species except in the Ouachita region.

Material and occurrence.—Nine topotype specimens from locality 23-B. A single specimen from locality 21-H may belong to this species.

Lophophyllidium cf. *L. angustifolium* Moore and Jeffords, 1945
Plate 3, figures 1-4

Lophophyllidium angustifolium Moore and Jeffords, 1945, p. 103, text-figs. 44-46.

Description.—The corallites here described are ceratoid and straight or slightly curved. The position of the cardinal fossula in relation to curvature cannot be determined. Incomplete heights range from about 14 to about 20 mm and maximum diameters from 7.6 to 10.6 mm. The epitheca is less than 1 mm thick at the calice in ephebic growth stages and is marked externally by narrow septal grooves and low, rounded interseptal ridges. Transverse rugae and growth lines are faint.

Major septa number about 12 at a diameter of 2.5 mm (septal ratio, 4.8) and increase to an observed maximum of 28 at a diameter of 9.7 mm (septal ratio, 2.9). The expected limits of variability in septal ratios in relation to height are shown in figure 7. The septal ratio decreases throughout the ephebic stages of growth. In mature individuals the base of the calice typically has 24 to 26 major septa. The septa are slightly rhopaloid and are joined axially in quadrants. Most septa tend toward a pinnate arrangement along the cardinal-counter plane in both the cardinal and counter quadrants, but a few are in contact with the columella. The cardinal septum is less than 1 mm long in ephebic growth stages and occupies an open fossula which narrows axially. The counter septum is distended axially to produce a narrow, lathlike columella which persists into the calice as a prominent calicular boss. Alar pseudofossulae are obscure or absent. The septal formula of a typical corallite in the ephebic stage is K 6 A 4 C 4 A 6 K. Minor septa are rudimentary in one corallite and are absent in other specimens.

Tabulae are complete and rise steeply toward the columella and are subhorizontal near the periphery of the corallites. They number 2 or 3 per 10 mm in mature stages of growth. Dissepiments are absent.

Discussion.—The assignment of these corallites from the Wa-

panucka Formation to *Lophophyllidium angustifolium* is tentative. The type specimens of this species, from Morrowan rocks of western Arkansas, have not been examined. The Wapanucka specimens differ from published illustrations by Moore and Jeffords (1945, p. 102, text-figs. 44-46) in that the major septa are rhopaloid and the columella is thicker and more persistent. They differ from *L. idonium* primarily in having much less secondary thickening of internal structures. Thus in typical specimens of *L. idonium* the colum-

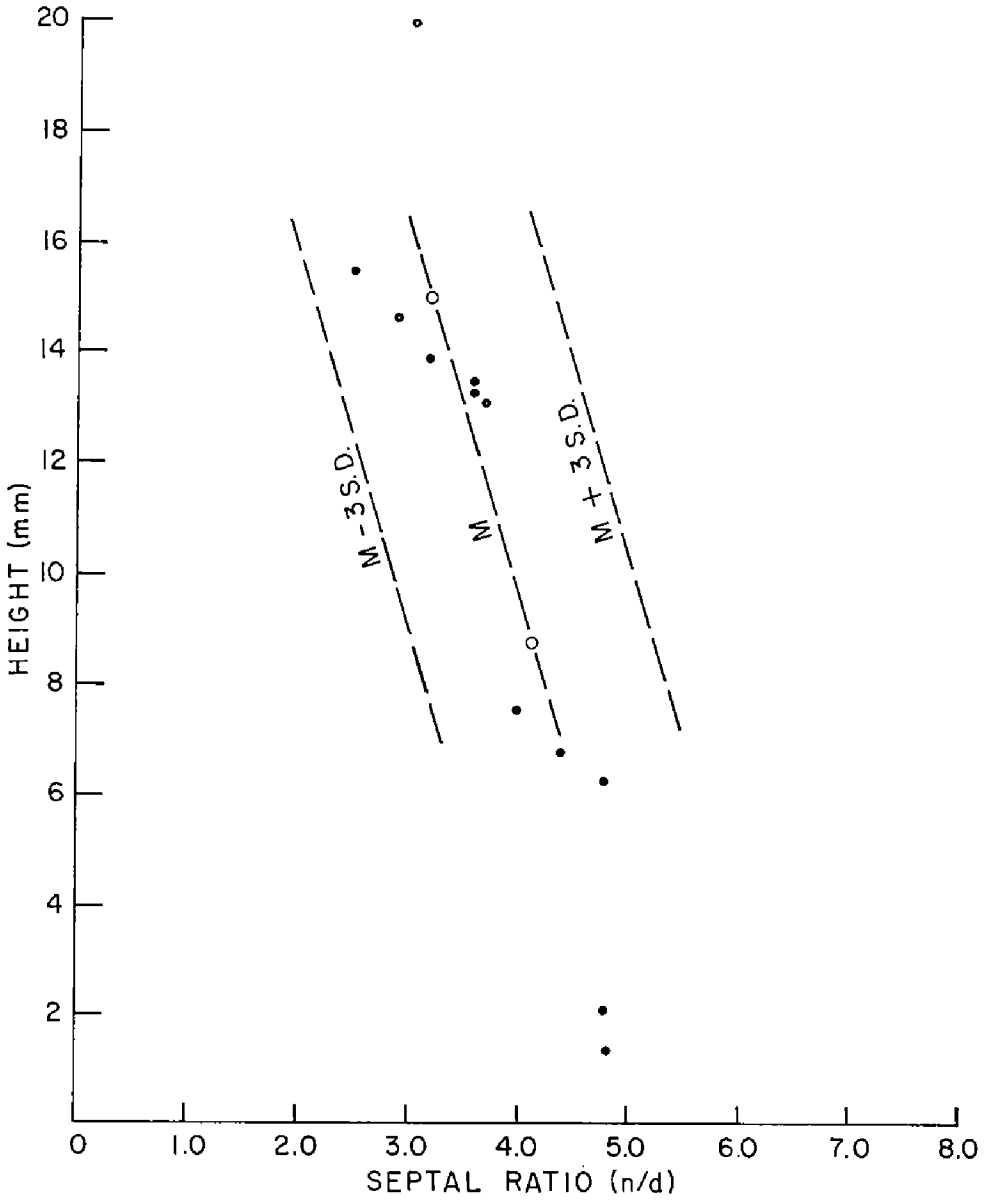


Figure 7. Relationship of height to septal ratio (n/d) in *Lophophyllidium* cf. *L. angustifolium*, based upon specimens from all localities. Circles indicate mean values (M) for n/d, computed by classes (class intervals, 6 mm). Outer lines indicate expected limits of variability in n/d (based upon 3 standard deviations) for all stages of growth at heights greater than 6 mm.

TABLE 4.—VARIATION IN *Lophophyllidium* cf. *L. angustifolium*

All measurements taken in growth stages higher than 5 mm from proximal end. All specimens are from one locality and stratigraphic interval (4-A).

	Diameter	*Septal Ratio*
N.	8	8
O.R.	6.5-9.5	2.5-3.7
M.	8.0	3.2
S.D.	0.99	0.45
C.V.	12.4	13.1
$S.E._M$	0.3	0.1

ella is thicker, the proximal portion of the corallite more dense, and the major septa much more rhopaloid. The Wapanucka specimens here compared to *L. angustifolium* differ also from *L. idonium* in having more numerous tabulae and a distinctly lower septal ratio at a corresponding height (compare figs. 4 and 7).

The observed variation in diameter and septal ratio has been computed for this species (table 4).

Range and distribution.—The original description of *L. angustifolium* Moore and Jeffords (1945, p. 103) was based on a single corallite from the Hale Formation one mile south of Morrow, Arkansas, and two paratypes collected from Morrowan rocks near Greenleaf Lake in northeastern Oklahoma. The specimens from the Wapanucka Formation which may represent this species have been found only in the lower part of the formation in one of the most western localities in the Arbuckle region.

Material and occurrence.—Six corallites from locality 4-A.

Lophophyllidium sp. A
Plate 3, figures 5, 6

Description.—The three corallites here described are trochoid and medium in size, are curved slightly in the cardinal-counter plane, and have the cardinal fossula on the concave side of curvature. Incomplete heights range from about 26 to 31 mm and maximum diameters from 12.7 to 18.3 mm. The epitheca is less than 1 mm thick at the calice and is marked externally by well-developed septal grooves and interseptal ridges. Transverse rugae and growth lines are inconspicuous or absent. The calice contains a prominent, thin, calicular boss.

Major septa number about 16 at a diameter of 3.6 mm (septal ratio, 4.4) and increase to an observed maximum of 31 at a diameter of 14.0 mm (septal ratio, 2.2). Major septa are thin but are distinctly rhopaloid and radially arranged. Axial ends of some septa are joined irregularly with adjacent septa and some are connected to the columella. The cardinal septum is less than one-third the length of adjacent metasepta in the ephebic stages and occupies a narrow open or closed fossula. The counter septum is expanded axially to produce a lathlike columella in the neanic and early ephebic stages. In later ephebic stages it becomes irregular in two of the three specimens available and includes sparse, irregularly developed septal lamellae (pl. 3, figs. 5c, 6d). What seem to be irregular axial tabellae are developed in the late ephebic stage in one specimen (pl. 3, fig. 5b). The septal formula of one specimen (pl. 3, fig. 6b) is K 9 A 4 C 4 A 9 K, which shows the marked acceleration of septal insertion in the counter quadrants. Minor septa are rudimentary.

Tabulae are complete, tent shaped, and vary from subhorizontal to steeply inclined near the columella. They number about 3 to 5 per 10 mm vertically. Dissepiments are absent.

Discussion.—The species here described does not compare closely to any published Morrowan species. In the irregularlity of the columella the form is similar to *L. murale* Jeffords (1942), from Desmoinesian strata in Kansas. It differs from that species in its smaller size and in having a short cardinal septum and a well-developed cardinal fossula.

The observed variation in diameter and septal ratio has been computed for this species (table 5).

Range and distribution.—This species has been found only

TABLE 5.—VARIATION IN *Lophophyllidium* sp. A

All measurements taken in growth stages higher than 8 mm from proximal end. All specimens are from one locality and stratigraphic interval (4-A).

	Diameter	*Septal Ratio*
N.	7	7
O.R.	6.0-16.5	1.8-3.7
M.	12.2	2.5
S.D.	3.31	0.19
C.V.	2.7	7.6
$S.E._M$	1.2	0.07

in the lower part of the Wapanucka Formation in one of the westernmost exposures in the Arbuckle region.

Material and occurrence.—Three specimens from locality 4-A.

Lophophyllidium sp. B

Plate 2, figures 7, 8

Description.—The two corallites here described are small, trochoid, and straight or slightly curved. Maximum height is about 19 mm and maximum diameter 11 mm. The epitheca is marked externally by narrow septal grooves and broad interseptal ridges. Radiciform processes are absent.

Major septa number about 14 at a diameter of 2.8 mm (septal ratio, 5.0) and increase to an observed maximum of 26 at a diameter of 7.8 mm (septal ratio, 3.3). The major septa are thin and some are slightly rhopaloid. In the early ephebic stage they are pinnately bunched axially in distinct quadrants (pl. 2, figs. 7c, 8c) but are free in later stages. The cardinal septum is thin, less than 1 mm long in all growth stages observed, and occupies a distinct open fossula. The counter septum is expanded axially to form a thin, lathlike columella, which persists for several millimeters into the calice. The axial ends of the counter-lateral septa diverge away from the counter septum in a pinnate arrangement with adjacent metasepta (pl. 2, figs. 7b, 8b). Alar pseudofossulae are prominent. The septal formula at the base of the calice in one specimen is K 7 A 4 C 4 A 7 K. Minor septa are rudimentary or absent.

Longitudinal sections were not made. Tabulae were not observed in any of seven transverse thin sections and the matrix extends downward between the septa into the apical region of the corallite.

Discussion.—The two corallites here described are distinctive in character but do not compare closely with any described Morrowan species. They are characterized by their small size, a marked division of the septa into quadrants, and the corresponding occurrence of a well-developed cardinal fossula and alar pseudofossulae. They appear to lack tabulae. These specimens differ from *L. minutum,* another small Morrowan species, in the absence of internal thickening of the septa and columella and in having a higher septal ratio.

Range and distribution.—This uncommon species has been

found only in the lower part of the Wapanucka Formation near Wapanucka in the Arbuckle region.

Material and occurrence.—Two specimens from locality 16-D.

Family TIMORPHYLLIDAE Soshkina, 1941

Genus *LEONARDOPHYLLUM* Moore and Jeffords, 1941

Type species.—Leonardophyllum distinctum Moore and Jeffords, 1941; Lower Permian, western Texas.

Diagnosis.—Corallites ceratoid, cylindrical, or scolecoid; septal grooves faint to well developed; major septa radially arranged and typically withdrawn from the axial region in adult stages, except for the counter septum which may be elongate; cardinal septum commonly short but a prominent fossula not developed; axial structure commonly with a median lamella and irregularly disposed radial lamellae and axial tabellae; tabulae tent shaped and complete or incomplete; dissepiments absent.

Remarks.—The only previously described species assignable with certainty to this genus are *Leonardophyllum distinctum,* the type species, and *L. acus,* both described by Moore and Jeffords (1941, p. 88) from a single locality in rocks of Early Permian age in western Texas. *L. distinctum* was described on the basis of about one dozen specimens and *L. acus* on the basis of only two specimens. The latter species differs from the former primarily in having a more complex axial structure with more numerous incomplete tabulae in the axial region. We have examined the holotypes of these two species. We believe that it is likely that the two forms described as *L. distinctum* and *L. acus* represent variants of a single species and that further collecting from the type locality and reevaluation of material would support this contention. *L. morrowense,* new species, here described from the Wapanucka Formation, shows marked variability in the complexity of the axial column and in the number of incomplete tabulae in the axial region, but intermediate forms have been observed.

Leonardophyllum morrowense, new species, represents the first certain occurrence of this genus in rocks of Pennsylvanian age. Ross and Ross (1962, p. 1180) described *L. kingi* from the upper part

of the Gaptank Formation in western Texas, which they believe may be Virgilian in age. However, their illustrations of this species, based on two incomplete specimens, do not clearly support assignment to the genus *Leonardophyllum*.

Moore and Jeffords (1941, p. 85) stated that *Leonardophyllum* includes corals that bear "no clearly defined septal grooves," but examination of the holotype of *L. distinctum* by the authors revealed the presence of shallow but distinct septal grooves and interseptal ridges. *L. morrowense,* new species, has well-developed narrow septal grooves and broad interseptal ridges.

A discussion of the generic relations of *Leonardophyllum* is given by Moore and Jeffords (1941, p. 86).

Leonardophyllum morrowense, new species
Plate 4, figures 1-9; plate 5, figures 1-5

Description.—The corallites here described are ceratoid, cylindrical, or scolecoid, with an early trochoid stage which may be slightly curved. The position of the cardinal septum with respect to curvature is not constant. Complete specimens range in height from 32 to 48 mm and from 8 to 11 mm in maximum diameter. The epitheca is 0.2 to 0.6 mm thick at the calice and is marked externally by shallow septal grooves and low, rounded septal ridges. Growth lines are fine but distinct; transverse rugae are irregularly spaced and conspicuous. A double row of radiciform processes are present at the proximal end of complete corallites. These are irregular in spacing and number and extend along one side of the proximal end for distances of 4 to 10 mm.

Major septa number about 8 at a diameter of 1.1 mm (septal ratio, 7.3) and increase to an observed maximum of 27 at 10.6 mm (septal ratio, 2.5). The expected limits of variability in septal ratios in relation to height are shown in figure 8. The septal ratio in this species decreases uniformly throughout the cylindrical ephebic stages of growth. Major septa typically number 22 to 26 at the base of the calice in mature specimens. Major septa are straight or slightly curved, nonrhopaloid, slightly amplexoid, and in length are about one-half to two-thirds the radius. They do not extend to the axial structure, except for the counter septum, which is elongate in many specimens (pl. 5, fig. 2b). In the ephebic stages the cardinal septum is approximately one-half the length of adjacent metasepta and

occupies an obscure open fossula. Alar pseudofossulae are not developed and alar septa consequently are not easily identified. The septal formula of a typical specimen (ephebic stage) is K 6 A 4 C 4 A 6 K. Minor septa are short and are well developed only in adult growth stages. They are commonly 0.5 mm or less in length at the base of the calice.

The axial structure is highly variable in character. When well developed, it consists of crooked, irregular-branching lamellae and supporting axial tabellae. In some specimens a crooked median lamella is in alignment with the elongate counter septum (pl. 4, fig. 6d). In other specimens the axial structure is less well developed and consists of only 3 or 4 irregularly arranged lamellae. The axial structure may become discontinuous in adult stages (pl. 4, fig. 1).

The degree of development of tabulae appears to vary with the complexity of the axial structure. The number of tabulae measured at the periphery is typically 5 or 6 in 10 mm; as many as 8 per 10 mm may be present in some intervals. Specimens with a thin, narrow

TABLE 6.—VARIATION IN *Leonardophyllum morrowense* FORM A

All measurements taken in growth stages higher than 8 mm from proximal end.

	Diameter	*Septal Ratio*
	Locality 3-A	
N.	5	5
O.R.	4.9-9.2	2.4-3.9
M.	7.5	3.0
S.D.	1.76	0.66
C.V.	23.4	22.0
$S.E._M$	0.79	0.29
	Locality 4-A	
N.	21	21
O.R.	5.5-10.5	2.3-4.3
M.	6.8	3.0
S.D.	2.14	0.53
C.V.	31.4	17.7
$S.E._M$	0.82	0.20
	Both Localities	
N.	26	26
O.R.	4.9-10.5	2.3-4.3
M.	6.9	3.0
S.D.	2.09	0.54
C.V.	30.3	17.9
$S.E._M$	0.42	0.10

axial structure (pl. 5, fig. 5b) tend to have mostly complete, tent-shaped tabulae, which are arched upward in the axial region and downbent in the peripheral one-third of the corallite. Where the axial structure is discontinuous, the tabulae tend to be complete and horizontal in the axial region. In specimens with a well-developed and broad axial structure (pl. 4, fig. 6) approximately the same number of tabulae are in the peripheral region as are present in forms with a less complex axial structure, but axially there are numerous additional incomplete tabulae which are steeply inclined and are gradational with an irregular series of axial tabellae. The axial tabellae are reinforcing elements in the open framework of the axial structure and do not form a regular series. In longitudinal sections the axial structure shows intersections of the crooked and twisted septal lamellae, which apparently are discontinuous vertically (pl. 4 fig. 6a).

Transverse sections at 1 or 2 mm from the proximal end of corallites show from 8 to 12 more or less straight major septa, which

TABLE 7.—VARIATION IN *Leonardophyllum morrowense* FORM B

All measurements taken in growth stages higher than 8 mm from proximal end.

	Diameter	*Septal Ratio*
	Locality 3-A	
N.	13	13
O.R.	6.5-10.6	2.4-3.7
M.	8.5	2.9
S.D.	1.22	0.36
C.V.	14.3	12.4
$S.E._M$	0.34	0.10
	Locality 4-A	
N.	7	7
O.R.	6.0-12.0	2.2-3.3
M.	9.4	2.7
S.D.	1.64	0.36
C.V.	17.4	13.3
$S.E._M$	0.62	0.15
	Both Localities	
N.	20	20
O.R.	6.0-12.0	2.2-3.7
M.	8.75	2.8
S.D.	1.48	0.36
C.V.	16.9	13.7
$S.E._M$	0.34	0.09

are joined axially around an elongate counter septum. At diameters of 3 to 3.5 mm are from 18 to 20 major septa, which may be slightly twisted axially (pl. 5, fig. 5f). The diameter and height at which

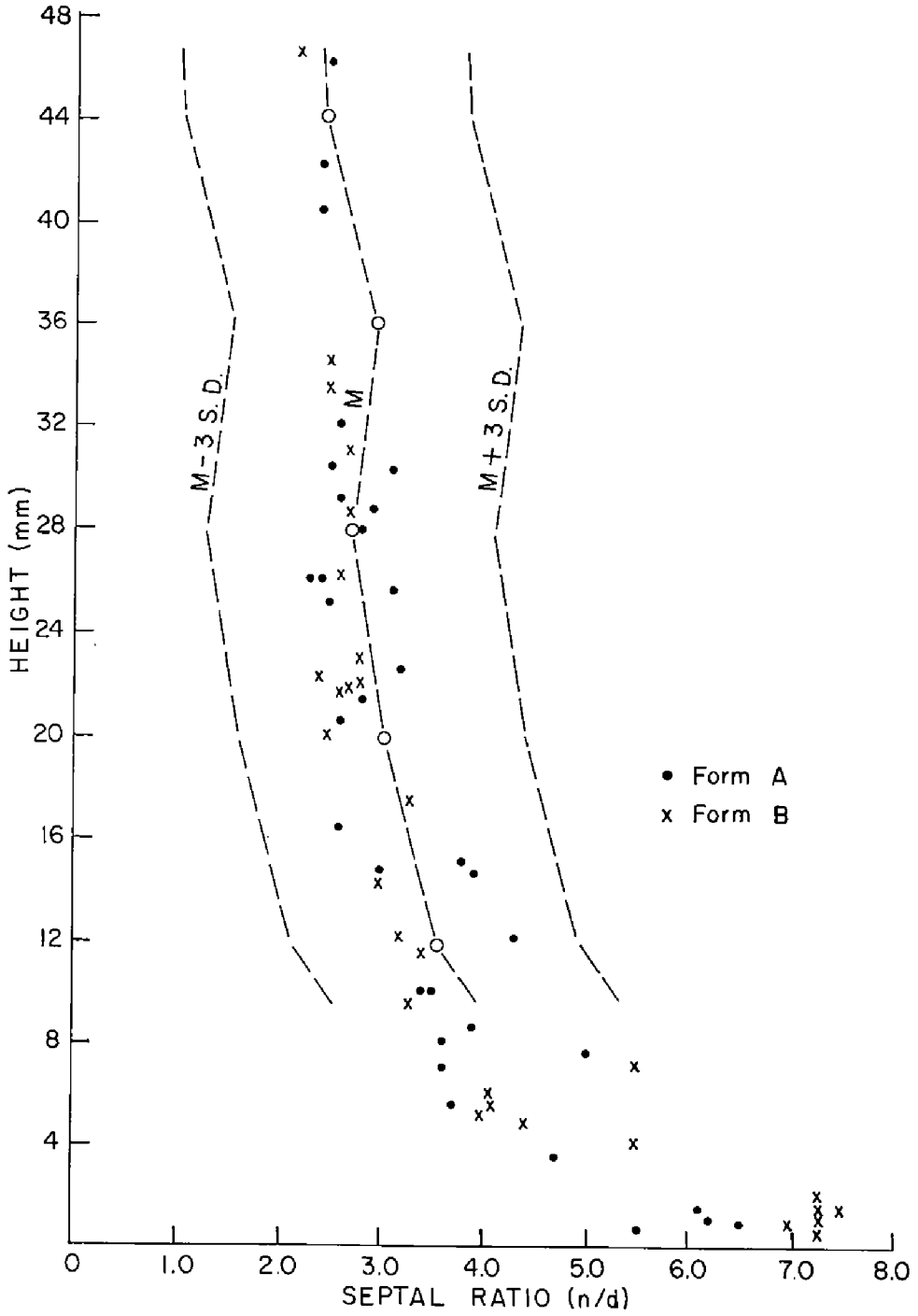


Figure 8. Relationship of height to septal ratio (n/d) in *Leonardophyllum morrowense*, based upon specimens from all localities. Form A and form B are differentiated on the diagram. Circles indicate mean values (M) for n/d, computed by classes (class intervals, 8 mm). Outer lines indicate expected limits of variability in n/d (based upon 3 standard deviations) for all stages of growth at heights greater than 8 mm.

the first suggestion of a complex axial structure appears are variable. The complex column of this species appears to originate from the joining and twisting of the axial ends of all the major septa and not from the extended counter septum only.

Discussion.—All specimens here described as *Leonardophyllum morrowense,* new species, were collected from the same stratigraphic interval at two localities in Pontotoc County (3-A and 4-A), which are about 0.4 mile apart. Initial studies of the material suggested that two closely related species were present at both localities. One group (herein designated form A) included specimens with a well-developed axial structure and numerous incomplete and steeply inclined tabulae in the axial region (pl. 4, figs. 5-9; pl. 5, figs. 1-3). A second group (form B) included specimens with an axial structure composed of fewer structural elements, less steeply inclined tabulae, and few incomplete tabulae in the axial region (pl. 4, figs. 1-4; pl. 5, figs. 4, 5). A slight difference also is in the mean septal ratio in the ephebic growth stage (tables 6, 7; fig. 8). However, evaluation

TABLE 8.—VARIATION IN *Leonardophyllum morrowense* FORMS A AND B

All measurements taken in growth stages higher than 8 mm from proximal end.

	Diameter	*Septal Ratio*
	Locality 3-A	
N.	18	18
O.R.	4.9-10.6	2.4-3.9
M.	8.2	2.9
S.D.	1.34	0.42
C.V.	16.3	14.5
$S.E._M$	0.31	0.9
	Locality 4-A	
N.	28	28
O.R.	5.5-12.0	2.2-4.3
M.	7.4	3.0
S.D.	2.12	0.48
C.V.	28.6	16.0
$S.E._M$	0.40	0.9
	Both Localities	
N.	46	46
O.R	4.9-12.0	2.2-4.3
M.	7.7	3.0
S.D.	1.81	0.46
C.V.	23.2	15.3
$S.E._M$	0.26	0.7

of the difference in septal ratio by means of a standard formula for statistical discrimination of samples (Simpson, Roe, and Lewontin, 1960, p. 176) indicated that the difference is not statistically significant. Other morphological parameters, including mean diameters, were also tested by this method and were not found to differ significantly. The variation in the degree of complexity of the axial structure in these corals is striking when extreme examples are compared, but this feature does not lend itself to quantitative tests. We nevertheless believe this feature to be gradational in nature and have observed several specimens which are intermediate in the development of a complex axial structure (pl. 4, fig. 2). We have also observed that the degree of complexity of the axial structure may vary considerably within a single corallite. The statistical parameters were computed separately for form A (table 6) and form B (table 7), as well as for the species (table 8). The slight difference in the septal ratios in these two variants and the expected limits of variability in this factor in relation to height are shown in figure 8.

Range and distribution.—This new species occurs only in the lower part of the Wapanucka Formation in its westernmost exposures in the Arbuckle Mountains region.

Material and occurrence.—More than 100 specimens, of which approximately 50 were thin-sectioned for study, from localities 3-A and 4-A, Pontotoc County, Oklahoma.

Figured type specimens.—Holotype, OU 4838, from locality 4-A; paratypes, OU 4834, 4835, 4836, 4839, and 4841 from locality 3-A; paratypes OU 4833, 4837, 4840, 4842, 4843, 4844, 4845, and 4846 from locality 4-A.

Family HAPSIPHYLLIDAE Grabau, 1928

Remarks.—Hill (1956, p. 267) considered the position of the cardinal fossula in relation to curvature to be significant in the separation of genera in the family Hapsiphyllidae. She divided the genera of this family into two informal groups: Group I, with the fossula on the concave side of curvature, and Group II, with the fossula on the convex side of curvature. We cannot agree with this division. The position of the cardinal fossula in relation to curvature is remarkably constant in some species. However, Sutherland (1958, p. 48) demonstrated that in some species the cardinal fossula does

not lie invariably in the cardinal-counter plane. In some species it varies in position, and in others it lies approximately at a right angle to the cardinal-counter plane or in the plane of an alar septum (e. g., *Barytichisma callosum*). We consider the location of the fossula to be an important factor in the definition of many species but not in the separation of genera.

Genus *AMPLEXIZAPHRENTIS* Vaughan, 1906

Type species.—*Zaphrentis bowerbanki* Thomson, 1883; Lower Carboniferous, Scotland.

Diagnosis.—Small, solitary, trochoid to ceratoid corallites in which the major septa may or may not unite around the conspicuous cardinal fossula. Septa commonly withdraw from the axis in late stages of growth. Alar pseudofossulae commonly are well developed in early stages but may become inconspicuous in the ephebic stage. The tabulae tend to be complete and are arched or flattened axially except in the cardinal fossula, where they turn downward abruptly.

Remarks.—The history of the taxonomy of small Carboniferous zaphrentid corals is a morass of revision and redefinition. A summary of this history is given by Sutherland (1958, p. 44) and will not be repeated here. We follow the usage by Hill (1956, p. 267) and Sutherland (1958, p. 48) of restricting the genus *Hapsiphyllum* to species having contratingent minor septa. Two species described by Moore and Jeffords (1945) as *Hapsiphyllum tumidum* and *H. crassiseptatum,* which possibly occur in the Wapanucka Formation, are here referred to the genus *Amplexizaphrentis.* Specimens of the genus *Amplexizaphrentis,* which has not previously been reported from the Wapanucka Formation, are rare in the formation, and only six specimens have been collected from all localities.

Amplexizaphrentis cf. *A. tumida* (Moore and Jeffords), 1945

Plate 5, figures 6, 8

?*Hapsiphyllum tumidum* Moore and Jeffords, 1945, p. 125, text-figs. 98-99.

Description.—The three corallites described here are trochoid and are slightly curved. In one specimen the cardinal fossula is on the convex side of curvature (pl. 5, fig. 6). In the other two specimens the position of the cardinal fossula in relation to curvature could not be determined. Incomplete heights range from 20 to 31

mm and maximum diameters from 11.5 to 14.8 mm. The epitheca is less than 0.5 mm thick at the calice and is marked externally by narrow septal grooves and low, rounded interseptal ridges. The calice is deep and lacks a calicular boss. Rugae and growth lines are inconspicuous.

Major septa number 14 at a diameter of 3.5 mm (septal ratio, 4.0) and increase to 30 at a diameter of 11.0 mm (septal ratio, 2.7). Major septa are rhopaloid and are joined axially by skeletal tissue to form an irregular inner wall around an open axial region. The cardinal septum is short and occupies a prominent, axially narrowing fossula. Alar pseudofossulae are not developed. The septal formula of one specimen (ephebic stage) is K 8 A 5 C 5 A 8 K. Minor septa are rudimentary in one corallite and absent in the others.

Tabulae are complete and number 6 to 9 per 10 mm vertically. They rise steeply from the periphery for a distance of approximately one-half the radius and sag in the open axial region. Dissepiments are absent.

Discussion.—We have compared our specimens with the holotype of *A. tumida* (TU P-11799a). There appear to be no marked differences but our material is too limited for adequate comparison. Moore and Jeffords (1945) did not indicate the position of the cardinal fossula in relation to curvature in their description of this species.

Range and distribution.—Corals described by Moore and Jeffords (1945, p. 125) as *Hapsiphyllum tumidum* were collected from the Smithwick Shale (Bend Series, Lower Pennsylvanian) of San Saba County, Texas. Specimens which are here compared with this species are rare in the lower part of the Wapanucka Formation in the Ouachita and Arbuckle Mountains regions.

Material and occurrence.—Three specimens from localities 4-A and 18-C.

Amplexizaphrentis aff. *A. crassiseptata* (Moore and Jeffords), 1945
Plate 5, figure 9

?*Hapsiphyllum crassiseptatum* Moore and Jeffords, 1945, p. 128, text-fig. 101.

Description.—The single small trochoid corallite here described is slightly curved in the cardinal-counter plane. The cardinal fossula

is on the concave side of curvature. The height is 14.1 mm and the maximum diameter is 9.0 mm. The epitheca is 0.2 mm or less thick at the calice and is marked externally by narrow septal grooves and rounded interseptal ridges. Growth lines are very fine. Small radiciform processes are preserved at the proximal end.

Major septa number 10 at a diameter of 1.8 mm (septal ratio, 5.6) and increase to 30 at a diameter of 7.5 mm (septal ratio, 4.0). Major septa are joined axially by skeletal tissue to produce an inner wall, which surrounds a prominent cardinal fossula. The cardinal septum is long and thin and extends to the axial region in the early ephebic stage but becomes shortened at the base of the calice, where it is less than 1 mm long. Alar pseudofossulae are distinct but are not prominent. Major septa are markedly thickened in the early growth stages. Minor septa are absent.

Longitudinal thin sections were not made. Several thin tabulae can be seen in transverse sections and appear to slope steeply downward near the periphery.

Discussion.—The corallite described above was compared with the holotype of *A. crassiseptata* (KU 7744-21b). It differs in having a more prominent inner wall, a thinner epitheca, and a longer cardinal septum in the early growth stages. Satisfactory comparison cannot be made because of the inadequate material.

Range and distribution.—Moore and Jeffords based *A. crassiseptata* on a single specimen collected from the Hale(?) Formation near Keough quarry, north of Fort Gibson, Oklahoma. The specimen from the Wapanucka Formation compared to this species was collected from the lower part of the formation in the Arbuckle region.

Material and occurrence.—One specimen from locality 16-D.

Amplexizaphrentis sp. A

Plate 5, figure 7

Description.—The single specimen here described is small, trochoid, and slightly curved. The cardinal fossula is on the concave side of curvature. The height is 18.0 mm and the maximum diameter is 9.8 mm. The exterior of the corallite is obscured by matrix.

Major septa number 24 at a diameter of 8.7 mm (septal ratio, 2.8). The septa are rhopaloid and are joined axially by skeletal

tissue to form an irregular inner wall around the elongate, narrow cardinal fossula. Alar pseudofossulae are not developed. Minor septa are absent.

Tabulae are complete and number 6 or 7 per 10 mm vertically. They rise steeply from the periphery and sag at the margin of the cardinal fossula.

Discussion.—This corallite is similar to the specimens here described as *A.* cf. *tumida,* except that the cardinal fossula is on the concave side of curvature.

Range and distribution.—Upper part of the Wapanucka Formation at one locality in the Ouachita region.

Material and occurrence.—One specimen from locality 19-E.

Amplexizaphrentis sp. B
Plate 5, figure 10

Description.—The single specimen here described is small, trochoid, and slightly curved. The position of the cardinal fossula in relation to curvature could not be determined. The height of the corallite is 18.0 mm and the maximum diameter is 9.5 mm. The exterior is obscured by matrix.

Major septa number 14 at a diameter of 2.3 mm (septal ratio, 6.1) and increase to 22 at a diameter of 8.3 mm (spetal ratio, 2.7). Septa are thick near the periphery of the corallite and taper evenly toward a small open axial area. The cardinal septum is less than 1 mm long and occupies a narrow open fossula. The counter septum is slightly longer than adjacent metasepta and extends into the open axial area. Alar pseudofossulae are not developed and alar septa are not readily identified. The septal formula for the base of the calice is K 6 A? 3 C 3 A? 6 K. Minor septa are absent.

Longitudinal sections were not made and no tabulae are visible in transverse sections.

Discussion.—This corallite does not compare closely to any described species. The species can not be evaluated at this time because of the lack of material.

Range and distribution.—Lower part of the Wapanucka Formation at one locality in the Ouachita Mountains region.

Material and occurrence.—One corallite from locality 23-B.

Genus *BARYTICHISMA* Moore and Jeffords, 1945

Type species.—*Barytichisma crassum* Moore and Jeffords, 1945; Lower Pennsylvanian, Marble Falls Formation, central Texas.

Diagnosis.—Solitary corallites with a well-developed zaphrentid septal arrangement and a prominent cardinal fossula; wide peripheral stereozone formed by peripheral thickening of major and minor septa; septa amplexoid, reaching axis immediately above tabulae only; tabulae subhorizontal axially; dissepiments and axial structure absent.

Remarks.—The genus *Barytichisma* was questionably regarded by Hill as a junior synonym of *Amplexizaphrentis* Vaughan. We believe that *Barytichisma* can be separated from that genus primarily on the basis of the unusually wide peripheral stereozone.

Barytichisma callosum Moore and Jeffords, 1945

Plate 6, figures 1-5

Barytichisma callosum Moore and Jeffords, 1945, p. 134, text-figs. 116a-116f.

Description.—The corallites here described are medium to large, ceratoid to cylindrical, and curved in the plane of the cardinal septum, an alar septum, or in a plane intermediate to the cardinal septum and an alar septum. The cardinal fossula is on the concave side of curvature but not necessarily in the plane of curvature. Heights of complete specimens range from 21.5 to 89.5 mm and maximum diameters from 13.4 to 33.3 mm. The epitheca is marked externally by septal grooves and interseptal ridges of approximately equal width. Growth lines and rugae are subdued. Small radiciform processes are present near the proximal end of some specimens.

Major septa number about 8 at a diameter of 1.3 mm (septal ratio, 6.2) and increase to about 51 at a diameter of 33.0 mm (septal ratio, 1.5). The expected limits of variability in septal ratios in relation to height are shown in figure 9. It will be noted that the septal ratio decreases only slightly throughout the upper cylindrical portion of the corallites. In the ephebic stages the number of major septa commonly ranges from 38 to 44. Septa are straight and extend to the axis in the early stages of growth (brephic and neanic stages). In

the ephebic stages they become distinctly amplexoid (pl. 6, fig. 5b), and in the late ephebic stages major septa reach the axis only on the upper surfaces of tabulae. Immediately below tabulae the axial region is open. In the ephebic stages of some specimens the major septa are slightly thicker in the counter quadrants than in the cardinal quadrants (pl. 6, fig. 5c), but this feature is not consistently pre-

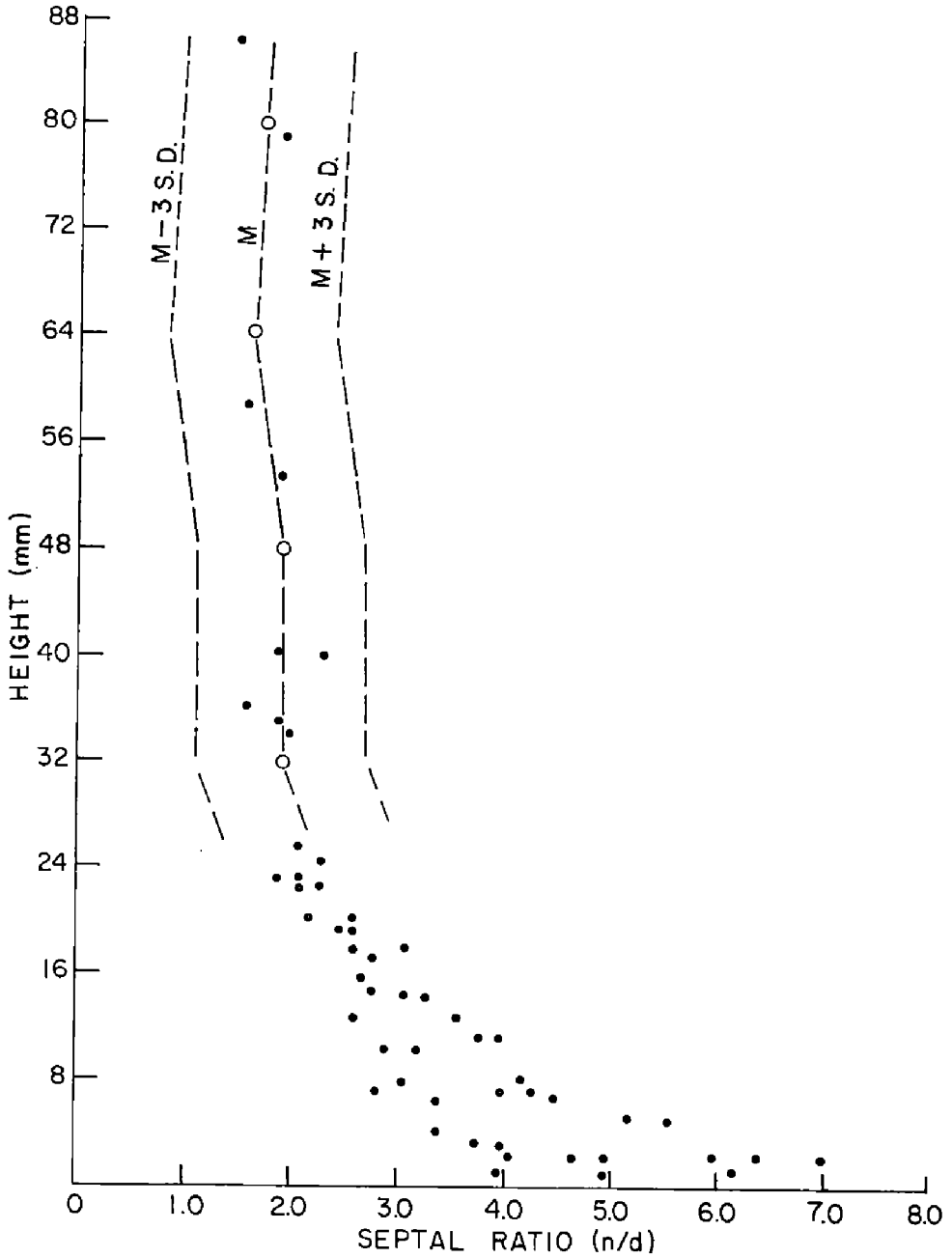


Figure 9. Relationship of height to septal ratio (n/d) in *Barytichisma callosum*, based upon specimens from all localities. Circles indicate mean values (M) for n/d, computed by classes (class intervals, 16 mm). Outer lines indicate expected limits of variability in n/d (based upon 3 standard deviations) for all stages of growth at heights greater than 24 mm.

sent. Septa may also be rhopaloid in the neanic stages of some specimens. The cardinal septum is thinner than other septa and in the early and middle stages of growth extends to the axis of the corallite (pl. 6, fig. 5a). In later growth stages the cardinal septum shortens and occupies a prominent fossula which is marked by downbent tabulae. The counter septum is identifiable only by its position relative to other protosepta. Alar pseudofossulae are not well developed and alar septa are not readily identifiable. The septal formula of a typical specimen (ephebic stage) is K 12 A 7 C 8 A 12 K.

A wide and prominent peripheral stereozone is formed primarily by the peripheral thickening of the major and minor septa. The stereozone exceeds one-third the radius in the late ephebic stages of some specimens (pl. 6, fig. 3) but may be narrower in earlier stages of growth. Minor septa are confined primarily to the peripheral stereozone but may protrude as much as 1.0 mm into the tabularium in the calice.

Tabulae are commonly complete and subhorizontal except in the axial region, where they sag slightly. At the periphery of the corallites the tabulae are inclined downward and away from the axis at from 25 to 40 degrees. From 6 to 10 tabulae are present per 10 mm vertically in the adult stages.

Septal microstructure is fibrolamellar. The fiber fascicles are perpendicular to the septal plane and are not grouped into trabeculae.

Discussion.—Moore and Jeffords (1945) based the genus *Barytichisma* on five sectioned specimens from several localities in the Marble Falls Formation in Texas. Three species were described and were separated primarily upon the basis of differences in the position of the cardinal septum in relation to curvature, as follows:

TABLE 9.—VARIATION IN *Barytichisma callosum*

All measurements taken in growth stages higher than 26 mm from proximal end. Specimens from all localities are included.

	Diameter	*Septal Ratio*
N.	9	9
O.R.	18.4-33.0	1.5-2.3
M.	24.7	1.8
S.D.	5.09	0.25
C.V.	16.5	13.9
$S.E._M$	1.7	0.08

B. crassum (type species), based upon three specimens in which the "curvature is mainly in the alar plane, but the cardinal septum may approach the concave side" (1945, p. 131); *B. repletum,* based upon a single corallite in which the cardinal septum was stated to be on the convex side of the corallite; and *B. callosum,* also based upon one corallite, in which the cardinal septum was stated to be on the concave side of the corallite.

The genus *Barytichisma* is represented in the Wapanucka Formation by corallites that appear to include *B. crassum* and *B. callosum.* A total of 20 specimens has been collected, of which 9 are from one locality. In our specimens the position of curvature varies from the plane of an alar septum to the plane of the cardinal septum, and the cardinal septum is variously situated on some part of the concave side of the corallite. Thus, some of the specimens from the Wapanucka agree in this respect with *B. crassum* and others with *B. callosum.* Most of the larger specimens, however, agree in internal morphology with *B. callosum,* irrespective of the direction of curvature. We have examined the type specimens of *B. crassum* (TU P-11908b) and *B. callosum* (TU P-11916a), which are from the same locality in the Marble Falls Formation. Although these two specimens differ in size and have a corresponding difference in the maximum number of septa, we believe that they represent variants of a single species. This contention is based on examination of the types and the marked variability in internal morphology of the Wapanucka specimens (see table 9 and fig. 9). Topotype material should be collected and studied in order to clarify this species.

B. repletum does not differ appreciably from the above species in its internal characters. The described position of the cardinal septum, on the convex side of the corallite, in this single specimen should also be substantiated by the collection and study of additional material from the Marble Falls Formation.

The observed variation in diameter and septal ratio has been computed for this species (table 9).

Range and distribution.—Barytichisma callosum was described by Moore and Jeffords (1945) from the lower Marble Falls Formation of Texas. This is the first recorded occurrence of this genus from the Wapanucka Formation. The genus is restricted to the lower part of the formation in the Arbuckle Mountains region.

Material and occurrence.—Twenty specimens from localities 3-C, 4-A, 9-B, 24-E, 27-A, and 28-A.

Family AULOPHYLLIDAE Dybowski, 1873

Genus *KONINCKOPHYLLUM* Thomson and Nicholson, 1876

Type species.—*Koninckophyllum magnificum* Thomson and Nicholson, 1876; Lower Carboniferous, Scotland.

Diagnosis.—Solitary or fasciculate corallites, with a well-developed zone of dissepiments and numerous tabulae which are tent shaped or flat. The columella, which may be discontinuous or absent in adult stages, may have a few septal lamellae. Minor septa may be discontinuous in the dissepimental zone.

Remarks.—The involved taxonomic history of *Koninckophyllum, Dibunophyllum,* and related genera is discussed in Hill (1938-1941, p. 86), Moore and Jeffords (1945, p. 153), and Sutherland (1958, p. 74) and will not be repeated here.

Koninckophyllum simplex (Moore and Jeffords), 1945

Plate 7, figures 1, 2; plate 8, figures 4-6

Neokoninckophyllum simplex Moore and Jeffords, 1945, p. 159, text-figs. 149, 150.

Description.—The corallites here described are medium to large and ceratoid to cylindrical. The plane of curvature is approximately at a right angle to the cardinal-counter plane. Observed heights range from 15 to 61 mm and maximum diameters range from 17 to 26 mm. The epitheca is 1.0 mm or less in thickness at the calice in adult specimens and is marked externally by faint septal grooves and interseptal ridges. The calice is broad, deep, and contains an arched axial boss. Irregularly spaced rugae mark stages of rejuvenescence. The proximal ends of corallites may be flattened into a broad attachment surface or may bear small, irregularly spaced radiciform processes.

The number of major septa is about 27 at a diameter of 12.0 mm (septal ratio, 2.3) and increases to an observed maximum of 47 at a diameter of 24.5 mm (septal ratio, 1.9). The expected limits of variability in septal ratios in relation to height are shown in figure 10. It will be noted that the septal ratio is essentially constant throughout the upper cylindrical portions of the corallites. The number of major septa at the base of the calice in mature specimens is

commonly 36 to 44. Major septa are thin and slightly crooked in the dissepimentarium, but thicken slightly at the periphery of the

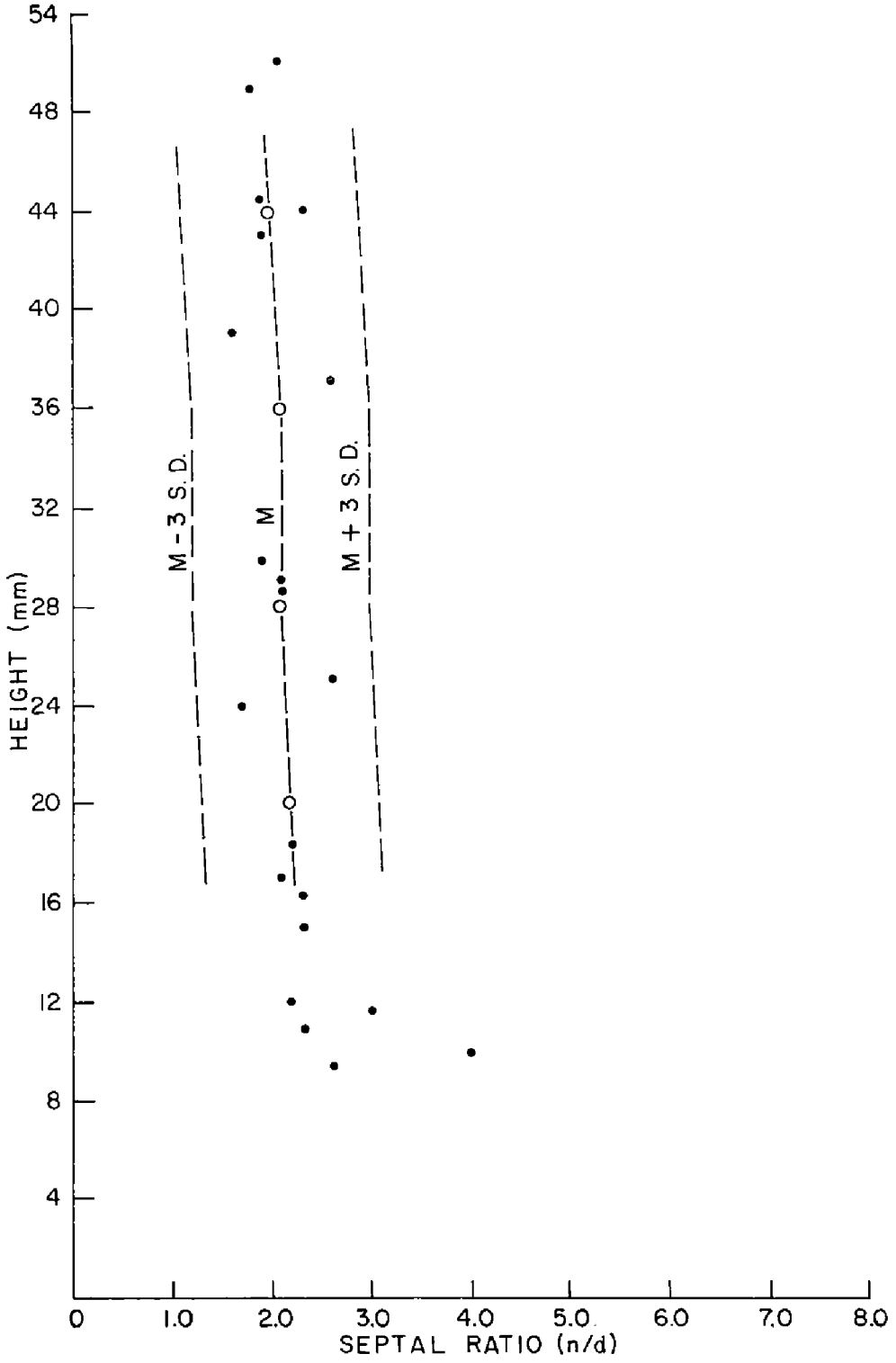


Figure 10. Relationship of height to septal ratio (n/d) in *Koninckophyllum simplex*, based upon specimens from all localities. Circles indicate mean values (M) for n/d, computed by classes (class intervals, 8 mm). Outer lines indicate expected limits of variability in n/d (based upon 3 standard deviations) for all stages of growth at heights greater than 14 mm.

tabularium to produce a poorly defined inner wall in some specimens. In the tabularium, major septa are straight and in length are equal to approximately two-thirds the radius (ephebic stage). Each third or fourth septum extends as a wavy lamella into the axial area. Rudimentary minor septa are present only in the ephebic stage. Alar pseudofossulae are not developed and alar septa are not readily identifiable. Septal arrangement of a typical corallite (ephebic stage) is K 12 A 10 C 9 A 12 K.

A simple, thin columella is present in most specimens. This structure is connected to both the cardinal and the counter septum and forms a continuous median lamella. In more than half of available specimens the columella becomes discontinuous and is absent in the late ephebic stage, leaving an open axial area (pl. 7, fig. 2c). In some specimens the cardinal septum becomes slightly shortened and occupies an obscure open fossula which is marked by a slight downbending of tabulae.

The wide dissepimentarium in this species narrows with stages of rejuvenescence but commonly occupies the peripheral one-third to one-sixth of the corallite (pl. 7, figs. 1, 2; fig. 12). The dissepimentarium is composed of dissepiments of various sizes which slope toward the axis at angles from 40 to 50 degrees. Dissepiments commonly number from 10 to 12 per 10 mm vertically adjacent to the epitheca, and horizontally are arranged in from 5 to 8 poorly de-

TABLE 10.—VARIATION IN *Koninckophyllum simplex*

All measurements taken in growth stages higher than 14 mm from proximal end.

	Diameter	*Septal Ratio*	*Tabularium Ratio*
	Locality 18-U		
N.	14	14	14
O.R.	14.0-24.0	1.6-2.6	0.58-0.87
M.	18.3	2.0	0.73
S.D.	3.46	0.30	0.10
C.V.	18.9	15.0	13.7
$S.E._M$	0.9	0.08	0.03
	All Localities		
N.	24	24	24
O.R.	13.0-24.5	1.6-2.6	0.58-0.90
M.	18.3	2.0	0.73
S.D.	3.46	0.30	0.10
C.V.	18.9	15.0	13.7
$S.E._M$	0.7	0.06	0.02

fined rows. Tabulae are incomplete, anastomosing, and subhorizontal in the axial region. Tabulae may sag slightly in the axial region where the columella is absent and are downbent slightly near the margin of the dissepimentarium. In number, tabulae range from 16 to 25 per 10 mm vertically in the axial region.

The septa are composed of slender, monacanthine trabeculae.

Discussion.—Moore and Jeffords (1945) described this species upon the basis of two corallites from the Hale Formation in northeastern Oklahoma. A total of 24 specimens from the Wapanucka Formation appear to belong to this species but reflect a much wider range of variation than is indicated by the original description of the species. Corallites from the Wapanucka Formation also commonly lack a columella in the adult growth stages and show a considerable degree of variation in the thickness of the inner wall adjacent to the dissepimentarium.

Koninckophyllum simplex occurs in approximately the same stratigraphic interval in the Wapanucka Formation as *Koninckophyllum oklahomense,* new species, but is geographically separated from this new species. *K. simplex* differs from *K. oklahomense,* new species, in having a consistently less well-developed inner wall, a narrower dissepimentarium, and distinctly larger dissepiments. *K. simplex* is also characterized by its thin, simple columella, which may terminate in the ephebic stages of growth.

The observed variation in diameter, septal ratio, and tabularium ratio has been computed for this species (table 10).

Range and distribution.—*Koninckophyllum simplex* was described by Moore and Jeffords (1945) as *Neokoninckophyllum simplex,* from the Hale Formation, north of Ft. Gibson in northeastern Oklahoma. The known occurrence of this species in the Wapanucka Formation is stratigraphically and geographically restricted to the upper part of the formation in the Ouachita Mountains region.

Material and occurrence.—Twenty-four specimens from localities 18-U, 19-E, 20-I, 21-J, and 23-I.

Koninckophyllum oklahomense, new species

Plate 8, figures 1-3

Neokoninckophyllum sp. A, Moore and Jeffords, 1945, p. 163, fig. 165.

Description.—The corallites here described are large, ceratoid to cylindrical, straight or slightly curved. Direction of curvature is

not consistent in relation to the cardinal-counter plane. The holotype (OU 4861) is 58.2 mm in height and 31.0 mm in maximum diameter. The original heights of several incomplete paratypes are estimated to have been in excess of 70 mm. The epitheca is 1.0 mm or less thick. The external surfaces of the epitheca are not well preserved in the specimens available and show only irregularly spaced rugae, which coincide with stages of rejuvenescence.

Major septa number about 8 at a diameter of 1.5 mm (septal ratio, 5.3) and increase to about 45 at a diameter of 29.0 mm (septal ratio, 1.6). The expected limits of variability in septal ratios in relation to height are shown in figure 11. The septal ratios are almost constant above heights of about 20 mm. Major septa commonly number from 36 to 44 at the base of the calice in mature specimens. The major septa are thin and crooked in the dissepimentarium and thicken abruptly at the periphery of the tabularium to produce a prominent inner wall. In the tabularium the major septa are straight, except in the axial region, where some septa are produced as wavy, twisted lamellae. A broad, open axial structure consists of the twisted ends of major septa and incomplete, anastomosing tabulae. A median lamella is not developed in most specimens, and the counter septum is recognized only by its position relative to other protosepta. A similar pattern is observed in the early stages of growth (pl. 8, figs. 1d, 1e, 3b). In the late ephebic stage, the cardinal septum is slightly shorter than adjacent major septa and occupies an open fossula, which is marked by a sag in the inner wall toward the peripheral edge of the corallite. Tabulae are downbent adjacent to the cardinal fossula. Alar septa are not readily identified and alar pseudofossulae are not developed. The septal formula of a typical specimen (ephebic stage) is K 11 A 9 C 9 A 12 K.

TABLE 11.—VARIATION IN *Koninckophyllum oklahomense*

All measurements taken in growth stages higher than 14 mm from proximal end. Specimens from all localities included.

	Diameter	*Septal Ratio*	*Tabularium Ratio*
N.	12	12	12
O.R.	16.0-29.0	1.6-2.4	0.49-0.73
M.	20.9	2.0	0.59
S.D.	4.69	0.30	0.10
C.V.	22.5	15.0	16.9
$S.E._M$	1.0	0.08	0.02

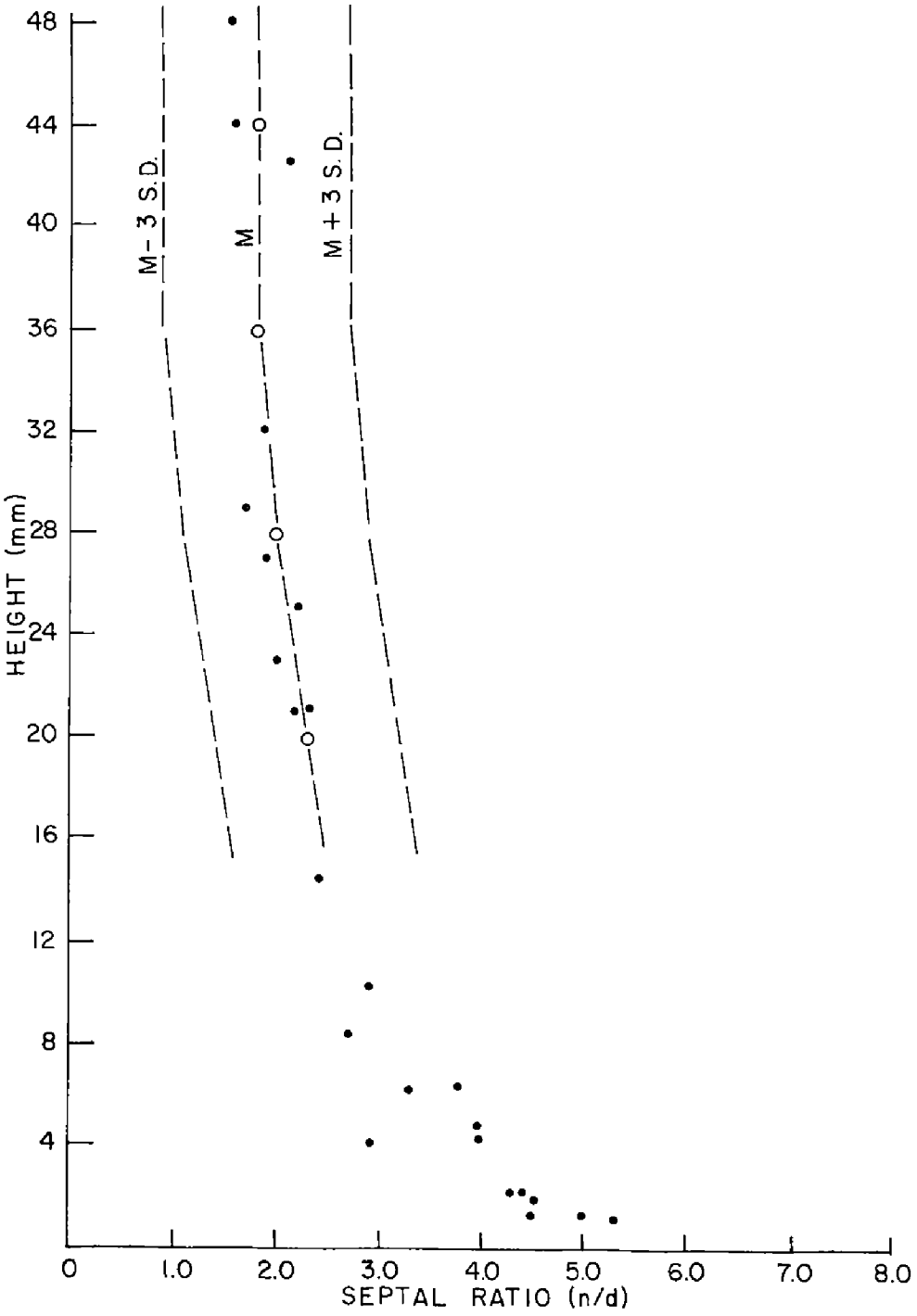


Figure 11. Relationship of height to septal ratio (n/d) in *Koninckophyllum oklahomense*, based upon specimens from all localities. Circles indicate mean values (M) for n/d, computed by classes (class intervals, 8 mm). Outer lines indicate expected limits of variability in n/d (based upon 3 standard deviations) for all stages of growth at heights greater than 14 mm.

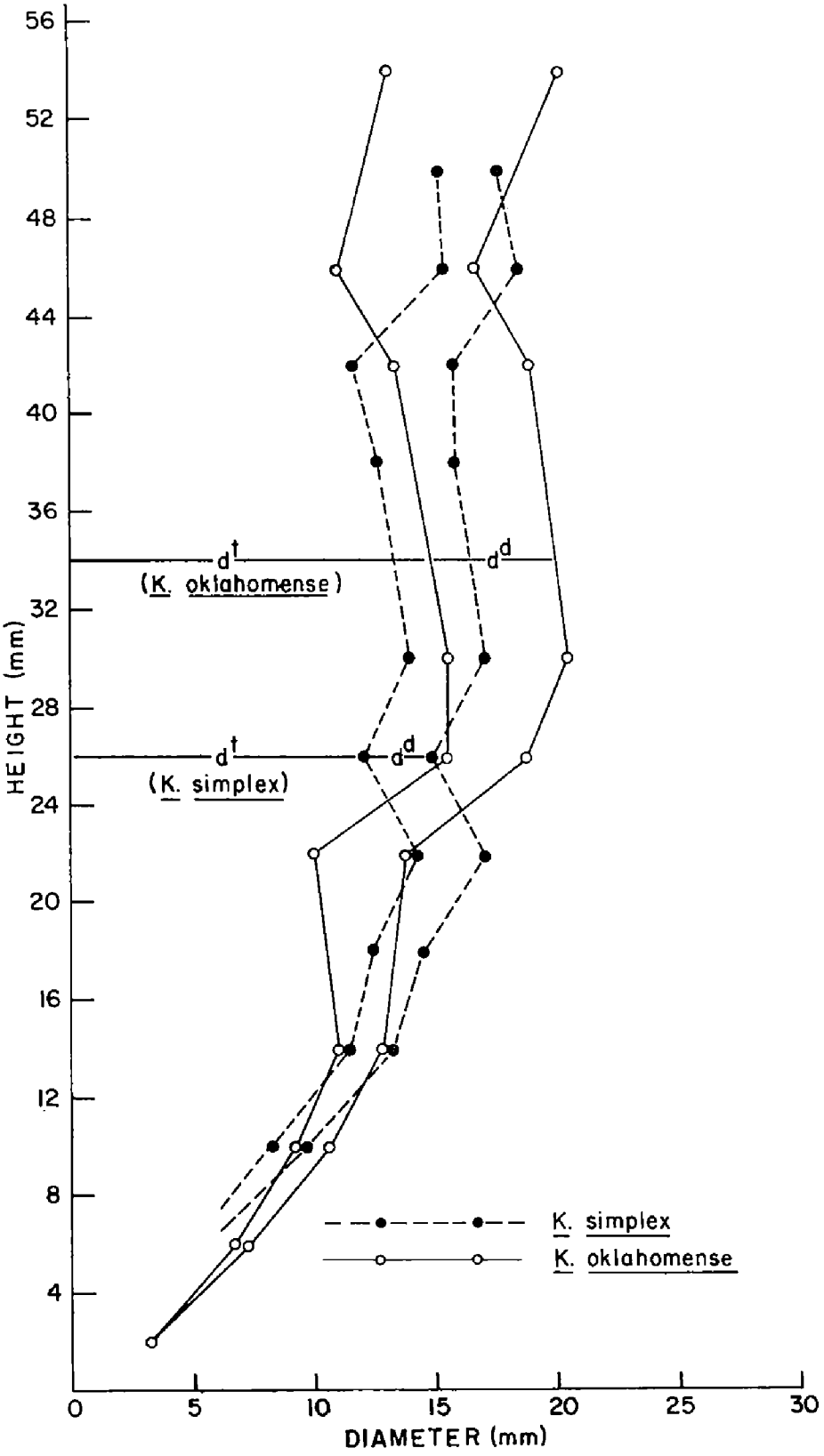


Figure 12. Comparison of tabularium diameter (d^t) and dissepimentarium diameter (d^d) in *Koninckophyllum simplex* and *Koninckophyllum oklahomense*. Points indicate mean values for d^t and d^d, computed by classes (class intervals, 4 mm) for all stages of growth in all specimens studied.

Minor septa are commonly less then 1.0 mm long and are restricted to the ephebic stages of growth.

The dissepimentarium is wide and comprises as much as one-half the radius in some corallites. Dissepiments are small and form an irregular herringbone pattern in transverse sections. From 12 to 14 irregular series of dissepiments are present in transverse sections through the ephebic growth stages. Dissepiments are inclined downward axially at from 40 to 50 degrees and number from 14 to 16 in 10 mm vertically adjacent to the epitheca. Tabulae are numerous, incomplete, and subhorizontal to slightly arched in the axial region. From 18 to 24 tabulae occur per 10 mm in the axial region.

The septa are composed of slender, irregular, monacanthine trabeculae.

Discussion.—Koninckophyllum oklahomense, new species, appears to include a single specimen described by Moore and Jeffords (1945, p. 163) as *Neokoninckophyllum* sp. A from the Marble Falls Formation of Texas. *K. oklahomense* differs from *K. simplex* in having uniformly smaller dissepiments, a relatively wider zone of dissepiments (compare tabularium ratios, tables 10 and 11, and see figure 12), and a broader, more complex axial structure. The inner wall separating the dissepimentarium and tabularium is also consistently more prominent in this new species. *K. oklahomense* and *K. simplex* occur at approximately the same stratigraphic horizon in the Wapanucka Formation but are separated geographically; *K. oklahomense* occurs only in the Arbuckle Mountains region, whereas *K. simplex* is restricted to the Ouachita exposures of the Wapanucka.

The observed variation in diameter, septal ratio, and tabularium ratio has been computed for this species (table 11).

Range and distribution.—Koninckophyllum oklahomense has been found only in the upper part of the Wapanucka Formation in the Arbuckle Mountains region. This species may also occur in the Marble Falls Formation (see *Discussion* pertaining to *Neokoninckophyllum* sp. A, Moore and Jeffords).

Material and occurrence.—Twelve specimens from localities 6-B, 17-A, 27-C, and 32.

Figured type specimens.—Holotype OU 4861 and paratype OU 4862 from locality 17-A; paratype OU 4863 from locality 27-C.

Koninckophyllum nitellus (Moore and Jeffords), 1945

Plate 9, figures 1-5

Pseudozaphrentoides nitellus Moore and Jeffords, 1945, p. 151, text-figs. 145-146.

Description.—The corallites here described are commonly solitary, small to medium, and trochoid in the lower 15 to 20 mm. Most specimens have a cylindrical upper portion, which is irregular in form and direction of curvature. Corallites uncommonly produce buds in the calice by peripheral increase, and as many as three new corallites may appear simultaneously. In one specimen two such corallites grew to adult size (pl. 9, fig. 5), but in other examples the buds are small in comparison to the protocorallite. Two specimens show a single small bud on the side of a protocorallite apparently produced by lateral budding. In these cases the protocorallite continued to grow after budding. One of these buds has an incomplete length of 15 mm and a maximum diameter of 7 mm. The epitheca is marked externally by well-developed, narrow septal grooves and interseptal ridges. Marked rejuvenescence occurs in most specimens and produces prominent transverse rugae. Some corallites show a change in the direction of growth at points of rejuvenescence (pl. 9, fig. 1a). Talons are preserved on one side of the proximal end of most corallites and extend distally in some examples as much as 8 mm. The proximal 4 to 8 mm in most specimens is produced to form one side of an attachment surface in which the talon forms the other side.

Major septa number about 12 at a diameter of 1.5 mm (septal ratio, 8.0) and increase to a maximum of 28 at a diameter of 12 mm (septal ratio, 2.3). The expected limits of variability in septal ratios in relation to height are shown in figure 13. The septal ratio is irregular in the upper cylindrical portion of corallites due to rejuvenescence. The number of major septa at the base of the calice in mature specimens typically is 24 to 28. In the ephebic stages of growth the major septa are thin and are about two-thirds the radius in length and terminate at the outer edge of the inner zone of tabulae (see discussion of tabulae, below). Major septa do not extend into the axial region in the neanic or ephebic stages. A marked radial symmetry obscures the position of the protosepta. Uncommonly one septum, presumably the cardinal septum, is slightly shortened in the late ephebic stages, but no fossula is developed.

A columella is present in the earliest growth stages in most specimens studied and may be present in all specimens. In some corallites the columella consists of a single compressed lamella, but in others it has several simple irregularly radiating lamellae. The columella disappears in most corallites within a few millimeters from the proximal end, but less commonly it extends for as much as 5 to 10 mm distally. In one incomplete specimen, 22 mm long, the columella extends throughout the full length of the specimen

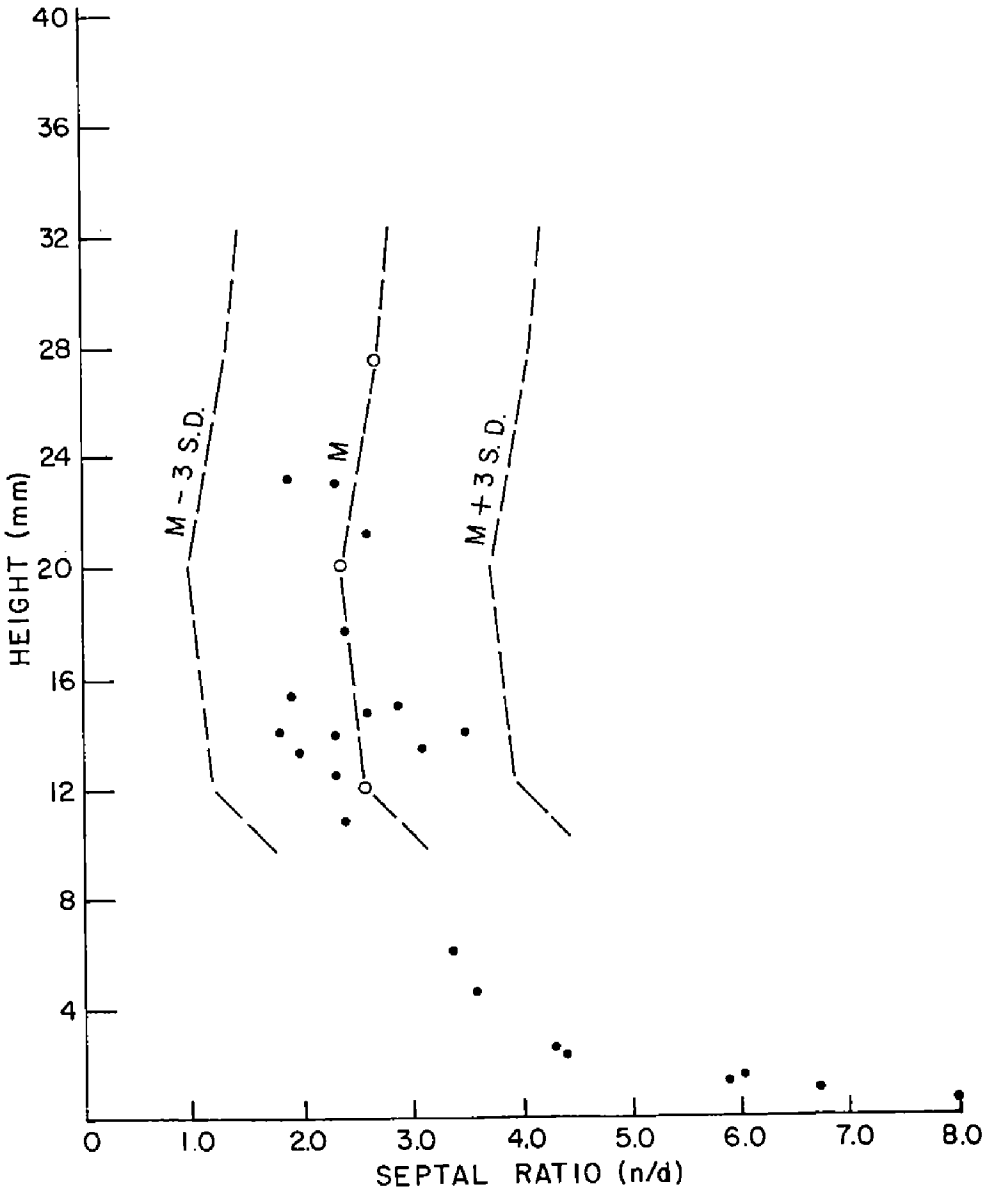


Figure 13. Relationship of height to septal ratio (n/d) in *Koninckophyllum nitellus*, based upon specimens from all localities. Mean values (M) for n/d, computed by classes (class intervals, 8 mm). Outer lines indicate expected limits of variability in n/d (based upon 3 standard deviations) for all stages of growth at heights greater than 8 mm.

(pl. 9, fig. 3) and can be seen in the calice. Minor septa are about two-thirds the length of the major septa and extend through the zone of dissepiments and into the outer zone of tabulae. Some minor septa are discontinuous in the dissepimentarium.

Three internal zones are present in this species and can be seen in transverse and longitudinal sections (pl. 9, fig. 1b, 1c): an inner tabularium, an outer tabularium, and the dissepimentarium. The inner tabularium is about one-third the total diameter in width and contains closely spaced complete and incomplete tabulae which number from 20 to 24 per 10 mm vertically. In the early stages of growth in which a columella is commonly present, these tabulae are inclined gently upward toward the columella. In the adult stages, in which the columella is rarely present, tabulae are more gently domed. Tabulae of the inner zone commonly form a broad, slightly raised boss in the floor of the calice (pl. 9, fig. 4) and clearly were deposited before the tabulae of the outer zone. The outer zone of tabulae is invariably sharply distinct from the inner zone and contains tabulae which are inclined slightly upward toward the axial region. This zone is commonly about 1 to 1.5 mm wide, and tabulae number from 24 to 28 per 10 mm vertically. The peripheral zone of dissepiments is narrow or absent near the proximal ends of corallites but increases in width throughout growth. In adult

TABLE 12.—VARIATION IN *Koninckophyllum nitellus*

All measurements taken in growth stages higher than 8 mm from proximal end.

	Diameter	*Septal Ratio*	*Tabularium Ratio*
	Locality 27-C		
N.	8	8	8
O.R.	6.3-13.0	1.8-3.5	5.1-8.4
M.	9.6	2.6	0.76
S.D.	2.02	0.50	0.06
C.V.	20.8	19.6	7.9
$S.E._M$	0.7	0.18	0.02
	All Localities		
N.	16	16	16
O.R.	6.3-14.0	1.8-3.5	5.1-8.5
M.	10.4	2.5	0.70
S.D.	2.12	0.47	0.08
C.V.	20.4	18.8	11.4
$S.E._M$	0.53	0.12	0.02

growth stages the dissepimentarium varies in width owing to rejuvenescence (pl. 9, fig. 1) and may be from one-quarter to one-third the radius in width. Individual dissepiments are variable in size but in general are small and vesicular in appearance. Dissepiments number from about 11 to as many as 18 per 10 mm vertically.

The septa are composed of closely spaced, slender, monacanthine trabeculae.

Discussion.—In the original description of *Pseudozaphrentoides nitellus* by Moore and Jeffords (1945, p. 151) it was stated that this species lacks a columella. However, the authors illustrated and described only adult stages and apparently did not examine early growth stages. Specimens from the Wapanucka Formation commonly have a columella, but they appear to be identical to Moore and Jeffords' species in all other respects. We make the assumption that a columella is present in the early growth stages of their specimens and that these corals are therefore a species of *Koninckophyllum* rather than of *Pseudozaphrentoides.*

Koninckophyllum nitellus, as here defined, is characterized by the presence of two zones of tabulae, long minor septa, an open axial region in the ephebic stages of most specimens and a discontinuous columella in the early growth stages.

Barbouria verticillata, described by Barbour (1911, p. 38) from the Upper Pennsylvanian Douglas Group in Nebraska, differs from *K. nitellus* primarily in the occurrence of several rings of numerous small lateral buds developed at various growth stages. It also has shorter minor septa. Barbour's species was described as having no columella, but the early growth stages were not studied. Restudy of Barbour's species also may show it to be a species of *Koninckophyllum.* It is similar to *K. nitellus,* particularly in the size of the corallite and the character of the tabulae and dissepiments.

The observed variation in diameter, septal ratio, and tabularium ratio has been computed for this species (table 12).

Range and distribution.—Pseudozaphrentoides nitellus was described by Moore and Jeffords (1945, p. 151) from the Hale (Bloyd?) Formation near Greenleaf Lake in northeastern Oklahoma. In the Wapanucka Formation this species is stratigraphically restricted to the upper part of the formation (*Koninckophyllum* zone) and occurs in both the Arbuckle and Ouachita regions.

Material and occurrence.—Thirty-nine specimens from localities 3-E, 3-F, 7-A, 9-C, 14-B, 17-A, 19-E, 27-C, and 32.

Genus *DIBUNOPHYLLUM* Thomson and Nicholson, 1876

Type species.—Dibunophyllum muirheadi Thomson and Nicholson, 1876; Lower Carboniferous, Scotland.

Diagnosis.—Solitary corallites with a well-developed complex axial structure typically consisting of a median plate, a series of septal lamellae, and supporting axial tabellae; less commonly the median lamella is absent and the axial lamellae are irregularly arranged. Minor septa may become discontinuous in the wide dissepimentarium.

Dibunophyllum sp. A
Plate 9, figure 6

Description.—The cylindrical portion of a single incomplete corallite here described is 18.9 mm high and has a maximum diameter of 17.0 mm. The calice and early portions are not preserved.

Major septa number 28 at a diameter of 13.0 mm (septal ratio, 2.1) and increase to 30 at a diameter of 17.0 mm (septal ration, 1.7). The major septa are thin and crooked in the dissepimentarium but thicken abrubtly at the margin of the tabularium; thereafter they taper evenly toward the axis. The cardinal and counter septa are long and are continuous with the median lamella of the axial structure. In the calice the cardinal septum is slightly shorter than adjacent major septa. Alar septa are not readily identifiable. The septal arrangement is K 8 A 5 C 5 A 8 K. Minor septa are slightly less than one-half the length of the major septa, and extend across the dissepimental zone and up to 0.5 mm into the tabularium. Minor septa are also thin and crooked in the dissepimentarium.

The axial structure is dibunophylloid and consists of a distinct medial plate with 4 to 6 irregular, radially disposed lamellae (pl. 9, fig. 6c). The septal lamellae are reinforced by numerous axial tabellae which produce a web-like axial complex, which is one-third the diameter in maximum width.

Discussion.—Dibunophyllum sp. A differs from a coral described by Moore and Jeffords, from the Marble Falls Formation in central Texas, as *Neokoninckophyllum arcuatum* (1945, p. 161) in having a more complex axial structure, a narrower dissepimentarium, and minor septa which extend into the tabularium.

Range and distribution.—A single specimen has been found in the *Koninckophyllum* zone at one locality in the upper part of the Wapanucka Formation in the Ouachita region.

Material and occurrence.—One corallite from locality 18-U.

REFERENCES

BARBOUR, E. H., 1911, A new Carboniferous coral, *Craterophyllum verticillatum*: Nebr. Geol. Survey, Pub., vol. 4, pt. 3, p. 38-49.

BARKER, J. C., 1950, The geology of a portion of the Lawrence uplift, Pontotoc County, Oklahoma: Okla., Univ., unpublished Master of Science thesis, 63 p.

BELL, W. C., 1957, Study of Lower Pennsylvanian and Mississippian rocks of the northeast Llano uplift: Abilene Geol. Soc. and Fort Worth Geol. Soc., Guidebook, Field Trip, Oct. 25-26, p. 1-45.

BURMA, B. J., 1948, Studies in quantitative paleontology: I. Some aspects of the theory and practice of quantitative invertebrate paleontology: Jour. Paleontology, vol. 22, p. 725-761.

CHILINGAR, G. V., 1956, Review: About dynamics of septal development in tetracorals during ontogeny, by K. G. Voynovskiy-Kriger: Jour. Paleontology, vol. 30, p. 406-411.

CLINE, L. M., 1960, Late Paleozoic rocks of the Ouachita Mountains, Oklahoma: Okla. Geol. Survey, Bull. 85, 113 p.

FOLK, R. L., 1959, Practical petrographic classification of limestones: Amer. Assoc. Petroleum Geologists, Bull., vol. 43, p. 1-38.

HARLTON, B. H., 1934, Carboniferous stratigraphy of the Ouachitas—A special study of the Bendian: Amer. Assoc. Petroleum Geologists, Bull., vol. 18, p. 1018-1049.

_____1938, Stratigraphy of the Bendian of the Oklahoma salient of the Ouachita Mountains: Amer. Assoc. Petroleum Geologists, Bull., vol. 22, p. 852-914.

HILL, DOROTHY, 1938-1941, Carboniferous rugose corals of Scotland: Palaeontographical Society [London], Mon., 231 p.

_____1956, Rugosa, *in* Coelenterata, pt. F. *of* Treatise on invertebrate paleontology, Moore, R. C., ed.: Geol. Soc. America and Univ. Kans. Press, p. 233-323.

HOLLINGSWORTH, R. V., 1933, The Union Valley sandstone member of the Wapanucka formation: Okla., Univ., unpublished Master of Science thesis, 118 p.

HUFFMAN, G. G., 1958, Geology of the [south and west] flanks of the Ozark uplift, northeast Oklahoma: Okla. Geol. Survey, Bull. 77, 281 p., 6 maps.

IMBRIE, JOHN, 1956, Biometrical methods in the study of invertebrate fossils: Amer. Museum Nat. History, Bull., vol. 108, art. 2, p. 217-252.

INGRAM, R. L., 1954, Terminology for the thickness of stratification and parting in sedimentary rocks: Geol. Soc. America, Bull., vol. 65, p. 937-938.

JEFFORDS, R. M., 1942, Lophophyllid corals from Lower Pennsylvanian rocks in Kansas and Oklahoma: Kans., State Geol. Survey, Bull. 41, pt. 5, p. 185-260.

_____1947, Pennsylvanian lophophyllidid corals: Kans., Univ., Paleont. Contr. [No. 1], Coelenterata, art. 1, 84 p.

KUHLEMAN, M. H., 1948, Mississippian and Lower Pennsylvanian stratigraphy of portions of Stonewall and Atoka quadrangles, Oklahoma: Okla., Univ., unpublished Master of Science thesis, 52 p.

MATHER, K. F., 1915, The fauna of the Morrow Group of Arkansas and Oklahoma: Denison Univ., Bull., Jour., Sci. Labs., vol. 18, p. 59-284.

MCKEE, E. D., and WIER, G. W., 1953, Terminology for stratification and cross-stratification in sedimentary rocks: Geol. Soc. America, Bull., vol. 64, p. 381-389.

MOORE, R. C., and JEFFORDS, R. M., 1941, New Permian corals from Kansas, Oklahoma and Texas: Kans., State Geol. Survey, Bull. 38, pt. 3, p. 65-120.

_____1945, Description of Lower Pennsylvanian corals from Texas and adjacent states, *in* Contributions to geology, 1944: Texas, Univ., Pub. 4401, p. 77-208.

MOORE, R. C., HILL, DOROTHY, and WELLS, J. W., 1956, Glossary of morphological terms applied to corals, *in* Coelenterata, Pt. F *of* Moore, R. C., ed., Treatise on invertebrate paleontology: Geol. Soc. America and Univ. Kans. Press, p. 245-251.

MORGAN, G. D., 1924, Geology of the Stonewall quadrangle, Oklahoma: Bur. Geol. [Okla.], Bull. 2, 248 p.

OLIVER, W. A., 1960, Rugose corals from reef limestones in the Lower Devonian of New York: Jour. Paleontology, vol. 34, p. 59-100.

PLUMMER, F. B., 1945, Stratigraphy of the Lower Pennsylvanian coral-bearing strata of Texas, *in* Contributions to geology, 1944: Texas, Univ., Pub. 4401, p. 64-76.

ROSS, C. A., and ROSS, J. P., 1962, Pennsylvanian, Permian rugose corals, Glass Mountains, Texas: Jour. Paleontology, vol. 36, p. 1163-1188.

ROWETT, C. L., 1959, Petrographic description of the Wapanucka limestone at Limestone Gap, Atoka County, Oklahoma: Tulane Univ., unpublished Master of Science thesis, 76 p.

_____1962, Biostratigraphic interpretation and coral fauna of the Wapanucka Formation of Oklahoma: Okla., Univ., unpublished doctoral dissertation, 287 p.

———1963a, Wapanucka-Atoka contact in the eastern and northeastern Arbuckle Mountains, Oklahoma: Okla. Geol. Survey, Okla. Geology Notes, vol. 23, p. 30-48.

———1963b, History of deposition during Morrow time (Early Pennsylvanian), eastern Arbuckle Mountains, Oklahoma, abs., *in* Abstracts for 1962: Geol. Soc. America, [Spec. Paper 73], p. 230-231.

ROZKOWSKA, MARIA, 1957, Considerations on Middle and Upper Devonian Thamnophillidae Soshkina in Poland, Pt. II: Acta Palaeont. Polonica, vol. 2, p. 81-153.

SIMPSON, G. G., ROE, ANNE, and LEWONTIN, R. C., 1960, Quantitative zoology, revised ed.: New York, Harcourt, Brace and Company, 440 p.

SUTHERLAND, P. K., 1958, Carboniferous stratigraphy and rugose coral faunas of northeastern British Columbia: Canada, Geol. Survey, Mem. 295, 177 p.

TAFF, J. A., 1901, Description of the Coalgate quadrangle [Indian Terr.]: U. S. Geol. Survey, Geol. Atlas, Folio 74, 6 p., maps.

WALLIS, B. F., 1915, The geology and economic value of the Wapanucka limestone of Oklahoma, with notes on the economic value of adjacent formations: Okla. Geol. Survey, Bull. 23, 102 p.

APPENDIX I

Stratigraphic Sections

Introduction.—In these descriptions of stratigraphic sections in the Wapanucka Formation, localities are designated by numbers and lithic units are designated by letters; thus, 18-U indicates locality 18 and lithic unit "U". A unit, as here used, implies a distinct bed or series of beds that can be distinguished in the field from overlying and underlying units; it may be of any thickness.

In the description of bedding we have followed the classification of McKee and Wier (1953) as modified by Ingram (1954), as follows:

description	*bedding*
massive bedding	no visible bedding
very thick bedded	over three feet
thick bedded	from one to three feet
medium bedded	from four to twelve inches
thin bedded	from one to four inches
laminated	less than one inch

In many cases field descriptions are supplemented with petrographic descriptions based on thin-section study. Thin-section numbers indicate the distance (in feet) above the base of the unit at which the rock was sampled. Because thin sections show only a small part of the rock, the petrographic description does not always correspond to the description of the gross lithology of the unit. The classification of carbonate rocks proposed by Folk (1959) is followed.

The sections are arranged in numerical order according to their designations. The sections in the Arbuckle Mountains area are numbered 1-10, 12, 14-17, 24-29, 31, and 32. The locations of most of the Arbuckle Mountains localities are shown on figure 1. The Ouachita Mountains localities are numbered 18-21 and 23.

Locality 1

Description of locality: This locality is within 100 yards of the northwestern extremity of the outcrop of the Wapanucka Formation. Exposures of the lower part of the Wapanucka Formation here form a low tree-covered strike ridge in the NE¼ SW¼ sec. 6, T. 1 N., R. 7 E., Pontotoc County, Oklahoma.

Exposures are poor and only a partial section could be measured. Strike ranges from N40°W to N65°W. The dip of the strata is also variable, ranging from 35° to 45°N. The section is overlain by deeply weathered unfossiliferous calcareous sandstones, tentatively assigned to the lower part of the Atoka Formation and underlain by shales of the Springer Formation.

This area corresponds to a locality described by Morgan (1924, loc. 19). Section measured by C. L. Rowett, November 8, 1959.

Unit	Description	Thickness (feet)
Wapanucka Formation:		
B	Shale and limestone, interbedded: shale, calcareous, gray, unfossiliferous; interbedded with thin (1 to 4 inches) calcareous and arenaceous limestone, locally conglomeratic. Thickness approximate. *Remarks*: These strata are unconformably overlain by calcareous sandstones of the Atoka Formation. The contact is abrupt and slightly undulatory.	16.0
A	Limestone, fossiliferous, fine-crystalline; tan to brown on fresh and weathered surfaces; bedding, thin, regular. Base not exposed. *Petrographic description*: A - 1: Silty brachiopod biomicrosparrudite and biomicrudite	2.0
	Total thickness of exposures:	18.0

LOCALITY 2

Description of locality: Fossiliferous limestones of the middle part of the Wapanucka Formation are exposed approximately 200 yards south and 30 yards east of NW cor. sec. 8, T. 1 N., R. 7 E., Pontotoc County, Oklahoma.

Exposures are poor, and only one lithologic unit is recognizable. These strata appear to be underlain by shales and thin limestones, but the lower part of the section is mostly covered. The strike is N60°W; the dip is variable, from 10° to 15°N.

This locality was listed by Morgan (1924, loc. 41) and by Kuhleman (1948, loc. 9). Section measured and described for this study by C. L. Rowett, November 8, 1959.

Unit	Description	Thickness (feet)
Wapanucka Formation:		
A	Limestone, partly oölitic, medium- to coarse-crystalline, tan; weathers tan to yellow brown; bedding, thin to medium, regular; fossiliferous. Base covered. *Petrographic description*: A - 1: Oölitic biosparrudite	5.0
	Total thickness of exposures:	5.0

LOCALITY 3

Description of locality: This locality was described by Morgan (1924, p. 57) and fossils were subsequently collected here by Kuhleman (1948, locs. 10, 11). The section is well exposed and is highly fossiliferous.

The exposures are in NE¼ NW¼ SE¼ sec. 8, T. 1 N., R. 7 E., Pontotoc County, Oklahoma. The Wapanucka Formation and the overlying strata of the Atoka Formation are exposed in the bed and banks of Canyon Creek. The strata dip 35° to 40°NE and strike N70°W. Section measured by C. L. Rowett and D. M. Strong, August 8, 1960.

Unit	Description	Thickness (feet)
Wapanucka Formation:		
F	Limestone and brachiopod coquina: limestone, arenaceous, medium-crystalline, tan; weathers buff to yellow brown; bedding, thin, irregular; fossils dominantly brachiopod valves. *Remarks*: Unit F forms a series of ledges which overhang the creek bed. Thickness of the unit varies, owing to the irregular contact with the basal sandstones and shales of the Atoka Formation. The upper beds are oxidized to a depth of several inches and are deep red to maroon. Shell coquina consists primarily of crushed and disarticulated brachiopod valves. Coral species: *Koninckophyllum nitellus.* *Petrographic description*: F - 10: Oölitic biosparrudite	10.0
E	Shale, calcareous, blue to dark-gray, mostly covered. Fossiliferous in lower part. Coral species: *Koninckophyllum nitellus.*	55.0
D	Limestone, fossiliferous, medium- to coarse-crystalline, light-tan; weathers tan to brown; bedding, thick, regular. Coral species: *Lophophyllidium idonium.* *Petrographic description*: D - 4: Fossiliferous oösparrudite	4.5
C	Shale, dark-gray to black, fissile; unfossiliferous except in upper part. Coral species: *Barytichisma callosum.*	65.5
B	Limestone, oölitic, fine- to medium-crystalline; gray on fresh surfaces; weathers gray to white; bedding, thick, regular.	2.5

A	Shale, calcareous, blue to gray, highly fossiliferous. Base not exposed. *Remarks*: About 200 square feet of the shale is exposed above the water level of Canyon Creek and forms a low bank on the north side of the creek. The shale is alternately clayey and calcareous. The calcareous zones are highly fossiliferous. The fauna is dominated by spiriferoid and productid brachiopods but includes pelecypods, cephalopods, gastropods, solitary corals, blastoids, and crinoids. The crinoid fauna is especially noteworthy for its variety. Coral species: *Leonardophyllum morrowense.*	43.5
	Total thickness of exposures:	181.0

LOCALITY 4

Description of locality: Exposures at this locality are limited to the lower part of the Wapanucka Formation. The section is complicated by faulting. Exposures occur in the northeast side of the ridge formed by the formation in a small knoll. Strata dip 38°N at the eastern extremity of the exposures but are vertical to slightly overturned about 50 yards to the west. At the western extremity, the steeply dipping strata are in fault contact with Atokan sandstones. The Wapanucka ridge terminates here and does not reappear for a distance of almost one mile to the southeast.

These exposures are in NE¼ SE¼ SE¼ sec. 8, T. 1 N., R. 7 E., Pontotoc County, Oklahoma. This locality was first described by Morgan (1924, loc. 28). The exposures occur near the west bank of a tributary of Canyon Creek, which enters the section at the SE corner. Section measured by C. L. Rowett and D. M. Strong, August 9, 1960.

Unit	Description	Thickness (feet)
Wapanucka Formation:		
B	Limestone, oölitic, fine- to medium-crystalline, tan to blue; weathers tan to brown; bedding, thin, irregular. *Petrographic description*: B - 1: *Millerella* biomicrosparrudite B - 2: Oölitic, pelletiferous biomicrosparrudite	2.0
A	Shale, gray to brown, clayey, highly fossiliferous. Base not exposed. *Remarks*: This shale is exposed over a large area, which is partly overgrown. The brachiopod, coral,	

	and crinoid faunas correspond closely to those of the basal shale at Canyon Creek. Coral species: *Lophophyllidium idonium, L. minutum, L.* cf. *L. angustifolium, L.* sp. *A, Leonardophyllum morrowense, Amplexizaphrentis* cf. *A. tumida, Barytichisma callosum.*	43.0
	Total thickness of exposures:	45.0

LOCALITY 5

Description of locality: The Wapanucka Formation forms a narrow prominent ridge in this area, which trends eastward across the N½ SW¼ sec. 34, T. 1 S., R. 8 E., about 2.5 miles northeast of Bromide in Coal County, Oklahoma. Strata strike N90°E and dip from 20° to 25°S, toward the axis of the Wapanucka syncline. The best exposures are along the south bank of Moseley Creek; the section was measured from the bed of this creek southward across the ridge, in the north-central part of NE¼ SW¼ sec. 34.

Kuhleman (1948, p. 33) recorded a measured section in the Wapanucka about a quarter of a mile east of this locality. The section was measured for the present study by C. L. Rowett and D. E. Waddell, September 9, 1961.

Unit	Description	Thickness (feet)
	Base of Atoka Formation:	
D	Limestone conglomerate; clasts of pebble to cobble size; thin sections of this unit indicate that many of the clasts are composed of oölites which were derived from the underlying Wapanucka Formation (unit B). This unit is overlain by a thick section of unfossiliferous concretionary shale.	3.5
	Wapanucka Formation:	
C	Limestone, glauconitic, locally oölitic, gray-green; weathers gray to brown; bedding, thin, irregular; locally cross-bedded. *Remarks*: This unit varies in composition and appearance along strike. A quarter of a mile to the east, it contains oölitic intraclasts and is moderately glauconitic; at the present locality, glauconite is abundant, and cross-bedding is well developed. Thickness ranges along strike from 3.0 to 3.5 feet. These beds are unconformably overlain by basal conglomerates of the Atoka Formation.	3.5
B	Limestone, oölitic, fine- to medium-crystalline, light gray; weathers dark gray to brown; bedding, thick	

	to massive; extensively veined and jointed; unfossiliferous where examined; mostly covered and slumped. *Petrographic description*: B - 1: Oösparite	71.0
A	Limestone, fine- to medium-crystalline, dark blue-gray; weathers pink to brown; bedding medium, regular; sparsely fossiliferous. *Remarks*: The lower part of these strata is exposed in the bed of Moseley Creek. Locally it is underlain by unfossiliferous gray-green shales of undetermined age. *Petrographic description*: A - 1: Spicular biosparite	15.0
	Total thickness (Wapanucka Formation only):	89.5

LOCALITY 6

Description of locality: Middle part of the Wapanucka Formation, SE¼ SE¼ sec. 15, T. 1 N., R. 7 E. Exposures are in the southwest side of a ridge, about 2 miles south and 1 mile west of Jessie, Pontotoc County, Oklahoma. The strike is N45°W and the dip is 30° to 35°N. The exposures are about 200 yards southeast of the point where Coal Creek crosses the ridge.

Fossils were collected in this area by Kuhleman (1948, loc. 15).

Section measured by C. L. Rowett and D. M. Strong, August 10, 1960.

Unit	Description	Thickness (feet)
Wapanucka Formation:		
C	Limestone, oölitic, argillaceous, yellow; weathers yellow to white; bedding, thin, regular; fossiliferous. *Remarks*: These beds are exposed at the top of the knoll and dip to the north; about 30 feet northward, brown ferruginous sandstones occur that are typical of the basal part of the Atoka Formation. The contact is covered.	4.0
B	Limestone, medium-crystalline, tan; weathers yellow brown; bedding, thin to medium, regular; fossiliferous. Coral species: *Koninckophyllum oklahomense.*	5.0
A	Shale, brown to gray, deeply leached, unfossiliferous. *Remarks*: This shale forms a gentle overgrown	

slope which grades imperceptibly into the valley formed in the underlying Springer and Caney Shales. Fossils which occur on this surface were derived from the overlying unit. 10.0

Total thickness of exposures: 19.0

LOCALITY 7

Description of locality: An undetermined part of the Wapanucka Formation is exposed in the bed of a small creek and in a low hill, NE¼ NE¼ sec. 33, T. 3 N., R. 7 E., Pontotoc County, Oklahoma.

This locality was listed by Morgan (1924, loc. 170-A), Hollingsworth (1933, loc. 8), and Barker (1950, locs. 28-A and 28-B), but the section here had not previously been measured.

These exposures occur about ten miles north of the main exposures of the Wapanucka Formation in southeastern Pontotoc County, and are separated from them by a major structural feature, the Franks graben. They occur at the east margin of the Lawrence uplift. In this area the Wapanucka is only slightly more resistant to erosion than the overlying shales of the Boggy Formation and the underlying Union Valley Formation, and exposures are consequently poor. An upper limestone forms a low, sinuous ridge, which begins near Stonewall (sec. 2, T. 2 N., R. 7 E.) and terminates near Union Valley (sec. 33, T. 3 N., R. 7 E.). The ridge has a relief of 20 feet or less and is mostly overgrown. Strata strike N45°W and dip 10° to 15°E.

Section measured by C. L. Rowett, August 11, 1960.

Unit	Description	Thickness (feet)
	Wapanucka Formation:	
C	Limestone, fossiliferous, medium-crystalline, tan to blue; weathers yellow brown; bedding, thin to medium; mostly covered. *Remarks*: These beds form the crest of a small knoll 150 yards south of the creek, where only the upper three feet is well exposed; below this horizon, the unit is mostly covered and only a few ledges crop out. Brachiopods, bryozoans, cephalopods, and casts of scyphozoan medusae are common. Thickness approximate.	20.0
B	Shale, calcareous, gray, platy to nodular; silty to sandy in part; unfossiliferous. *Remarks*: The lower 12 feet of this shale is exposed in the south bank of the creek. Casts of scyphozoan medusae occur throughout the unit. Thickness approximate.	37.0

A	Limestone and shale: limestone, medium-crystalline, gray; weathers tan; bedding, thin, irregular; moderately fossiliferous; interbedded with thin shales. Base not exposed. *Remarks*: These beds form ledges in the bed of the creek. The contact with the overlying shale is abrupt. Fossils include small goniatite cephalopods, corals, brachiopods, crinoids, and blastoids. Coral species: *Koninckophyllum nitellus.* *Petrographic description*: A - 1: Fossiliferous oösparite	4.0
	Total thickness of exposures:	61.0

LOCALITY 8

Description of locality: An undetermined part of the Wapanucka Formation forms a hill in the NE¼ SE¼ SW¼ sec. 34, T. 3 N., R. 7 E., Pontotoc County, Oklahoma. This locality, as does loc. 7, lies north of the Franks graben, at the east margin of the Lawrence uplift.

Strata dip 0° to 15°E; strike is N40°W. The section was measured from the edge of a small stock tank eastward to the crest of the hill, by C. L. Rowett and D. M. Strong, August 15, 1960.

Unit	Description	Thickness (feet)
Wapanucka Formation:		
B	Limestone and shale: limestone, fine- to medium-crystalline, tan; weathers brown to maroon; bedding, thin to medium, regular; interbedded with shales 1 to 2 feet thick; mostly covered.	71.5
A	Shale and siltstone: shale calcareous, blue-gray, unfossiliferous; interbedded with thin (1 to 2 inch) layers of tan siltstone. Base not exposed. *Remarks*: The siltstone layers within this unit are oxidized to deep shades of maroon and red; they contain numerous internal molds of goniatite cephalopods, which are typically compressed and not identifiable. The base of the unit is not exposed.	16.5
	Total thickness of exposures:	88.0

LOCALITY 9

Description of locality: A sinuous ridge is formed by the Wapanucka Formation about two miles east of Clarita, Oklahoma. Dips are

15° or less to the east, and the ridge consequently is low and broad in this area. Contacts with the underlying Springer Formation and overlying Atoka Formation are not exposed. Section measured in SW¼ NE¼ sec. 18, T. 1 S., R. 9 E., by C. L. Rowett and D. M. Strong, August 16, 1960.

Unit	Description	Thickness (feet)
	Wapanucka Formation:	
D	Limestone, oölitic, gray to white; weathers white; bedding, thin to medium in lower part; thick in upper part; regular throughout. *Remarks*: This unit forms the crest and dip slope of the ridge. It is fossiliferous in the lower part, where brachiopods and cephalopods are common, but becomes thick bedded and less fossiliferous in the upper part. Thickness calculated.	20.0
C	Shale and limestone: shale, calcareous, gray-green, concretionary; interbedded with a few ledge-forming limestones in upper part; fossiliferous throughout. *Remarks*: Complete crinoid crowns (*Delocrinus*) have been collected from this shale; other fossils include spiriferoid brachiopods and solitary rugose corals. Coral species: *Koninckophyllum nitellus.*	30.0
B	Limestone, medium- to coarse-crystalline, tan; weathers brown; bedding, thin to medium, irregular; sparsely fossiliferous throughout. *Remarks*: A broad terrace is formed by this unit and exposures are poor. Coral species: *Barytichisma callosum.*	10.0
A	Shale and limestone, interbedded: shale, gray, fissile, unfossiliferous; interbedded with thin (2 to 6 inch) limestone layers which form small ledges; sparsely fossiliferous. Mostly covered; base not exposed.	50.0
	Total thickness of exposures:	110.0

LOCALITY 10

Description of locality: No section was measured at this locality, but the exposures are lateral equivalents of units B and C at locality 9, about half a mile to the south. These limestones and shales contain a similar fauna and are exposed in the center of the NW¼ NE¼ sec. 7, T. 1 S., R. 9 E., Coal County, Oklahoma.

LOCALITY 12

Description of locality: A low ridge is formed by the Wapanucka Formation where it crosses the SE¼ SE¼ sec. 3, T. 1 S., R. 8 E., Coal County, Oklahoma. Strata dip 10° and strike N88°W. The contact with the Atoka Formation is not exposed, but unit C can be traced eastward a short distance to the section road between sections 2 and 3 of this township, where it is overlain by thin-bedded sandstones and shales of the Atoka Formation which contain *Fusulinella prolifica*.

A measured section in the Wapanucka Formation was described by Wallis (1915, p. 50). This locality was also recorded by Kuhleman (1948, loc. 29), who did not describe the section. Section measured for this study by C. L. Rowett and D. M. Strong, August 16, 1960.

Unit	Description	Thickness (feet)
	Wapanucka Formation:	
C	Limestone, oölitic, fine- to medium-crystalline, gray to white; weathers gray; bedding, thick, regular; sparsely fossiliferous. *Petrographic description*: C - 15: Oölitic biosparite	16.0
B	Limestone, cherty, fine- to medium-crystalline, blue to gray; weathers gray; bedding medium to thick, slightly irregular; interbedded with nodules and stringers of dark-blue chert, which weather to irregular masses; unfossiliferous.	51.0
A	Shale, calcareous, brown; locally oxidized to yellow brown and red; interbedded with thin-bedded ledge-forming silty limestone; tan on fresh and weathered surfaces; sparsely fossiliferous. Base not exposed. *Petrographic description*: A - 7: Silty biomicrosparrudite	7.0
	Total thickness of exposures:	74.0

LOCALITY 14

Description of locality: The ridge formed by the Wapanucka Formation at this locality stands an estimated 70 to 80 feet above the broad valley to the west. Dips are low, averaging 10°E, and consequently the ridge is almost three-quarters of a mile across. Strata strike N10°E. The crest of the ridge is formed by a resistant limestone (unit B) which occurs lower in the section exposed at locality 9, about half a mile to the northeast. Fossils were collected at this

locality by Kuhleman, (1948, loc. 36). The section was measured from the foot of the ridge westward across the ridge, parallel to and about 20 yards south of the section-line fence marking the north line of the NW¼ of this section (sec. 19, T. 1 S., R. 9 E., Coal County, Oklahoma). Section measured by C. L. Rowett and D. E. Duggan, November 26, 1961.

Unit	Description	Thickness (feet)
Wapanucka Formation:		
D	Limestone, oölitic, fossiliferous, gray to white; weathers white; bedding, thin to medium, regular. *Remarks*: These beds are well exposed only in the dip slope and as isolated ledges near the crest of the ridge. The upper portion of this oölitic limestone is not fossiliferous, but a few fossils occur in the lower part. The contact with the overlying Atoka Formation is covered at or near the base of the dip slope. Thickness calculated.	20.0
C	Shale, calcareous, gray-green, concretionary, fossiliferous. *Remarks*: These shales contain large well-preserved spiriferoid brachiopods. The contact with the overlying oölite is regular. Limonite concretions are common. Thickness calculated.	33.0
B	Limestone, medium- to coarse-crystalline, blue-gray; weathers tan to gray; bedding, thin, irregular; contains shaly zones which are fossiliferous. *Remarks*: Fossils include several crinoid, coral, and brachiopod species. Coral species: *Koninckophyllum nitellus.*	9.5
A	Shale and limestone, interbedded: talus and soil cover most of this unit; thickness, calculated and approximate. Unfossiliferous where examined.	50.0
	Total thickness of exposures:	112.5

LOCALITY 15

Description of locality: Excellent exposures of the upper oölitic portion of the Wapanucka Formation occur in two large abandoned limestone quarries and along a railroad cut, SE¼ SW¼ and SW¼ SE¼ sec. 4, T. 2 S., R. 8 E., Johnston County, Oklahoma. Delaware Creek cuts the ridge formed by the Wapanucka along the south line of this section and is parallel to the railroad for about half a mile.

Strata forming this ridge are part of the south limb of the Wapanucka syncline. The beds strike N40°W and dip 5° to 15°NE, toward the axis of the syncline.

This section was measured and described by Wallis (1915, p. 46). The section was measured in the quarry and along the railroad cut by C. L. Rowett and D. M. Strong, August 18, 1960.

Unit	Description	Thickness (feet)
	Basal Atoka Formation:	
D	Limestone conglomerate; gray, tan, and blue-gray on fresh and weathered surfaces; composed of subangular to angular limestone clasts of pebble to cobble size, in part oölitic; interbedded with lenticular zones of cross-bedded fossil debris; pyrite crystals common throughout matrix. *Remarks*: This conglomerate is exposed about 500 yards east of the main quarry, on the north and south sides of Delaware Creek. The lateral distribution of the conglomerate seems limited. About 50 yards east of the exposures on the north side of the creek outcrops of thin ferruginous sandstones and concretionary shales typical of the lower part of the Atoka Formation are present. The contact of the conglomerate with the Wapanucka Formation is poorly exposed. Petrographic study (thin sections D-1, D-2) of the conglomerate indicates that this conglomerate was derived from erosion of the underlying Wapanucka Formation.	2.5
	Wapanucka Formation:	
C	Limestone, fine- to medium-crystalline, tan to dark-blue; weathers brown; bedding, thin to medium, irregular in upper part; sparsely fossiliferous.	22.0
B	Limestone and chert: limestone, fine- to medium-crystalline, tan; weathers tan to yellow-brown; bedding, thin, regular; interbedded with thin cherty layers; upper surfaces leached. *Remarks*: Units B, C, and D are local in their distribution, and correlative beds have not been recognized elsewhere.	5.5
A	Limestone, oölitic, white; weathers gray; bedding, thick to massive, lenticular; torrential cross-bedding; sparsely fossiliferous. *Remarks*: This thick oölitic unit is exposed in a large abandoned quarry at the crest of the ridge	

and in a smaller quarry about 30 feet east from the main quarry. In the main quarry, the beds are distinctly lenticular and thicken rapidly to the southeast. The rock is white and deeply leached. In the smaller quarry cross-bedding of the oölites is emphasized by weathering.

Talus and large slump blocks cover the base of the oölite at this locality, but it is believed to rest unconformably on shales of the Springer Formation. At a distance of about 200 yards northwest from the main quarry the oölite disappears entirely at the crest of the ridge. To the southeast, the oölite thins to a minimum of about 3 feet, locally thickening to 10 or 15 feet in small depressions which differ from those at Delaware Creek only in size. A similar deposit of the oölite also occurs at the crest of the ridge about half a mile to the northwest from Delaware Creek (loc. 28, this report). The oölite is fossiliferous throughout and contains cephalopods, bryozoans, gastropods, and brachiopods.

Petrographic descriptions:

A - 20: Oösparite

A - 70: Oösparite

Thickness of oölite (base not exposed):	72.0
Total thickness (Wapanucka Formation only):	99.5

LOCALITY 16

Description of locality: Exposures of the Wapanucka Formation occur at this locality in bluffs facing the east side of a small reservoir formed by Sulfur Creek, about 1.4 miles west of Wapanucka, Johnston County, Oklahoma. Strata dip from 25° to 30°NE; the strike is variable, as the ridge shifts from a generally eastward to a northward trend.

This section was measured and described by Wallis (1915, p. 46). The section was measured for the present study from the edge of the spillway eastward to the crest of the ridge in the NE¼ NW¼ sec. 22, T. 2 S., R. 8 E., by C. L. Rowett and D. M. Strong, August 20, 1960.

Unit	Description	Thickness (feet)
Wapanucka Formation:		
I	Limestone, oölitic, light-gray; weathers white; bedding, thick, irregular; fossiliferous. *Remarks*: These oölitic beds form the dip slope of the ridge, and are undulatory on the upper surfaces owing to solution. They rest with apparent unconformity on the underlying limestone unit and are	

overlain by the Atoka Formation at the foot of the dip slope. Thickness calculated.

Petrographic description:

I - 1: Fossiliferous oösparite and biosparrudite, zoned.

5.5

H Limestone, medium-crystalline, tan; weathers tan to gray; bedding, thick, regular; contains nodules and stringers of dark-blue chert; unfossiliferous. Partly covered.

30.5

G Limestone, medium- to coarse-crystalline, gray; weathers blue-gray; bedding, thick, regular; unfossiliferous.

4.0

F Limestone and shale, interbedded: limestone, medium- to coarse-crystalline, tan; weathers tan to gray; bedding, thick, regular; interbedded with shales of approximately equal thickness; both shales and limestones unfossiliferous.

Petrographic description:

F - 1: Biomicrosparite

17.0

E Limestone, medium- to coarse-crystalline, blue; weathers gray; bedding, thin to medium, regular; sparsely fossiliferous.

2.5

D Shale and limestone, interbedded: shale, calcareous, yellow-brown, abundantly fossiliferous; interbedded with thin discontinuous layers of cherty limestone; highly fossiliferous. Coral species: *Lophophyllidium idonium, L.* sp. B, *Amplexizaphrentis* aff. *A. crassiseptata.*

9.0

C Limestone, arenaceous, tan; weathers yellow brown; bedding, medium, regular; unfossiliferous.

2.0

B Limestone, fine- to medium-crystalline, blue-gray; weathers tan; bedding, thin, regular; fossiliferous in lower part (mostly crinoid parts).

2.0

A Shale and limestone, interbedded; limestone, medium- to coarse-crystalline, blue; weathers yellow brown; bedding, thin, lenticular; interbedded with thin lenticular blue-gray shales; fossiliferous. Base not exposed.

5.5

Total thickness of exposures: 88.0

LOCALITY 17

Description of locality: The upper part of the Wapanucka Formation forms a narrow ridge in this area which crosses the NE¼ NE¼ sec. 30, T. 1 N., R. 8 E., Coal County, Oklahoma. Strata dip 19°N and strike N20°W. Section measured in the bed and along the banks of the creek by C. L. Rowett and D. M. Strong, August 19, 1960.

Unit	Description	Thickness (feet)
Basal Atoka Formation:		
C	Limestone conglomerate, tan; weathers dark gray to brown; bedding, thick irregular; sparsely fossiliferous. *Remarks*: The lower part of these beds contains thin shale lenses and reworked fossil debris; they are overlain by ferruginous red-brown sandstones of the lower Atoka Formation. The lower contact appears to be regular at this locality.	24.0
Wapanucka Formation:		
B	Limestone, oölitic, gray to white; weathers white; bedding thin to medium, regular; sparsely fossiliferous in lower part. *Petrographic description*: B - 2: Fossiliferous oösparite	19.0
A	Limestone, medium-crystalline, tan to gray; weathers gray to blue gray; bedding, medium to thick, regular; partly covered. Base not exposed. Coral species: *Koninckophyllum oklahomense, K. nitellus.* *Petrographic description*: A - 10: Biosparrudite	25.0
	Total thickness (Wapanucka Formation only)	44.0

LOCALITY 18

Description of locality: A thick section of the Wapanucka Formation is exposed at Limestone Gap, about 10 miles northeast of Stringtown, Atoka County, Oklahoma, NE¼ sec. 31, T. 2 N., R. 13 E. The Wapanucka in this area forms a high ridge which trends northeast and has a relief of from 140 to 180 feet. At this locality the ridge is cut by Limestone Creek, which forms a prominent water gap. The Kansas, Missouri, and Texas Railroad also crosses the ridge obliquely here. The lower part of the section (units A-M) was measured in a cut northeast of the railroad bridge, and the upper part (units O-U) was measured in the larger cut to the southwest of this bridge. Unit V

is exposed only in the bed of Limestone Creek. All beds strike N54°E and dip from 35° to 45°S.

This is a key exposure of the Wapanucka Formation in the frontal belt of the Ouachita Mountains. The section here was measured and described by Wallis (1915, p. 59); fossils were collected from the lower part of the section by Hollingsworth (1933, loc. 7), but the section was not measured at that time; Harlton (1938, p. 904) measured and described the section here in some detail. The top of the Wapanucka Formation is covered but apparently is in fault contact with the overlying Atoka Formation. The section was measured and sampled by Rowett (1959) as the basis of a petrographic study of the Wapanucka Formation. Measurements made at that time are recorded here.

Unit	Description	Thickness (feet)
Wapanucka Formation:		
V	Shale, black, blocky, well-indurated; bedding, thin, regular; unfossiliferous. *Remarks*: This unit is exposed in the bed of Limestone Creek, approximately 100 yards southwest of the small bridge at Gap, Oklahoma. The contact with the underlying massive limestones of unit U is exposed. The upper part of the unit is covered by stream alluvium. Thickness recorded is the maximum exposed.	5.0
U	Limestone, fine- to coarse-crystalline, blue-gray; weathers gray to white; bedding, thick to massive; cherty, oölitic, and crinoidal in zones; sparsely fossiliferous throughout; coral zone in lower 6 feet. *Remarks*: These strata typically weather to cavernous smooth surfaces, hollows, and other unusual forms. Calcite-filled joints and "birds-eye" structures occur in the upper part. Coral species: *Stereocorypha* cf. *S. spissata, Amplexocarinia corrugata, Koninckophyllum simplex, Dibunophyllum* sp. A. *Petrographic description*: U - 34, U - 53, U - 58: Intraclast pelmicrite and dismicrite U - 15: Oösparite U - 8: Crinoidal biosparrudite U - 1: Sandy spiculiferous biomicrite	58.5
T	Limestone and chert: limestone, fine-crystalline, tan; weathers tan to gray; bedding, medium, irregular; interbedded with dark-blue chert. *Petrographic description*: T - 3: Cherty spiculiferous biomicrosparite	3.0
S	Limestone, oölitic, medium-crystalline, gray; weathers light gray; bedding, thick, regular.	

Petrographic description:
S - 1, S - 2, S - 3: Fossiliferous oösparite

2.5

R Limestone and chert: limestone, tan; weathers tan to brown; bedding, thin, irregular; almost completely replaced by chert.
Petrographic description:
R - 3, R - 11, R - 24, R - 31, R - 33: Spiculiferous micrite, replaced by chert.

32.0

Q Limestone, crinoidal, coarse-crystalline, pink; weathers tan to gray; current bedded.
Petrographic description:
Q - 1, Q - 2: Crinoidal biosparrudite

1.5

P Sandstone, chert, and shale: sandstone, cherty, spiculiferous, buff; weathers tan; bedding, thin, regular; interbedded with dark-gray to black shale, chert stringers and nodules; sparsely fossiliferous.
Petrographic description:
P - 1, P - 5: Sandy biomicrite and spiculiferous shale, interbedded. The biomicrite contains hydrous iron oxide, sapropelic material, and detrital quartz grains in a cryptocrystalline siliceous matrix. The matrix may originally have been microcrystalline calcite.

4.5

O Limestone, crinoidal, coarse-crystalline, pink; weathers tan to gray; current bedded.
Petrographic description:
O - 1, O - 2: Crinoidal biosparrudite

1.5

N Shale and spiculiferous limestone: shale, partly siliceous, light- to dark-gray, fissile, concretionary; interbedded with thin spiculiferous limestone; mostly covered; unfossiliferous.
Remarks: Limestone Creek crosses the ridge through a water gap which is eroded in this shale. The shale is mostly covered by talus and vegetation. Thickness calculated.

149.0

M Limestone, spiculiferous, fine-crystalline, light- to dark-gray; weathers tan to red brown; bedding, thin to medium, regular.
Petrographic description:
M - 1, M - 5: Spiculiferous biomicrite (M-1), grading upwards to silty spiculiferous biomicrite (M-5); siliceous sponge spicules (monaxons) constitute up to 70% of the rock in the lower part; partly replaced by chert.

7.0

L Shale, siliceous, spiculiferous, gray to black, fissile. 6.5

K Limestone, spiculiferous, fine-crystalline, gray; weathers buff to brown; bedding, medium to thick, regular. 11.0
Petrographic description:
K - 1, K -10: Spiculiferous biomicrosparite; silty in lower part; partly replaced by chert.

J Shale, siliceous, spiculiferous, partly calcareous, gray to black, platy; sparsely fossiliferous, interbedded with thin spiculites. 10.5
Petrographic descriptions:
J - 3, J - 8: Silty spiculiferous biomicrosparite and biomicrite; partly replaced by chert.

I Limestone, spiculiferous, fine-crystalline, gray to blue; weathers tan; bedding, medium to thick, regular. 15.0
Petrographic description:
I - 1, I - 5, I - 10, I - 11, I - 13, I - 16: Silty biosparite; partly replaced by chert.

H Shale, siliceous, spiculiferous, partly calcareous, gray to black, platy; sparsely fossiliferous. 6.5

G Limestone, spiculiferous, fine-crystalline, gray; weathers brown to red brown; bedding, medium, regular. 5.0
Petrographic description:
G - 2, G - 3, G - 5: Silty biomicrite and microsparite; intraclasts of micrite and quartz silt; partly replaced by chert.

F Shale, siliceous, spiculiferous, gray to black, fissile; unfossiliferous. 8.5

E Limestone, spiculiferous, fine-crystalline, gray; weathers tan; bedding, medium to thick, regular. 8.0
Petrographic description:
E - 1, E - 8: Silty spiculiferous biomicrosparite and micrite; partly replaced by chert.

D Shale, siliceous, spiculiferous, partly calcareous, gray to black, platy, unfossiliferous. 3.5

C Limestone, spiculiferous, fine-crystalline, tan; weathers brown to red brown; bedding, medium to thick, regular. Coral species: *Amplexizaphrentis* cf. *A. tumida*.
Petrographic description:
C - 1, C - 4, C - 8, C - 11: Silty spiculiferous bio-

	micrite, grading in places to biomicrosparite. Sponge spicules comprise up to 70% of the rock; partly replaced by chert.	10.0
B	Shale, siliceous, spiculiferous, gray to black, platy.	4.5
A	Limestone, spiculiferous, fine-crystalline, gray to blue; weathers dark brown; bedding, medium, regular. *Petrographic description*: A - 1, A - 3: Silty spiculiferous biomicrite and microsparite. Unit A is underlain by an undetermined thickness of light- to dark-gray spiculiferous shale which is sideritic, nodular, and concretionary. There is at present no satisfactory criterion for establishing the base of the Wapanucka Formation in the frontal Ouachita Mountains; the base of the Wapanucka Formation at this locality is therefore arbitrarily placed at the base of Unit A until further study provides data for a more satisfactory lower boundary in this area. Thickness of Unit A	2.5
	Total thickness of exposures:	356.0

LOCALITY 19

Description of locality: A limestone quarry near the Oklahoma Subprison exposes vertical to slightly overturned strata of the upper part of the Wapanucka Formation. The quarry is about nine miles northeast of Atoka, Atoka County, Oklahoma, approximately half a mile northwest of U. S. Highway 69: south line, NE¼ sec. 15, T. 1 N., R. 12 E.

The single Wapanucka ridge in this area trends generally in a northeast direction, but is locally deformed into sharp S-shaped curves. Strata exposed here strike N30°E and are overturned from 5° to 8° to the northwest. Near-vertical bedding planes exposed in the quarry are visible from the highway. This section is correlated with the upper part of the exposures at Limestone Gap (loc. 18). The top of the Wapanucka Formation is covered but is apparently in fault contact with the overlying Atoka Formation. Section measured by C. L. Rowett and D. M. Strong, August 23, 1960.

Unit	Description	Thickness (feet)
	Wapanucka Formation:	
F	Limestone, fine-crystalline, gray; weathers gray; bedding, thick, regular; numerous calcite-filled joints.	

	Remarks: Most bedding planes show slickensides; this feature and numerous thick calcite-filled joints reflect strong deformation of the unit. Strike faulting at the top of the unit has resulted in an incomplete section. Few megafossils observed.	24.0
E	Limestone, fine- to medium-crystalline, gray to dark-blue; weathers gray; bedding, thick, regular; extensively jointed; fossiliferous. Coral species: *Amplexocarinia corrugata, Amplexizaphrentis* sp. A, *Koninckophyllum simplex, K. nitellus.*	25.5
D	Limestone and chert: limestone, fine- to medium-crystalline, dark-blue; weathers blue-gray; bedding, medium to thick, regular; interbedded with chert layers, stringers, and nodules.	45.0
C	Limestone, crinoidal, coarse-crystalline, gray to pink; weathers gray; current bedded.	1.5
B	Limestone and chert: limestone, medium-crystalline, silty, gray; weathers gray; bedding, thin, regular; interbedded with thin stringers and nodules of dark-blue chert.	5.0
A	Limestone and shale: limestone, fine- to medium-crystalline, blue; weathers blue gray; bedding, thin, irregular; interbedded with stringers of dark-blue to brown chert and thin shales; unfossiliferous. Base covered.	17.5
	Total thickness of exposures:	118.5

LOCALITY 20

Description of locality: The upper part of the Wapanucka Formation is exposed in a small abandoned limestone quarry and road cut where U. S. Highway 69 crosses the Wapanucka ridge, about half a mile northeast of the settlement of Chockie, Atoka County, Oklahoma, NE¼ SW¼ NE¼ sec. 1, T. 1 N., R. 12 E.

The Wapanucka Formation in this area forms a high ridge, which is a prominent topographic feature. The ridge has a relief of up to 200 feet over the valleys formed in shales to the north and south. The general trend of the ridge is northeast; strata dip from 45° to 75°S and strike N50°E.

This section was measured by Wallis (1915, p. 58) and by Harlton (1938, p. 912). The section was measured for this report along the south side of the highway (units A-C), the north side of the

highway (unit D), and in a small quarry on the north side of the highway (units E-I). The top of the formation is covered but is apparently in fault contact with the overlying Atoka Formation. Section measured by C. L. Rowett and D. M. Strong, August 23, 1960.

Unit	Description	Thickness (feet)
	Wapanucka Formation:	
I	Limestone, fine-crystalline, tan to blue-gray; weathers gray; bedding, thick to massive, regular; extensively jointed; oölitic in lower part; sparsely fossiliferous. Coral species: *Amplexocarinia corrugata, Koninckophyllum simplex.* *Petrographic description*: I - 10: Fossiliferous intrasparrudite	70.0
H	Limestone and chert: limestone, fine- to medium-crystalline, tan; weathers tan to gray; bedding, medium, slightly irregular; interbedded with dark blue "bedded cherts" of about equal thickness.	45.0
G	Limestone, crinoidal, coarse-crystalline, pink to gray on fresh and weathered surfaces; current bedded.	3.0
F	Limestone, silty, fine- to medium-crystalline, tan; weathers yellow brown; bedding, medium, regular.	14.5
E	Limestone, crinoidal, coarse-crystalline, gray to pink; weathers tan; current bedded. *Petrographic description*: E - 4: Biosparrudite	4.5
D	Limestone, shaly, tan; weathers gray to red; bedding, thin, blocky; interbedded with gray to black siliceous to calcareous shale; highly fossiliferous.	7.0
C	Limestone, medium-crystalline, tan to blue-gray; weathers tan; bedding, thin, lenticular; silty in part.	2.0
B	Shale, platy, siliceous, gray, sparsely fossiliferous.	11.5
A	Limestone and shale: limestone, medium-crystalline, blue-gray; weathers gray; bedding, thin to medium, regular; spiculiferous in part; interbedded with thin shaly zones. *Remarks*: This unit is moderately fossiliferous and contains about the same fauna as unit D. It is underlain by a thick section of gray to black siliceous and spiculiferous shale of undetermined age. Correlation of this section with the strata exposed at Limestone Gap (loc. 18) indicates that	

	units identified as A through D occur at approximately the same horizon as the upper part of unit N at that locality.	17.5
	Total thickness of exposures:	175.0

LOCALITY 21

Description of locality: The Wapanucka Formation is exposed in a quarry at this locality, which is about 1.2 miles south of Hartshorne, Pittsburg County, Oklahoma. This quarry had not been in operation for more than 45 years until operations were recently resumed. Limestone was originally quarried here for use in a cement plant, and several of the buildings used for this operation are located at the foot of the ridge, on the east side of State Highway 63. A narrow road, now mostly overgrown, leads east from these buildings and up a steep slope to the quarry. The quarry is in the center of the NW¼ sec. 18, T. 4 N., R. 17 E.

The Wapanucka Formation in this area forms a ridge about 250 feet high. Strata dip 32°S and strike N50°E. A second and larger quarry lies about one mile east of this locality, and from it rock was extracted and crushed (loc. 23, this report). Comparison of the lithologic sequence here with that of the latter locality demonstrates abrupt facies changes and possibly local intraformational unconformities within the Wapanucka Formation in this area.

Fossils were collected from the carbonaceous shales near the base and in the middle of this section (here designated Unit B and Unit D) by Hollingsworth (1933, locs. 10, 11). This section was also measured in some detail by Harlton (1938, p. 906). At this locality the top of the formation is covered but is apparently in fault contact with the overlying Atoka Formation.

Section measured in the east and south face of the quarry by C. L. Rowett and D. M. Strong, August 25, 1960.

Unit	Description	Thickness (feet)
Wapanucka Formation:		
K	Limestone, cherty, fine-crystalline, blue to gray; weathers brown to red; bedding, medium to thick, regular.	18.0
J	Limestone, medium-crystalline, gray to blue-gray; weathers gray; bedding, massive, regular; fossiliferous. Coral species: *Amplexocarinia corrugata, Koninckophyllum simplex.*	19.0
I	Limestone, crinoidal, medium-crystalline, brown; weathers dark brown; bedding, massive, regular.	8.5

H	Limestone, cherty, fine- to medium-crystalline; light gray on fresh and weathered surfaces; bedding, thick, irregular; sparsely fossiliferous. Coral species: *Lophophyllidium ignotum*?	36.5
G	Limestone, coarse-crystalline, tan; weathers red brown; bedding, thick, highly irregular.	11.0
F	Limestone, glauconitic, arenaceous, fine- to medium-crystalline; buff to olive green on fresh and weathered surfaces; bedding, thin to medium, irregular; sparsely fossiliferous. *Petrographic description*: F - 1: Glauconitic biomicrosparite	2.0
E	Limestone and chert: limestone, fine- to medium-crystalline, blue-gray; weathers gray; bedding, medium to thick, regular; oölitic in upper part; interbedded with irregular stringers, lenses, and nodules of chert in lower 40 feet; oölitic in upper part.	48.5
D	Limestone and shale: limestone, argillaceous, tan; weathers gray; bedding, thin, regular; shaly in upper part; contains finely disseminated carbonaceous plant material and larger segments of carbonized stems and trunks.	2.5
C	Limestone, argillaceous and nodular, medium-crystalline, blue; weathers tan; bedding, thin, regular; becomes increasingly nodular in upper part; fossiliferous.	21.5
B	Shale, black, highly fissile, fossiliferous.	9.5
A	Limestone, medium-crystalline, blue to gray; weathers tan to brown; bedding, medium to thick, regular; base covered.	31.0
	Total exposed thickness:	208.0

LOCALITY 23

Description of locality: A large abandoned quarry exposes part of the Wapanucka Formation, about one mile south and one mile east of Hartshorne, Pittsburg County, Oklahoma: N½ NW¼ sec. 17, T. 4 N., R. 17 E. In this area the Wapanucka Formation forms a high ridge, which trends eastward and rises more than 200 feet above the

valley to the north. Strata dip 35° to 40°S. The top of the formation is covered but is apparently in fault contact with the overlying Atoka Formation.

The lower units (A-E) were measured in the western part of the quarry; the upper units (F-I) in the eastern part, and on the back slope of the ridge. Section measured by C. L. Rowett and R. W. Hedlund, August 10, 1960.

Unit	Description	Thickness (feet)
Wapanucka Formation:		
I	Limestone, fine- to medium-crystalline, gray to gray-blue; weathers gray; bedding, massive; partly covered. *Remarks*: These strata are stratigraphically the highest beds on the dip slope of the ridge; they are poorly exposed and deeply weathered. The top of the unit is covered and it could not be determined whether higher units in the Wapanucka intervene between these beds and the base of the Atoka Formation. Coral species: *Koninckophyllum simplex, Amplexocarinia corrugata.*	20.0
H	Limestone, crinoidal, medium-crystalline, brown; weathers dark brown; bedding, massive. *Remarks*: This unit forms the crest of the eastern part of the quarry; the brown color of the weathered surfaces is in strong contrast with the lighter grays of overlying and underlying units. The contact with the overlying beds is not well exposed but seems to be regular. *Petrographic description*: H - 9: Biosparrudite	13.0
G	Limestone, fine- to medium-crystalline, tan to blue; weathers gray; bedding, massive. *Petrographic description*: G - 10: Dismicrite	10.5
F	Limestone and chert: limestone, medium-crystalline, gray; weathers light gray; bedding, medium to thick; interbedded throughout with chert stringers and nodules. *Petrographic description*: F - 8: Biosparite	22.0
E	Limestone, crinoidal, fine- to medium-crystalline, blue-gray; weathers light gray; bedding, thick to massive; lower one foot locally conglomeratic.	15.5

D Sandstone, limestone, and chert: sandstone, fine-grained, glauconitic, buff to olive-green; interbedded with limestone, fine-crystalline, tan to blue-gray, nodular, concretionary; weathers tan to brown; contains thin bands of blue chert; bedding, thin to medium and irregular throughout.
Remarks: Unit D is visibly discontinuous laterally and may replace portions of adjacent units through a lateral change in facies. In the western part of this quarry this unit appears to thicken at the expense of Unit C, attains a maximum exposed thickness of about 24 feet, and extends to the quarry floor. However, truncation of the underlying units has not been demonstrated, and a chert bed about 1.5 feet thick near the base of the unit seems to be continuous. These beds disappear in the eastern part of the quarry, where the relationships to adjacent units are also uncertain.
Petrographic description:
D - 10, D - 11: Silty, spicular pelmicrite and intrapelmicrite, interbedded, locally silicified.
24.0

C Limestone and chert: limestone, fine- to medium-crystalline, blue-gray; weathers gray; medium to thick bedded; oölitic in upper part; sparsely fossiliferous; interbedded in lower 40 feet with regular beds of dark-blue chert.
Remarks: These beds are best exposed in a near-vertical cliff which separates the quarry into an eastern part and a western part; chert occurs as irregular beds 4 to 10 inches thick, which are relatively resistant to weathering.
Petrographic description:
C - 43: Intraclast oösparite; intraclasts are composed of oölites.
46.5

B Shale, carbonaceous, gray to black; weathers gray to white; fossiliferous.
Remarks: This shale has eroded back several feet, producing a strong overhanging ledge formed by the overlying unit. The shale is highly carbonaceous and contains abundant fossil debris including crinoid parts, bryozoans, fragments of pelecypod shells, solitary corals, and brachiopods. Preservation is poor. Coral species: *Lophophyllidium ignotum*, *Amplexizaphrentis* sp. B.
2.5

A Limestone and shale: limestone, fossiliferous, partly oölitic, medium- to coarse-crystalline, tan; weathers

	brown; bedding, thin, irregular; shale partings, concretionary, fossiliferous. *Remarks*: These beds underlie the carbonaceous shale with an abrupt and regular contact. The base of the unit is not exposed.	1.5
	Total thickness of exposures:	155.5

LOCALITY 24

Description of locality: In this area the Wapanucka Formation forms a steep-sided ridge which trends northwest. Strata dip from 12° to 25°NE and are exposed near the crest of the ridge. The section was measured from a road cut along State Highway 48 northeastward across the ridge; center of the W line, sec. 24, T. 2 S., R. 8 E. This area is about half a mile south of the town of Wapanucka, Johnston County, Oklahoma. Section measured by C. L. Rowett, August 26, 1961.

Unit	Description	Thickness (feet)
Wapanucka Formation:		
G	Limestone, medium-crystalline, blue; weathers tan; bedding, thick, regular; locally cherty; fossiliferous. *Remarks*: These beds form the dip slope of the ridge. The contact with the overlying Atoka Formation is covered at the foot of the dip slope.	11.0
F	Limestone, crinoidal, coarse-crystalline, tan; weathers dark gray and brown; bedding, medium to thick, regular; fossiliferous.	9.0
E	Limestone and shale, interbedded: limestone, medium-crystalline, tan; weathers tan to gray; bedding, thin, regular; interbedded with shales of about equal thickness; mostly covered. Coral species: *Empodesma* cf. *E. imulum, Lophophyllidium idonium, Barytichisma callosum.*	53.5
D	Shale, calcareous, gray, unfossiliferous.	1.0
C	Limestone, coarsely crystalline, light-gray; weathers tan to gray; bedding, thin, regular; unfossiliferous.	1.0
B	Limestone, fine- to medium-crystalline, blue; weathers gray; bedding, thin, irregular; contains numerous chert nodules and stringers; unfossiliferous.	6.5

A	Shale, calcareous, gray; unfossiliferous. Base covered.	6.0
	Total thickness of exposures:	88.0

LOCALITY 25

Description of locality: The Wapanucka Formation is exposed at this locality as a narrow, steep-sided ridge, in Coal County, Oklahoma, SW¼ SW¼ NE¼ sec. 19, T. 1 N., R. 8 E. The section was measured about 30 yards west of the point where this ridge is cut by Goose Creek, from the bottom of a small gully to the crest of the ridge. Strata dip from 25° to 70°N., and the strike is NW. Changes in strike and dip indicate that the upper unit (D) may be in fault contact with the Atoka Formation.

This section was measured by Wallis (1915, p. 51). Section measured for this study by C. L. Rowett, April 4, 1960.

Unit	Description	Thickness (feet)
	Basal Atoka Formation:	
E	Limestone, locally conglomeratic, medium- to coarse-crystalline, gray to tan; weathers gray to brown; bedding, thin to medium, irregular; fossiliferous in part. *Remarks*: These strata form the dip slope of the ridge and are overlain by ferruginous sandstones.	12.0
	Wapanucka Formation:	
D	Limestone, oölitic, medium-crystalline, gray to tan; weathers white; bedding, medium to thick, regular. *Remarks*: Oölites are concentrated in the lower part of the unit, but the unit is oölitic throughout. The contact with the overlying Atoka Formation is abrupt.	19.5
C	Limestone, medium-crystalline, gray; weathers gray to white; bedding, thin to medium, regular; partly covered.	33.0
B	Limestone and shale: limestone, fine- to medium-crystalline, blue-gray; weathers brown; bedding, thin to medium, regular, partly covered; interbedded with shales of about equal thickness. Mostly covered.	50.0
A	Limestone and shale: limestone, fossiliferous, medium-crystalline, tan; weathers brown; bedding, thin,	

	irregular; interbedded with thin shale partings throughout; mostly covered. Base not exposed. *Remarks*: Most of this unit is covered; the upper contact is not exposed, nor is the base of the unit. Bedding planes contain numerous fossils, mostly brachiopods.	13.0
	Total thickness (Wapanucka Formation only):	115.5

LOCALITY 26

Description of locality: The upper oölitic part of the Wapanucka Formation is exposed at this locality in an abandoned limestone quarry, center SE¼ NW¼ SE¼ sec. 6, T. 1 S., R. 9 E., Coal County, Oklahoma.

Beds strike N30°W; the dip is variable, but averages 10°E. The section is overlain by shales and sandstones of the Atoka Formation. This contact is well exposed at a second quarry, approximately one-fifth mile to the southeast, but is poorly exposed at this locality.

Fossils were collected here by Kuhleman (1948, loc. 35). The upper part of the section was measured and described for this study by C. L. Rowett, June 9, 1961.

Unit	Description	Thickness (feet)
Wapanucka Formation:		
A	Limestone and shale, interbedded: limestone oölitic, gray to white; weathers yellow white; bedding, thick to massive, regular; fossiliferous in some zones; interbedded with thin shaly zones near top. Base not exposed. *Remarks*: A zone in which the crinoid *Paragassizocrinus* is common occurs about 15 feet below the top of the section, in the quarry floor. Productid brachiopods and other crinoid species occur slightly higher in the section. Coral species: *Lophophyllidium idonium*.	18.5
	Total thickness measured:	18.5

LOCALITY 27

Description of locality: The Wapanucka Formation forms a steep ridge in this area which trends NW across the NE¼ NE¼ sec. 30, T. 1 N., R. 8 E., Coal County, Oklahoma. Strata in the south side

of the ridge are exposed along a fire lane. Beds strike N50°W and dip 10° to 15°N.

Fossils were collected in this area by Kuhleman (1948, locs. 22, 23), but no section was measured. Section measured for this study by C. L. Rowett, June 9, 1961.

Unit	Description	Thickness (feet)
	Basal Atoka Formation:	
E	Limestone conglomerate; clasts, pebble- to cobble-size; locally oxidized. Thickness variable along strike. *Petrographic description*: E - 1: Fossiliferous, oölitic limestone conglomerate. Many clasts contain oölites of same size and type as those which occur in the underlying oölitic unit of of the Wapanucka Formation (unit D).	3.0
	Wapanucka Formation:	
D	Limestone, oölitic, gray to white, weathers white; bedding, thin to medium, regular; partly covered. *Remarks*: The basal part of this oölite carries a crinoid fauna. Near the base of the dip slope, the oölite is overlain by a thin (2 to 3 feet) limestone conglomerate. The contact is not well exposed, but field relationships indicate that the conglomerate represents the basal part of the Atoka Formation. The conglomerate is in turn overlain by typical red-brown ferruginous sands of the Atoka Formation.	20.0
C	Limestone, fossiliferous, medium-crystalline, tan to blue; weathers gray blue; bedding, medium to thick; regular except near top; thin shaly partings and cherty zones in upper part. *Remarks*: These beds are exposed at the crest of the ridge at this locality; the contact with the overlying oölitic limestone is irregular and appears to be unconformable. Solitary corals, crinoids, and blastoids are common. Coral species: *Koninckophyllum oklahomense, K. nitellus.*	31.0
B	Limestone and shale: limestone, fine- to medium-crystalline, fossiliferous; weathers yellow brown; bedding, thin to medium, regular; interbedded shales mostly covered by soil and vegetation. *Remarks*: The lower 10 feet of this unit is exposed in a small wash about 40 yards WSW from the foot of the ridge; fenestrate bryozoans, brachiopods, and crinoid parts are abundant. Thickness calculated.	65.0
A	Shale and thin limestones: shale, calcareous, concretionary, gray-green to olive, fossiliferous; inter-	

	bedded with thin (2 to 6 inches) shaly limestones. *Remarks*: This shale is dissimilar in appearance to basal shales of the Wapanucka Formation observed elsewhere, but contains the characteristic crinoid and coral species found in this part of the section elsewhere. Brachiopods and casts of scyphozoan medusae are common. The shale contains numerous limonite concretions and thin calcite veins. The base of the shale is covered by stream alluvium. Coral species: *Lophophyllidium idonium, Barytichisma callosum.*	20.0
	Total thickness (Wapanucka Formation only):	136.0

LOCALITY 28

Description of locality: This section was measured primarily to confirm the unconformable relationship of the upper oölitic beds of the Wapanucka Formation in this area to underlying strata. The section was measured on the west side of the ridge, about one mile southeast of Bromide, NE¼ SE¼ NE¼ sec. 5, T. 2 S., R. 8 E., Johnston County, Oklahoma. A small abandoned quarry is at the crest of the ridge at this locality from which a few tons of the oölitic limestone have been removed for local building purposes.

Three lithologic units are recognized in this section. The upper unit, C, is also present at locality 15, about one mile to the southeast at Delaware Creek. The disappearance of Unit A and Unit B along strike can be explained by tracing the oölite southeastward along the ridge. In this direction the oölite thins rapidly and disappears at the crest of the ridge within a short distance of the small quarry. For the next 1,500 yards Unit B forms the crest and dip slope of the ridge. About 200 yards northwest of the large quarry at Delaware Creek the oölite reappears and thickens rapidly southeastward to more than 70 feet at the quarry (loc. 15). Through this interval the oölite progressively truncates the underlying units, A and B. These relationships are shown diagrammatically in figure 2.

Section measured by C. L. Rowett and R. W. Hedlund, June 19, 1961.

Unit	Description	Thickness (feet)
Wapanucka Formation:		
C	Limestone, oölitic, light-gray to white; weathers dark gray; bedding, thick to massive; sparsely fossiliferous. *Remarks*: This oölite forms the dip slope of the ridge and has the form of a small basin-shaped deposit. Maximum thickness is 11 feet in the quarry. Truncation of individual beds of Unit B by the	

	oölite was observed in several places at this locality.	0.0 to 11.0
B	Limestone and chert: limestone, medium-crystalline, locally oölitic, gray to blue; weathers tan; bedding, thin, irregular; interbedded with stringers and nodules of dark-blue chert. Base not exposed. *Remarks*: A maximum exposed thickness of 14 feet was recorded just south of the quarry; in the quarry, however, only 3 feet is exposed below the oölite. *Petrographic description*: B - 1: Oölitic biosparrudite, locally silicified.	14.0
A	Limestone, crinoidal, medium-crystalline, tan; weathers brown; bedding, thin to medium; mostly covered; base not exposed. Coral species: *Barytichisma callosum.*	26.0
	Total thickness of exposures:	Up to: 51.0

LOCALITY 29

Description of locality: The Wapanucka Formation in this area forms a prominent ridge which trends eastward about half a mile south of Wapanucka, Atoka County, Oklahoma: SW¼ NE¼ sec. 23, T. 2 S., R. 8 E. This is considered to be the type area of the Wapanucka Formation (Taff, 1901). Strata dip to the north at about 15°. The base of the section and the contact with the Atoka Formation are covered. The section was measured from the base of the south side of the ridge, 20 feet west of a cement well slab, to a small abandoned quarry at the crest of the ridge. A water tank is situated on top of the ridge about 200 yards east of this quarry. Section measured by C. L. Rowett, June 23, 1961.

Unit	Description	Thickness (feet)
	Wapanucka Formation:	
E	Limestone, locally oölitic, finely crystalline, gray to white; weathers mottled gray; bedding, thick and irregular; contact with underlying unit irregular. *Petrographic description*: E - 10: Pelletiferous dismicrite	19.0
D	Limestone, oölitic, and chert; limestone, locally oölitic, medium-crystalline; gray to blue on fresh and weathered surfaces; bedding, irregular and variable in thickness; interbedded with lenses and stringers of dark-blue to red-brown chert.	

	Petrographic description: D - 3: Fossiliferous oösparrudite	
		6.0
C	Limestone, limestone conglomerate, and chert: limestone, fine- to medium-crystalline; blue-gray on fresh and weathered surfaces, bedding, thick and regular except in upper two feet, where beds are contorted and lenticular; lenses of red-brown chert and limestone pebbles and cobbles in upper part; base covered. *Petrographic description*: C - 17: Fossiliferous intrasparrudite and intramicrosparrudite.	
		17.5
B	Limestone, crinoidal, medium- to coarse-crystalline, tan to pink; weathers dark brown; bedding, medium to thick, regular; partly covered. *Petrographic description*: B - 2: Biomicrosparrudite and biosparrudite	
		8.5
A	Limestone, crinoidal, fine- to medium-crystalline, gray to white; weathers gray; bedding, thin and regular. *Petrographic description*: A - 5: Oölitic biosparrudite	
		6.0
	Total thickness of exposures:	57.0

LOCALITY 31

Description of locality: The upper part of the Wapanucka Formation is exposed as a narrow, steep-sided ridge about 1.7 miles northeast of Bromide, Oklahoma: NW¼ SE¼ sec. 33, T. 1 S., R. 8 E., Coal County, Oklahoma.

These strata form part of the north limb of the Wapanucka syncline and dip steeply south toward the axis of this structure. The beds strike N80°W; the dip is variable and ranges from 35° to 65°S. This section was measured by Wallis (1915, p. 48). The locality is also listed by Kuhleman (1948, loc. 41). Section measured for the present study by C. L. Rowett, June 23, 1961.

Unit	Description	Thickness (feet)
Wapanucka Formation:		
B	Limestone, oölitic, medium-crystalline, white; weathers gray; bedding, thick, regular; cherty in lower part; sparsely fossiliferous throughout. *Remarks*: These steeply dipping limestone beds	

	form a steep-sided narrow ridge about 20 feet high at this locality and are in fault contact with incompetent shales of the lower part of the Atoka Formation.	52.0
A	Limestone and chert: limestone, medium-crystalline, blue; weathers tan to brown; interbedded with nodules and stringers of dark-blue chert; unfossiliferous. *Remarks*: The contact between these cherty beds and the overlying oölite is poorly exposed, but field evidence from adjacent localities (5, 28, 15) indicates that the contact is unconformable. The base of this unit probably is in fault contact with shales of the Springer or Caney Formations.	12.0
	Total thickness of exposures:	64.0

LOCALITY 32

Description of locality: No section was measured at this locality, which is exposed along the north line, SE¼ sec. 30, T. 1 N., R. 8 E., Coal County, Oklahoma. Fossils were collected here from limestones that are equivalent to fossiliferous limestones at adjacent localities (17-A, 27-C) and which are continuously exposed between these localities. Coral species collected include *Koninckophyllum oklahomense* and *K. nitellus*.

APPENDIX II

Tabulation of Data

All measurements of diameter (d), septal count (n), height (h), dissepimentarium diameter (d^d), tabularium diameter (d^t), and septal ratio (n/d) are recorded for each coral species. Most specimens with OU (University of Oklahoma) catalog numbers are illustrated in plates 1-9. Other designations are the authors' reference numbers.

Empodesma cf. *E. imulum*

Loc.	No.	d	n	h	n/d
24-E	OU 4801	15.0	32	35.0	2.1
		10.0	31	15.0	3.1
		6.0	24	3.7	4.0

Stereocorypha cf. *S. spissata*

Loc.	No.	d	n	h	n/d
18-U	OU 4802	15.2	39	18.0	2.6
		14.2	38	13.0	2.7
		12.5	37	7.0	3.0
		11.0	36	4.0	3.2
	54-u	12.0	34		2.8

Amplexocarinia corrugata

Loc.	No.	d	n	h	n/d
18-U	OU 4803	4.5	16	11.2	3.6
		4.0	16	10.2	4.0
		3.7	16	9.2	4.3
		3.4	16	8.5	4.7
	OU 4804	5.0	22	28.0	4.4
		4.7	21	27.5	4.5

Lophophyllidium idonium

Loc.	No.	d	n	h	n/d
3-D	38	7.5	24	11.0	3.2
		2.5	14	1.3	5.6
4-A	OU 4810	9.5	26	15.5	2.7
16-D	OU 4807	11.5	27	12.6	2.3
	OU 4808	12.0	28	13.0	2.3
	49	8.0	26	11.5	3.3
16-F	49-c	7.0	24	9.0	3.4
24-E	OU 4809	11.8	28	12.3	2.4
	59-a	8.0	26	11.6	3.3
		4.0	20	4.0	5.0
		3.8	18	3.5	4.7

		3.0	16	2.1	5.3
26-A	72	6.1	20	9.7	3.3
		2.2	14	1.4	6.4
	73	8.5	26	10.0	3.1
		5.0	22	2.7	4.4
27-A	88-b	6.7	24	12.0	3.6
		6.5	22	11.5	3.4
		4.4	20	4.0	4.5
		3.6	18	3.5	5.0
		3.0	16	1.0	5.3

Lophophyllidium minutum

Loc.	No.	d	n	h	n/d
4-A	OU 4811	6.0	22	8.7	3.7
	OU 4812	6.8	20	9.7	2.9
		6.2	20	7.9	3.2
		4.6	19	6.9	4.1
		1.8	14	1.0	7.8
	OU 4813	5.5	23	8.3	4.2
		2.1	12	0.5	5.7
	OU 4824	7.0	24	12.5	3.4
	OU 4825	7.1	23	12.6	3.2
	OU 4826	6.1	24	13.0	3.9
	OU 4871	6.3	21	11.0	3.3
		2.4	13	0.7	5.4
	OU 4872	6.0	21	9.5	3.5
		1.8	14	0.5	7.8
	OU 4873	6.0	21	11.8	3.5
		1.8	10	1.5	5.6
		1.5	8	1.3	5.3
	OU 4874	5.1	20	11.0	3.9
		2.0	12	1.0	6.0
	OU 4875	6.8	23	11.5	3.4
		2.5	18	1.2	7.2
	OU 4876	6.2	21	11.3	3.4
		2.4	14	1.5	5.8
	OU 4877	5.3	21	9.2	4.0
		5.2	19	8.7	3.7
	OU 4878	5.3	21	9.4	4.0
		1.3	11	0.5	8.5
	OU 4879	7.0	21	11.3	3.0
	OU 4880	6.0	21	9.5	3.5
	OU 4881	7.0	23	10.6	3.3
		2.2	16	1.5	7.3
	20	8.0	24	11.7	3.0
	21-b	6.0	22	7.4	3.7
	21-c	5.0	21	7.2	4.2
	21-i	5.2	22	8.3	4.2
	35-r	6.2	20	9.7	3.2
		3.3	14	2.7	4.2
		2.7	14	1.3	5.2

		2.2	14	0.7	6.4
	35-s	6.2	23	8.6	3.7
		1.2	10	0.5	8.3
	35-t	5.2	20	7.2	3.8
		2.0	12	1.0	6.0
	35-u	6.8	21	9.1	3.1
		2.0	10	1.5	5.0
	35-v	6.4	21	9.2	3.3
		2.8	14	1.0	5.0
	35-w	6.2	21	8.7	3.4
		3.3	16	3.4	4.8
	35-x	5.2	20	8.7	3.8
	35-y	4.6	20	7.1	4.3
		2.4	16	1.0	6.7

Lophophyllidium ignotum

Loc.	No.	d	n	h	n/d
23-B	OU 4827	12.0	29	23.5	2.4
		11.1	29	20.5	2.6
		8.5	26	13.0	3.1
	OU 4828	9.5	26	13.8	2.7
		9.0	22	11.8	2.4
	OU 4829	8.8	24	14.5	2.7
		8.0	24	10.0	3.0
		5.0	20	3.0	4.0
	OU 4830	9.0	25	18.0	2.8
	OU 4882	8.5	25	18.8	2.9
		7.6	24	13.8	3.2
		7.0	23	9.6	3.3
		3.8	20	2.0	5.3
	OU 4814	10.0	23	15.0	2.3
		8.5	22	10.0	2.6
		4.7	15	4.0	3.2
	OU 4815	10.3	27	18.3	2.6
		9.6	24	14.8	2.5
		9.0	24	13.3	2.7
		7.8	24	10.5	3.1
		7.1	22	9.0	3.1
		3.4	17	1.4	5.0
	OU 4816	10.0	24	14.1	2.4
		9.7	24	12.5	2.5
	51-f	9.7	26	15.0	2.7
		7.2	22	11.5	3.1
		6.9	21	10.0	3.0
		3.2	18	2.4	5.6
		2.0	10	1.0	5.0
	59-f	8.5	23	20.0	2.7
		7.8	23	16.0	2.9
		7.0	23	10.7	3.3
		3.6	20	3.0	5.6

Lophophyllidium cf. *L. angustifolium*

Loc.	No.	d	n	h	n/d
4-A	OU 4820	9.5	24	15.5	2.5
	OU 4821	9.0	26	14.8	2.9
	OU 4822	6.7	24	13.5	3.6
	OU 4823	8.5	25	14.7	2.9
	21-g	7.2	26	13.3	3.6
	30	9.2	28	20.3	3.0
		7.6	24	13.9	3.2
		6.5	24	13.1	3.7
		5.0	20	7.6	4.0
		4.5	20	6.8	4.4
		4.0	19	6.3	4.8
		2.9	14	2.1	4.8
		2.5	12	1.4	4.8

Lophophyllidium sp. A

Loc.	No.	d	n	h	n/d
4-A	OU 4831	16.5	30	21.6	1.8
		13.5	30	14.1	2.2
	OU 4832	11.5	30	20.0	2.6
		6.0	22	8.3	3.7
		4.5	20	5.0	4.4
	OU 4883	14.0	31	24.0	2.2
		12.8	29	18.0	2.3
		11.3	29	14.5	2.6
		3.6	16	1.6	4.4

Lophophyllidium sp. B

Loc.	No.	d	n	h	n/d
16-D	OU 4817	7.8	26	13.0	3.3
		7.5	26	11.5	3.5
		6.0	24	7.5	4.0
		5.4	20	6.6	3.7
		3.3	14	0.7	4.2
	OU 4818	7.5	25	13.0	3.3
		6.5	24	9.5	3.7
		6.0	20	7.0	3.3
		2.8	14	1.2	5.0

Leonardophyllum morrowense (form A)

Loc.	No.	d	n	h	n/d
3-A	OU 4839	9.2	24	29.1	2.6
		6.0	22	5.5	3.7
	OU 4841	9.0	22	42.1	2.4
		7.5	22	28.7	2.9
		6.9	22	22.5	3.2
		4.9	19	14.6	3.9
		3.6	18	7.6	5.0
		2.2	12	0.6	5.5

4-A	OU 4837	10.0	25	47.1	2.5
		9.9	25	25.1	2.5
		8.0	24	14.1	3.0
		6.0	21	10.0	3.5
	OU 4838	9.8	24	41.0	2.4
		7.0	24	10.0	3.4
	OU 4840	10.0	26	32.0	2.6
		6.0	23	15.0	3.8
	OU 4842	9.2	24	20.5	2.6
		5.5	20	7.0	3.6
		3.1	20	0.9	6.5
	OU 4843	8.1	23	27.9	2.8
		9.0	23	16.3	2.6
		4.7	22	3.5	4.7
	OU 4844	9.5	24	30.3	2.5
		8.5	24	21.3	2.8
	OU 4884	8.5	26	25.5	3.1
		5.6	24	12.0	4.3
	OU 4885	10.5	24	26.0	2.3
		5.8	21	8.0	3.6
	OU 4886	8.0	25	30.2	3.1
		5.5	21	8.6	3.8
	28	10.5	25	26.0	2.4
		3.1	19	1.5	6.1
		2.6	16	1.0	6.2

Leonardophyllum morrowense (form B)

Loc.	No.	d	n	h	n/d
3-A	OU 4834	9.5	23	22.0	2.4
		4.5	20	4.7	4.4
	OU 4835	7.0	26	34.0	3.7
		6.5	22	11.5	3.4
	65-i	9.2	25	28.5	2.7
		8.8	23	21.5	2.6
		3.0	22	2.0	7.3
		2.2	16	1.5	7.3
		1.6	12	1.1	7.5
		1.4	10	1.0	7.1
		1.1	8	0.5	7.3
	65-j	8.7	24	22.8	2.8
		7.3	24	17.3	3.3
		4.0	22	4.0	5.5
	65-k	10.6	27	33.2	2.5
		10.0	27	21.7	2.7
		7.9	24	14.2	3.0
		5.4	22	6.0	4.1
	65-l	8.9	24	30.8	2.7
		8.5	24	21.9	2.8
		7.2	23	12.1	3.2
		5.8	21	7.7	3.6
		2.2	16	0.1	7.3

4-A	OU 4833	10.5	25	-	2.4
		8.5	25	-	3.1
	OU 4836	9.0	23	26.0	2.6
		6.0	20	9.4	3.3
	OU 4845	9.6	24	19.9	2.5
		6.0	24	5.1	4.0
	OU 4846	12.0	26	47.3	2.2
		10.0	25	34.2	2.5
		8.5	24	21.8	2.8
		4.6	19	5.4	4.1

Amplexizaphrentis cf. *A. tumida*

Loc.	No.	d	n	h	n/d
4-A	OU 4847	11.0	30	13.5	2.7
18-C	OU 4849	11.9	28	14.5	2.4
	52-a	11.0	28	11.1	2.5
		4.5	18	2.5	4.0
		4.0	16	2.0	4.0
		3.5	14	1.0	4.0

Amplexizaphrentis aff. *A. crassiseptata*

Loc.	No.	d	n	h	n/d
16-D	OU 4850	7.5	30	11.4	4.0
		5.5	26	7.1	4.7
		5.0	15	1.7	5.0
		2.2	12	1.1	5.5
		1.8	10	0.6	5.6

Amplexizaphrentis sp. A

Loc.	No.	d	n	h	n/d
19-E	OU 4848	8.7	24	13.0	2.8

Amplexizaphrentis sp. B

Loc.	No.	d	n	h	n/d
23-B	OU 4851	8.3	22	13.3	2.7
		7.5	22	12.3	2.9
		7.4	22	10.3	3.0
		5.2	21	5.5	4.0
		3.3	18	1.0	5.5
		2.7	16	0.5	5.9
		2.3	14	0.3	6.1

Barytichisma callosum

Loc.	No.	d	n	h	n/d
3-D	OU 4858	27.0	44	58.8	1.6
		23.6	44	53.5	1.9
		18.4	43	38.8	2.3
		11.0	35	17.8	3.2
		8.0	10	3.0	4.0

	OU 4856	11.0	36	14.4	3.3
	39-a	14.0	36	17.5	2.6
		13.5	35	12.5	2.7
		5.5	26	7.5	4.7
		3.0	14	2.0	4.7
	36-b	21.0	40	40.0	1.9
		12.7	33	19.0	2.6
		8.1	23	7.0	2.8
		3.0	21	2.0	7.0
4-A	OU 4852	16.0	35	20.0	2.2
		9.5	29	14.0	3.1
		8.5	29	6.0	3.4
	OU 4853	15.0	31	25.4	2.1
		11.5	31	15.5	2.7
		1.5	26	11.0	4.0
	OU 4854	13.0	34	19.3	2.6
		6.0	23	11.0	3.0
		2.0	10	2.0	5.0
		1.2	6	0.5	5.0
	OU 4855	20.0	37	23.0	1.9
		9.5	34	12.5	3.6
	4	15.5	36	22.5	2.3
		12.5	35	17.0	2.8
		12.2	35	10.0	2.9
	7	12.0	33	14.5	2.8
		6.2	28	6.5	4.5
		4.5	25	5.0	5.6
		2.2	14	2.0	6.4
		1.3	8	1.0	6.2
	OU 4857	15.5	39	18.5	2.5
		8.0	25	7.5	3.1
		4.8	18	3.0	3.8
		2.9	12	2.2	4.1
		2.5	10	1.0	4.0
10-B	46	16.0	41	20.0	2.6
		7.0	30	7.0	4.3
17	41	16.0	37	24.0	2.3
24-E	59-e	21.0	39	35.0	1.9
		16.0	34	23.0	2.1
		5.0	26	5.0	5.2
		3.0	18	2.0	6.0
27-A	69-a	18.5	39	22.5	2.1
	86	33.0	51	86.7	1.5
		25.0	48	79.2	1.9
		21.0	43	34.0	2.0
		12.0	38	10.0	3.2
		7.0	24	4.0	3.4
28-A	OU 4891	32.0	50	36.0	1.6

Koninckophyllum simplex

Loc.	No.	d	d^t	d^d	n	h	n/d
18-U	OU 4864	15.0	13.0	1.0	34	-	2.3
	OU 4865	14.5	12.5	1.0	30	17.0	2.1
	OU 4866	15.6	11.0	2.3	-	17.5	-
	54	20.0	14.0	3.0	34	24.0	1.7
	54-p	17.0	13.0	2.0	31	-	1.8
	54-nn	14.0	12.0	1.0	37	25.0	2.6
		8.0	7.0	0.5	32	10.0	4.0
	54-gg	10.0	8.0	1.0	36	-	3.6
	54-rr	12.0	11.0	0.5	27	15.0	2.3
	54-a	23.0	16.0	3.5	42	49.0	1.8
	54-b	22.0	14.0	4.0	43	-	2.0
	54-d	15.4	11.0	2.2	37	-	2.4
	54-i	19.0	12.0	3.5	36	-	1.9
	54-j	17.5	12.5	2.5	37	29.0	2.1
		14.0	11.0	1.5	32	11.0	2.3
	54-k	19.5	12.5	3.5	36	-	1.8
	54-n	20.0	12.0	4.0	37	-	1.9
	54-r	24.0	14.0	5.0	39	39.0	1.6
		15.0	13.0	1.0	35	16.3	2.3
19-E	56-b	17.0	14.0	1.5	35	50.0	2.1
	56-d	14.0	11.0	1.5	36	37.0	2.6
20-I	79	15.0	12.0	1.5	34	20.0	2.3
	82	13.0	12.0	0.5	31	12.0	2.4
	81	19.0	11.0	4.0	37	43.0	1.9
		12.0	7.0	2.5	31	9.5	2.6
21-J	OU 4859	21.5	15.1	3.2	41	44.4	1.9
		18.5	13.5	2.5	38	28.7	2.1
		10.5	7.5	1.5	31	11.7	3.0
	OU 4860	20.5	12.1	4.2	47	44.0	2.3
		24.5	15.9	4.3	47	30.9	1.9
		20.0	13.6	3.2	44	18.5	2.2

Koninckophyllum oklahomense

Loc.	No.	d	d^t	d^d	n	h	n/d
17-A	OU 4861	29.0	15.0	7.0	45	42.0	1.6
		13.0	10.0	1.5	33	12.2	2.5
		4.0	4.0	0.0	16	4.2	4.0
	OU 4862	22.4	11.0	5.7	36	48.0	1.6
	OU 4889	25.0	18.0	3.5	45	27.0	1.8
27-C	OU 4863	19.0	13.0	3.0	41	25.5	2.2
		11.5	9.5	1.0	31	8.3	2.7
	OU 4887	25.0	16.0	4.5	45	32.0	1.8
	OU 4888	27.0	13.0	7.0	44	55.0	1.6
	68-a	19.9	11.9	4.0	41	42.6	2.1
		18.0	10.0	4.0	39	21.0	2.2
		11.0	9.0	1.0	32	10.3	2.9
		6.0	5.0	0.5	26	2.0	4.3

32	91-a	16.0	9.0	3.5	36	21.0	2.3
		9.5	7.5	1.0	28	4.0	2.9
	91-b	19.0	11.0	4.0	38	23.3	2.0
		3.6	3.3	0.0	16	2.0	4.4
		3.1	3.1	0.0	14	1.3	4.5
		2.2	2.0	0.0	11	1.2	5.0
		1.5	1.5	0.0	8	1.1	5.3
	91-c	16.5	12.1	2.2	39	14.5	2.4
		10.0	10.0	0.0	33	6.2	3.3
	91-d	26.0	15.0	5.5	44	28.9	1.7
		8.0	7.0	0.5	30	6.2	3.8
		6.0	5.0	0.5	24	4.5	4.0
		4.0	4.0	0.0	18	1.5	4.5

Koninckophyllum nitellus

Loc.	No.	d	d^t	d^d	n	h	n/d
3-D	37	10.0	7.0	1.5	23	12.3	2.3
		2.0	2.0	0.0	12	1.5	6.0
9-C	40	9.0	7.0	1.0	26	15.0	2.9
17-A	OU 4867	9.6	6.0	1.8	28	37.0	2.9
		12.0	7.6	2.2	28	23.2	2.3
27-C	69-g	9.0	7.0	1.0	24	27.5	2.7
		7.7	5.7	1.0	24	13.5	3.1
		6.5	5.1	0.7	22	6.0	3.4
	69-h	6.3	4.3	1.0	22	14.0	3.5
		1.5	1.5	0.0	12	0.5	8.0
	69-i	10.2	8.2	1.0	27	21.2	2.6
		5.0	4.0	0.5	18	4.5	3.6
		4.0	3.4	0.3	17	2.5	4.3
		1.8	1.8	0.0	12	1.0	6.7
	69-j	10.0	7.6	1.2	24	17.7	2.4
	69-c	9.5	7.5	1.0	23	10.8	2.4
		2.7	2.7	0.0	16	1.3	5.9
	69-d	11.0	8.4	1.3	25	13.8	2.3
	69-e	13.0	8.0	2.5	23	14.0	1.8
32	90-a	12.5	8.5	2.0	24	15.2	1.9
	90-b	13.5	7.5	3.0	27	13.3	2.0
	90-c	9.5	6.5	1.5	25	14.7	2.6
	90-f	14.0	8.0	3.0	27	23.2	1.9
		4.5	3.5	0.5	20	2.2	4.4

Dibunophyllum sp.

Loc.	No.	d	d^t	d^d	n	h	n/d
18-U	OU 4870	17.0	12.0	2.5	30	-	1.8
		16.0	12.0	2.0	30	-	1.9
		14.4	11.0	1.7	30	-	2.1
		13.0	10.0	1.5	28	-	2.2

WAPANUCKA CORALS

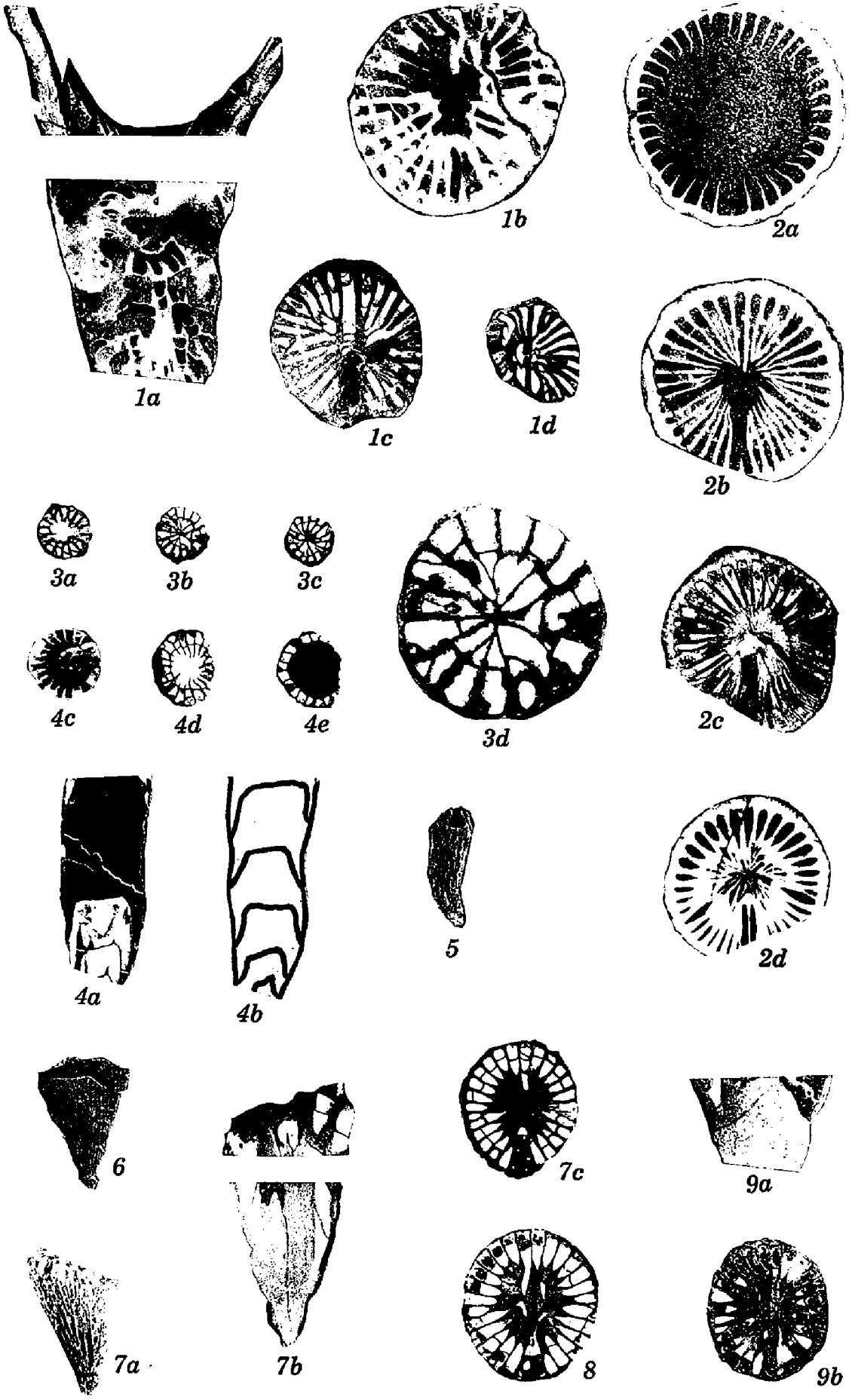
Plates 1-9

Plate 1

(All figures x2 unless stated otherwise)

Page

1. *Empodesma* cf. *E. imulum* Moore and Jeffords, OU 4801, loc. 24-E. 20
   a. Longitudinal section, alar plane.
   b. Transverse section at base of calice.
   c. Transverse section of ephebic stage.
   d. Transverse section of neanic stage; note joined cardinal and counter septa.
2. *Stereocorypha* cf. *S. spissata* Moore and Jeffords, OU 4802, loc. 18-U. 22
   a. Transverse section through upper part of calice.
   b. Transverse section at base of calice (reflected light).
   c. Transverse section of ephebic stage.
   d. Transverse section of early ephebic stage (reflected light, section reversed).
3. *Amplexocarinia corrugata* (Mather), OU 4803, loc. 18-U. 23
   a-c. Transverse sections of ephebic stages.
   d. Figure b enlarged, x7.5.
4. *Amplexocarinia corrugata* (Mather), OU 4804, loc. 18-U. 23
   a. Longitudinal section, alar plane.
   b. Diagram showing attitude of tabulae in figure a; note steeply inclined peripheral portions.
   c-e. Transverse sections showing shortened septa below tabulae.
5. *Amplexocarinia corrugata* (Mather), OU 4805, loc. 18-U, x1. Exterior of weathered corallite. 23
6. *Lophophyllidium idonium* Moore and Jeffords, OU 4806, loc. 4-A, x1. Exterior of typical corallite. 26
7. *Lophophyllidium idonium* Moore and Jeffords, topotype OU 4807, loc. 16-D. 26
   a. Exterior, x1.
   b. Longitudinal sections, alar plane.
   c. Transverse section at base of calice.
8. *Lophophyllidium idonium* Moore and Jeffords, topotype OU 4808, loc. 16-D. Transverse section; note interseptal spaces between counter and counter-lateral septa. 26
9. *Lophophyllidium idonium* Moore and Jeffords, OU 4809, loc. 24-E. 26
   a. Longitudinal section, cardinal-counter plane.
   b. Transverse section at base of calice.


1a
1b
1c
1d
2a
2b
2c
2d
3a
3b
3c
3d
4a
4b
4c
4d
4e
5
6
7a
7b
7c
8
9a
9b

1b

3

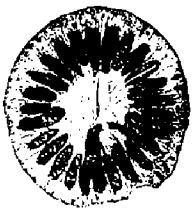
4a

4b

6a

6b

5

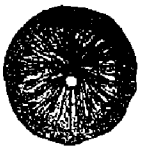


1a

2a

2b

9a



9b

10a

10b

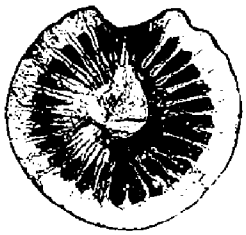
8a

8b

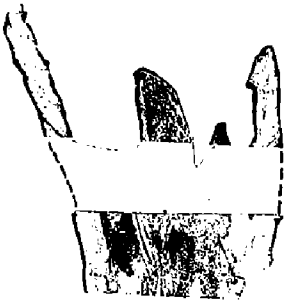
8c

7c

11

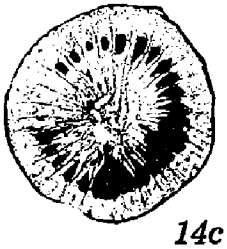


14b



7b

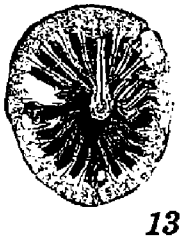
12



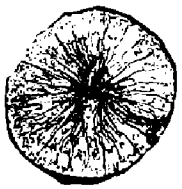
14c

14a

7a



13



14d

Plate 2

(All figures x2 unless stated otherwise)

Page

1. *Lophophyllidium idonium* Moore and Jeffords, OU 4810, loc. 4-A. 26
   a. Transverse section of ephebic stage; interseptal spaces between counter and counter-lateral septa not typically developed.
   b. Enlargement of axial region, x8.5.
2. *Lophophyllidium minutum* Jeffords, OU 4811, loc. 4-A. 28
   a. Exterior of incomplete corallite, x1.
   b. Transverse section at base of calice; note prominent alar pseudofossulae and axial thickening.
3. *Lophophyllidium minutum* Jeffords, OU 4812, loc. 4-A. Exterior of well-preserved specimen, x1. 28
4. *Lophophyllidium minutum* Jeffords, OU 4813, loc. 4-A. 28
   a. Longitudinal section, alar plane.
   b. Transverse section at base of calice; tabulae are not visible in this corallite.
5. *Lophophyllidium minutum* Jeffords, OU 4824, loc. 4-A. Exterior of corallite, x1. 28
6. *Lophophyllidium minutum* Jeffords, OU 4826, loc. 4-A. 28
   a. Transverse section at base of calice.
   b. Longitudinal section, cardinal-counter plane; note tabulae in this specimen.
7. *Lophophyllidium* sp. B, OU 4818, loc. 16-D. 39
   a. Transverse section through lower part of calice.
   b. Transverse section at base of calice.
   c. Transverse section of early ephebic stage.
8. *Lophophyllidium* sp. B, OU 4817, loc. 16-D. 39
   a. Exterior of corallite, x1.
   b. Transverse section at base of calice.
   c. Transverse section of early ephebic stage.
9. *Lophophyllidium ignotum* Moore and Jeffords, OU 4815, loc. 23-B. 31
   a. Transverse section of ephebic stage.
   b. Transverse section of early ephebic stage.
10. *Lophophyllidium ignotum* Moore and Jeffords, OU 4816, loc. 23-B. 31
    a. Longitudinal section, cardinal-counter plane.
    b. Transverse section of late ephebic stage; note thickening of stereozone and marked radial symmetry.
11. *Lophophyllidium ignotum* Moore and Jeffords, OU 4828, loc. 23-B. Transverse section of ephebic stage. 31
12. *Lophophyllidium ignotum* Moore and Jeffords, OU 4829, loc. 23-B. Exterior of reconstructed corallite, x1. 31
13. *Lophophyllidium ignotum* Moore and Jeffords, OU 4830, loc. 23-B. Transverse section at base of calice. 31
14. *Lophophyllidium ignotum* Moore and Jeffords, OU 4827, loc. 23-B. 31
    a. Longitudinal section, alar plane.
    b. Transverse section through lower part of calice.
    c. Transverse section at base of calice.
    d. Transverse section of early ephebic stage.

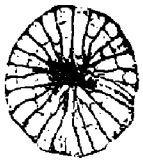
PLATE 3

(All figures x2 unless stated otherwise)

Page

1. *Lophophyllidium* cf. *L. angustifolium* Moore and Jeffords, OU 4822, loc. 4-A. 35
   a. Longitudinal section, alar plane.
   b. Transverse section at base of calice.
2. *Lophophyllidium* cf. *L. angustifolium* Moore and Jeffords, OU 4823, loc. 4-A. 35
   a. Longitudinal section, cardinal-counter plane.
   b. Transverse section at base of calice.
3. *Lophophyllidium* cf. *L. angustifolium* Moore and Jeffords, OU 4820, loc. 4-A. 35
   a. Exterior of corallite, x1.
   b. Longitudinal section, alar plane.
   c. Transverse section at base of calice.
4. *Lophophyllidium* cf. *L. angustifolium* Moore and Jeffords, OU 4821, loc. 4-A. 35
   a. Exterior of corallite, x1.
   b. Longitudinal section, alar plane.
   c. Transverse section at base of calice.
5. *Lophophyllidium* sp. A, OU 4831, loc. 4-A. 37
   a. Longitudinal section, alar plane.
   b. Transverse section through calice.
   c. Transverse section of ephebic stage.
   d. Exterior of corallite, x1.
6. *Lophophyllidium* sp. A, OU 4832, loc. 4-A. 37
   a. Longitudinal section, alar plane.
   b. Transverse section at base of calice.
   c. Transverse section of late neanic stage.
   d. Axial region shown in figure b enlarged x9.5.

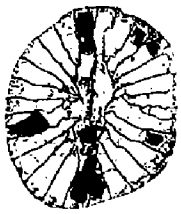
1a



1b

2a

2b

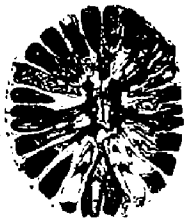


4c

4a

3a

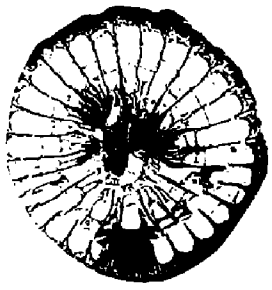
4b



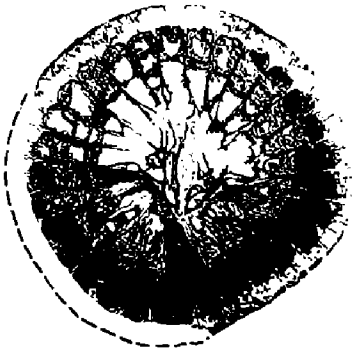
3c

3b

5d

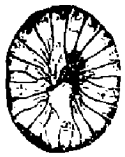


5c



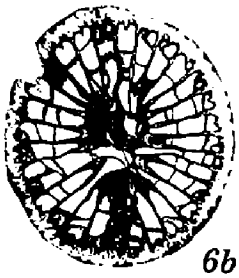
5b

5a

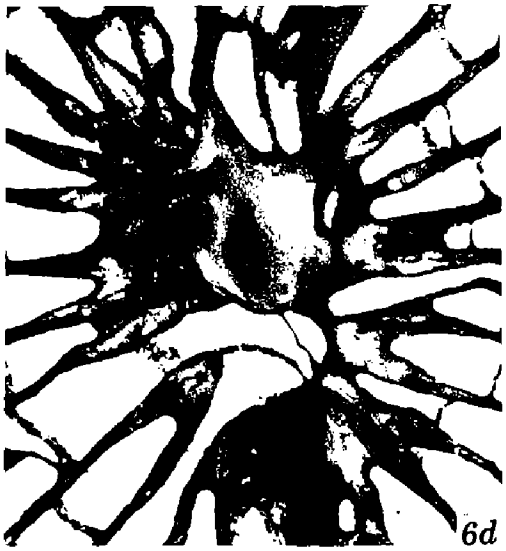


6c

6a



6b



6d

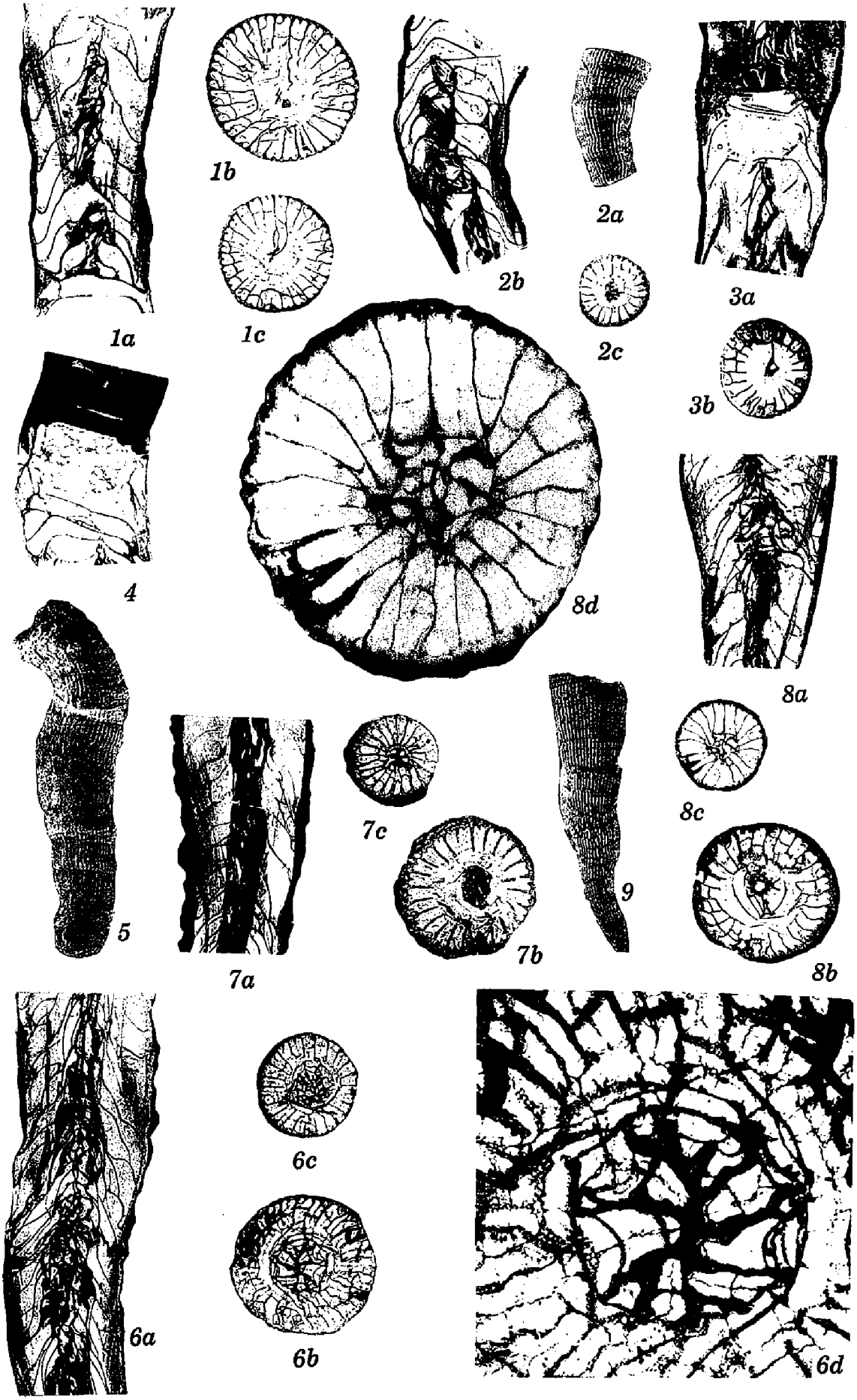

1a
1b
1c
2a
2b
2c
3a
3b
4
5
6a
6b
6c
6d
7a
7b
7c
8a
8b
8c
8d
9

Plate 4

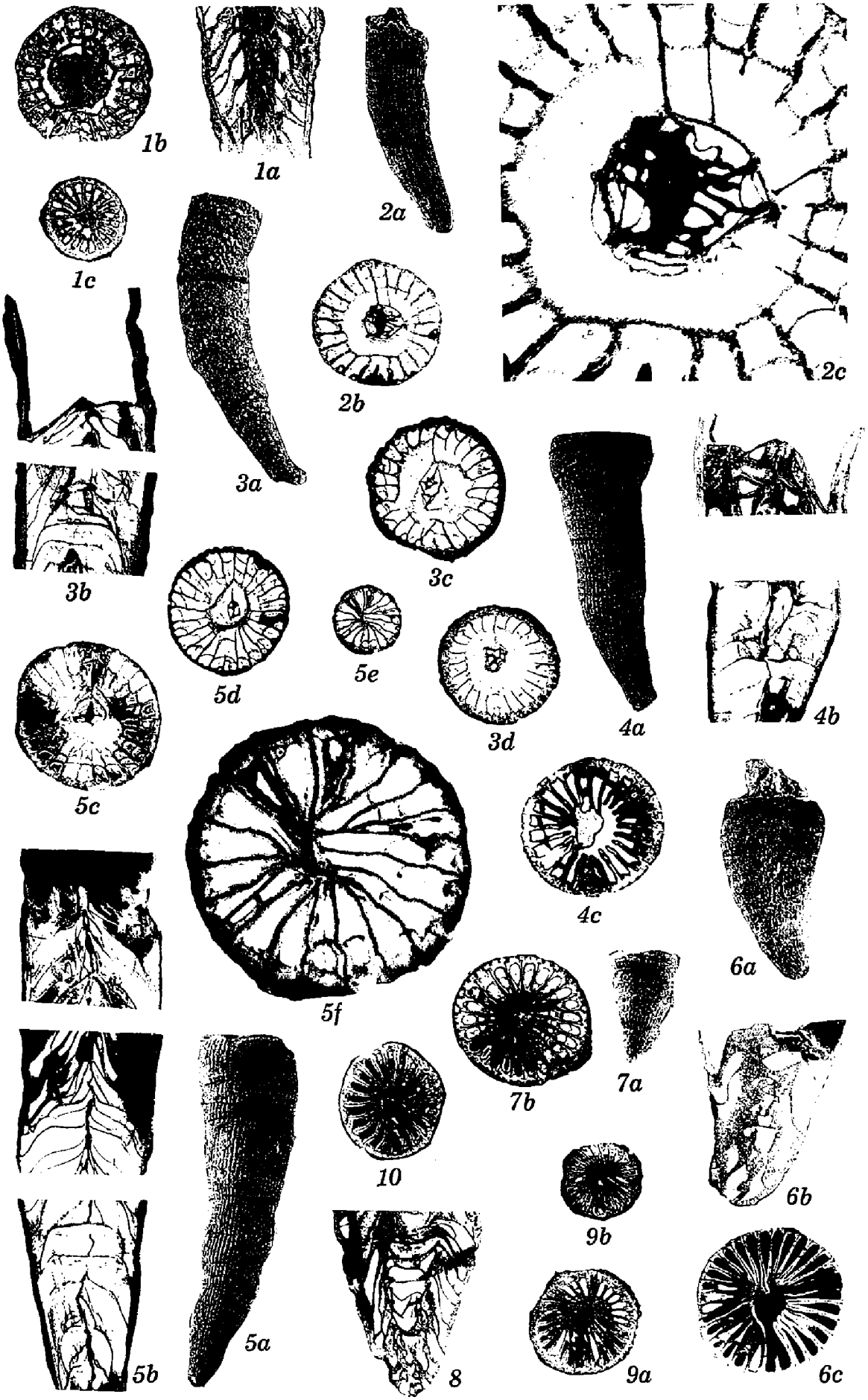
(All figures x2 unless stated otherwise)

Page

1. *Leonardophyllum morrowense*, new species, paratype OU 4833, loc. 4-A. 41
   a. Longitudinal section, alar plane; note discontinuous axial column.
   b, c. Transverse sections of ephebic stage.
2. *Leonardophyllum morrowense*, new species, paratype OU 4834, loc. 3-A. 41
   a. Exterior of corallite, x1.
   b. Longitudinal section, cardinal-counter plane.
   c. Transverse section of late neanic stage.
3. *Leonardophyllum morrowense*, new species, paratype OU 4835, loc. 3-A. 41
   a. Longitudinal section, alar plane.
   b. Transverse section of early ephebic stage.
4. *Leonardophyllum morrowense*, new species, paratype OU 4836, loc. 3-A. Longitudinal section, alar plane; note termination of axial column in lower part of section. 41
5. *Leonardophyllum morrowense*, new species, paratype OU 4837, loc. 4-A. Exterior of scolecoid specimen showing moderate rejuvenescence. 41
6. *Leonardophyllum morrowense*, new species, holotype OU 4838, loc. 4-A. 41
   a. Longitudinal section, alar plane.
   b, c. Transverse sections of late ephebic stage.
   d. Reversed view of axial column shown in figure b enlarged x8.
7. *Leonardophyllum morrowense*, new species, paratype OU 4839, loc. 3-A. 41
   a. Longitudinal section, alar plane.
   b, c. Transverse sections of ephebic stage.
8. *Leonardophyllum morrowense*, new species, paratype OU 4840, loc. 4-A. 41
   a. Longitudinal section, alar plane.
   b, c. Transverse sections of ephebic stage.
   d. Figure c, enlarged x10.5.
9. *Leonardophyllum morrowense*, new species, paratype OU 4841, loc. 3-A. Exterior, x1. 41

PLATE 5

(All figures x2 unless stated otherwise)


1b
1a
2a
1c
2b
2c
3a
3b
3c
5d
5e
3d
4a
4b
5c
5f
4c
6a
7b
7a
6b
10
9b
5a
8
9a
6c
5b

1a

1b

1c

2a

3

1d

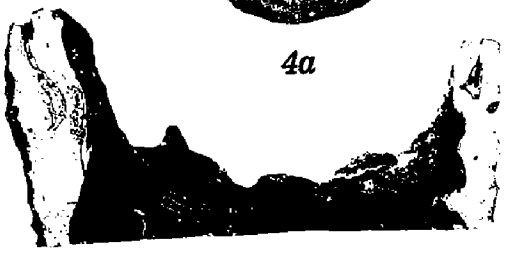
2b

4b

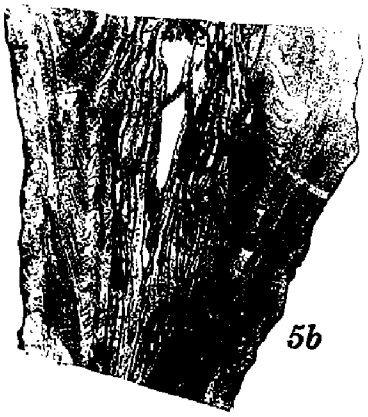
4a

5e

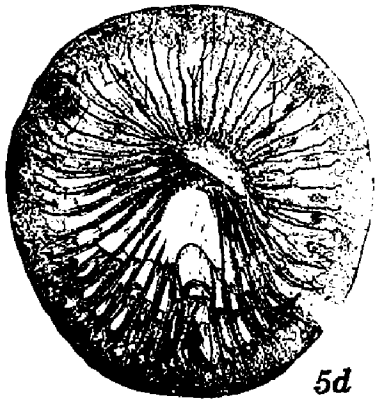
5c



5a



5b



5d

PLATE 6

(All figures x2 unless stated otherwise)

Page

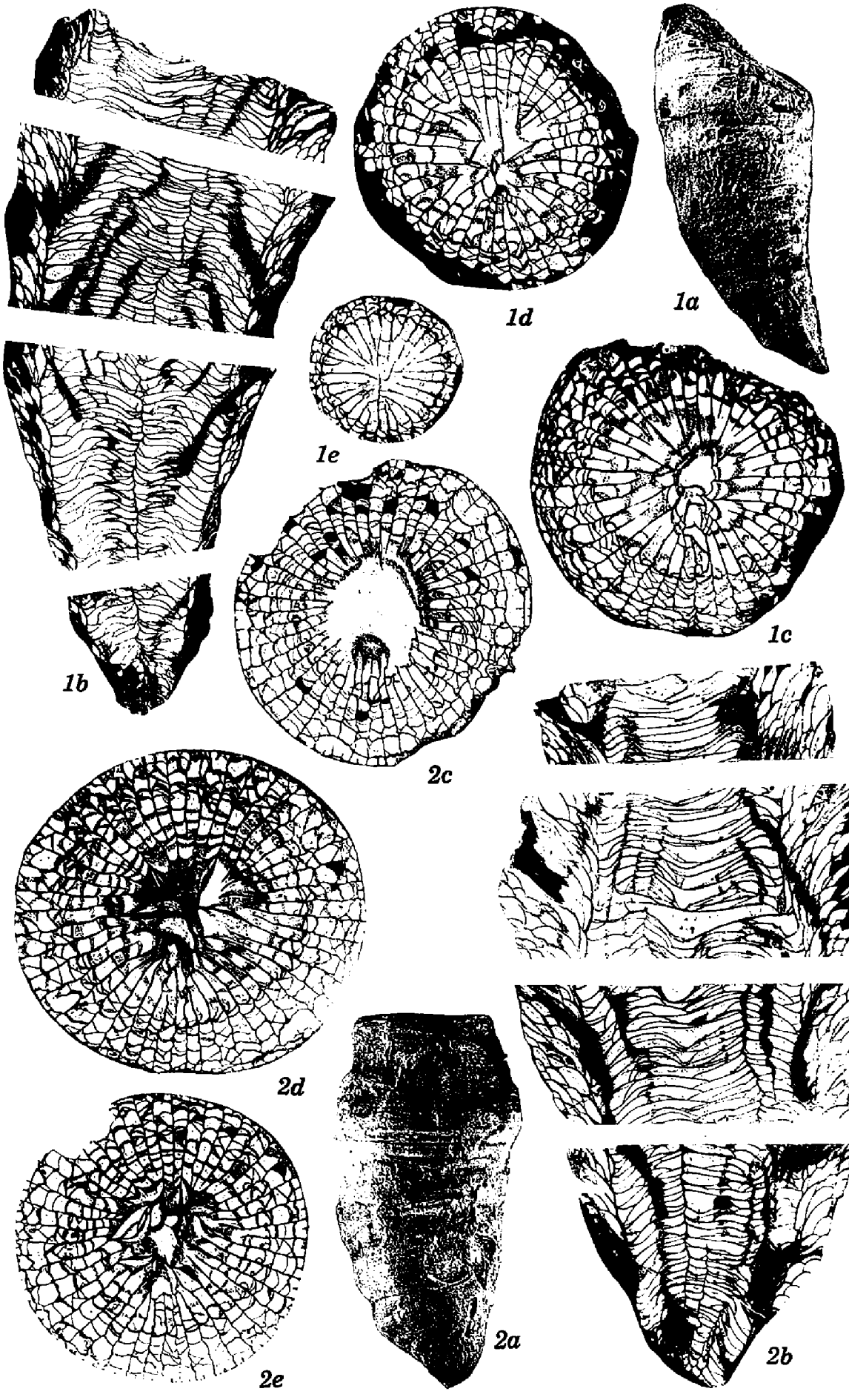
1. *Barytichisma callosum* Moore and Jeffords, OU 4852, loc. 4-A. 51
   a. Exterior, x1.
   b. Transverse section at base of calice.
   c. Transverse section of early ephebic stage.
   d. Transverse section of late neanic stage.
2. *Barytichisma callosum* Moore and Jeffords, OU 4854, loc. 4-A. 51
   a. Exterior, x1.
   b. Transverse section at base of calice.
3. *Barytichisma callosum* Moore and Jeffords, OU 4891, loc. 28-A. 51
   Transverse section of ephebic stage showing uncommonly thick peripheral stereozone.
4. *Barytichisma callosum* Moore and Jeffords, OU 4857, loc. 4-A. 51
   a. Transverse section of ephebic stage; note marginarium and long thin cardinal septum.
   b. Transverse section of neanic stage.
5. *Barytichisma callosum* Moore and Jeffords, OU 4858, loc. 3-D. 51
   a. Exterior, x1.
   b. Longitudinal sections, alar plane; note amplexoid nature of septa.
   c, d. Transverse sections of ephebic stage.
   e. Transverse section of late neanic stage or early ephebic stage.

Plate 7

(All figures x2 unless stated otherwise)

Page

1. *Koninckophyllum simplex* (Moore and Jeffords), OU 4859, loc. 21-J. 55
   a. Exterior, x1.
   b. Longitudinal sections, alar plane; note thin median lamella.
   c, d. Transverse sections of ephebic stage.
   e. Transverse section of late neanic stage.
2. *Koninckophyllum simplex* (Moore and Jeffords), OU 4860, loc. 21-J. 55
   a. Exterior, x1.
   b. Longitudinal sections, cardinal-counter plane.
   c-e. Transverse sections of ephebic stages.


1d
1a
1e
1b
1c
2c
2d
2a
2b
2e

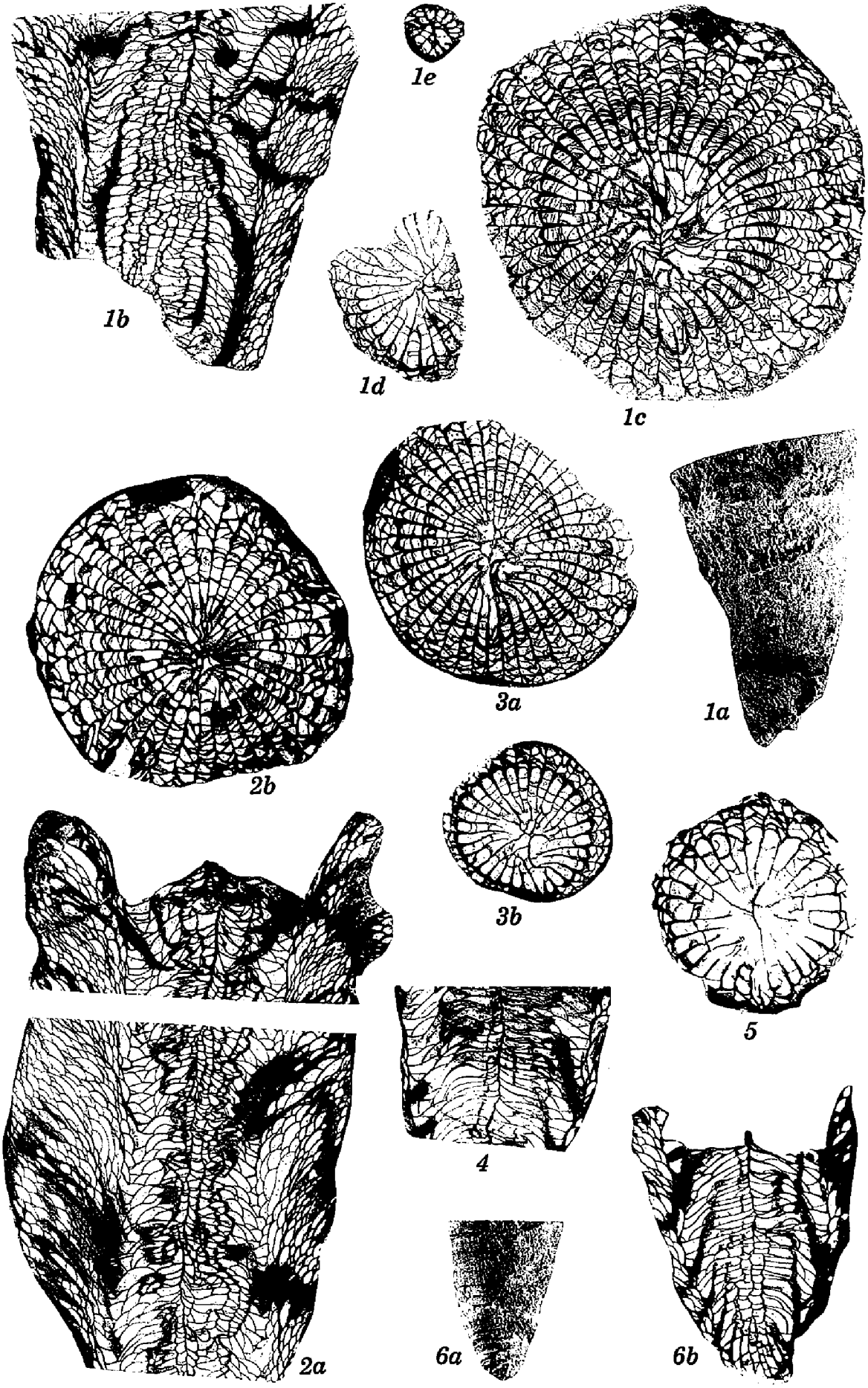

1e
1b
1d
1c
3a
1a
2b
3b
5
4
2a
6a
6b

PLATE 3

(All figures x2 unless stated otherwise)

Page

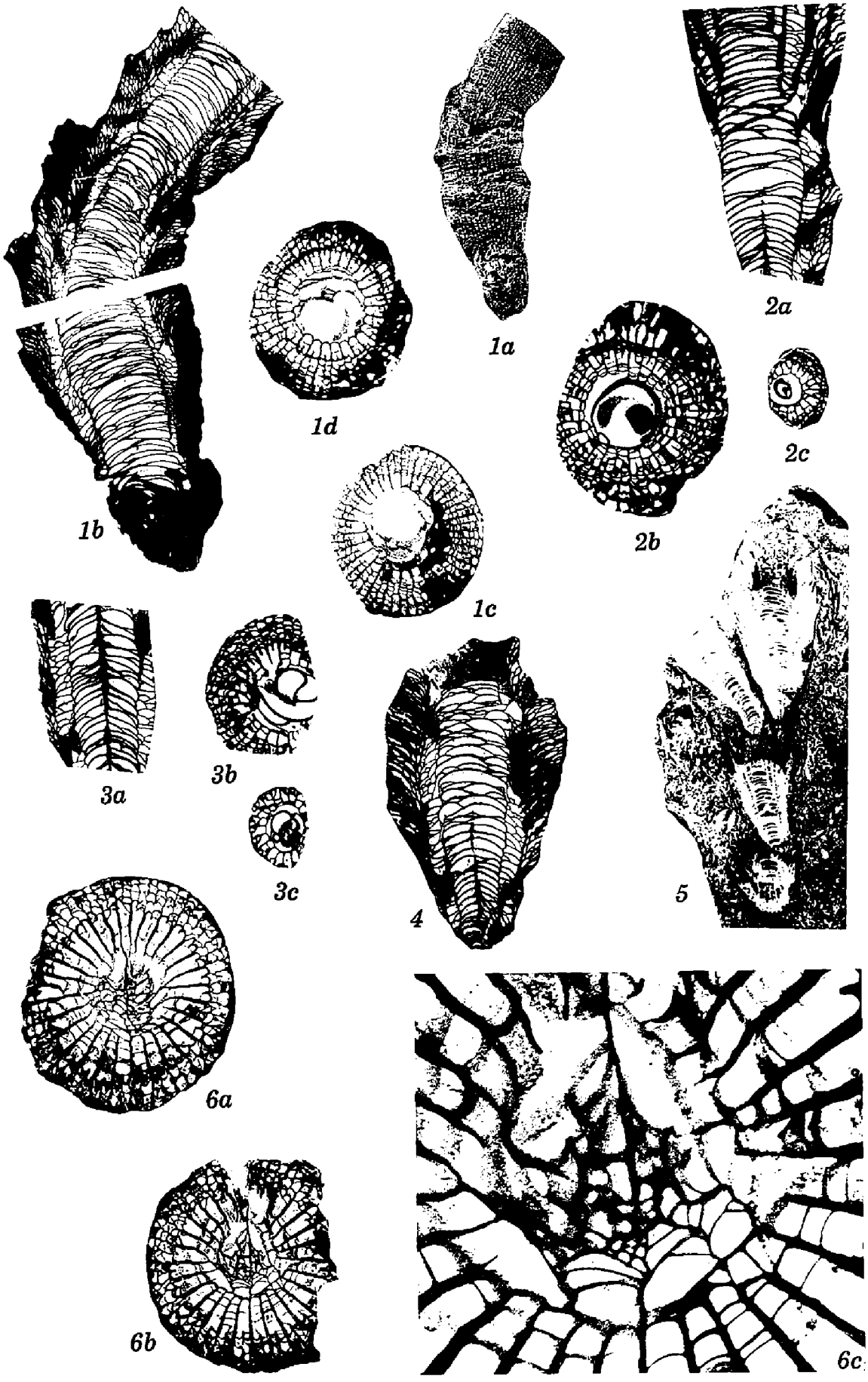
1. *Koninckophyllum oklahomense*, new species, holotype OU 4861, loc. 17-A. 58
   a. Exterior, x1.
   b. Longitudinal section, alar plane.
   c. Transverse section near base of calice.
   d. Transverse section of neanic stage.
   e. Transverse section of brephic stage.
2. *Koninckophyllum oklahomense*, new species, paratype OU 4862, loc. 17-A. 58
   a. Longitudinal sections, alar plane.
   b. Transverse section of ephebic stage.
3. *Koninckophyllum oklahomense*, new species, paratype OU 4863, loc. 27-C. 58
   a. Transverse section of ephebic stage.
   b. Transverse section of neanic stage.
4. *Koninckophyllum simplex* (Moore and Jeffords), OU 4864, loc. 18-U. Longitudinal section, alar plane. 55
5. *Koninckophyllum simplex* (Moore and Jeffords), OU 4865, loc. 18-U. Transverse section of ephebic stage. 55
6. *Koninckophyllum simplex* (Moore and Jeffords), OU 4866, loc. 18-U. 55
   a. Exterior, x1.
   b. Longitudinal section, alar plane.

PLATE 9

(All figures x2 unless stated otherwise)

Page

1. *Koninckophyllum nitellus* (Moore and Jeffords), OU 4867, loc. 17-A. 63
   a. Exterior, x1.
   b. Longitudinal section showing development of inner and outer zones in tabularium.
   c. Transverse section of ephebic stage.
2. *Koninckophyllum nitellus* (Moore and Jeffords), OU 4894, loc. 32. 63
   a. Longitudinal section showing columella in lower part.
   b. Transverse section of ephebic stage.
   c. Transverse section of neanic stage.
3. *Koninckophyllum nitellus* (Moore and Jeffords), OU 4895, loc. 32. 63
   a. Longitudinal section showing well-developed columella.
   b. Transverse section of ephebic stage.
   c. Transverse section of neanic stage.
4. *Koninckophyllum nitellus* (Moore and Jeffords), OU 4893, loc. 32. 63
   Longitudinal section; note column in early stages of growth, domed tabulae of inner tabularium in calice, and absence of dissepiments in the proximal portion of the corallite.
5. *Koninckophyllum nitellus* (Moore and Jeffords), OU 4896, loc. 17-A. 63
   Slab showing two calicular buds arising by peripheral increase from a corallite which in turn appears to have been budded from an earlier protocorallite, x1.
6. *Dibunophyllum* sp. A, OU 4870, loc. 18-U. 67
   a, b. Transverse sections of ephebic stage.
   c. Dibunophylloid axial structure shown in figure b enlarged x8.5.


1b
1d
1a
2a
2c
2b
1c
3a
3b
3c
4
5
6a
6b
6c

INDEX

(*Italic number* indicates main reference)