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MICROPALEONTOLOGY OF THE WETUI WEWOKA, AND HOLDENVILLE FORMATIONS

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INTRODUCTION

The Pennsylvanian strata which outcrop in the Mid-Continent region furnish the geologist with one of the best records of that period available anywhere in the world. Shallow seas supporting an abundance of life spread from Texas to Nebraska throughout much of the Pennsylvanian. Plants and animals, from the simple algae and protozoans to the amphibia and reptiles just emerging into the swamps along the shore, left their skeletons to be preserved in the muds and sands with a perfection remarkable in organic remains of such antiquity.

Most of the common (and therefore probably hardy) Pennsylvanian organisms are found as fossils of long time range, often occurring through almost the entire system with no readily discernible change. Living conditions seem to have varied little in the sea during the entire period, and there was probably scant stimulus either for development into new forms or for the immigration of exotic faunas. For this reason it is seldom possible to fix the position of any single bed in the system on the basis of one or a few species of fossils. Faunal groups must be recognized instead, and used in the correlation of Pennsylvanian strata. A founal group, however, can hardly be expected to retain its identity as such for distances much greater than about 200 miles, and reliance must then be placed upon the ranges of individual species in making correlations.

Much of the search for oil in the Mid-Continent region today is conducted in Pennsylvanian strata or in localities where they must be penetrated in order to reach the petroliferous horizons. To the geologist, and more particularly to the paleontologist, falls the task of determining within narrow limits the age of the rocks appearing at the surface and also the beds reached by the drill. In the latter case the identification must be based largely upon the extremely minute fossils which, on account of their small size, not only occur relatively unbroken in the well cuttings, but are found in great enough profusion so that a representative faunal assemblage may often be obtained from a teaspoonful of washed sample.

Active work on Pennsylvanian micropaleontology in this country has only been undertaken in recent years, and the published results have covered only a very small portion of the field. For the most part, the papers already written have either described the fossils of a single class of animals from one locality, or have described new forms from a scattering of horizons and localities. The applied micropaleontologist encounters fossils of many classes of animals in a single sample of rock, and can therefore render a more accurate opinion on the age of that sample if he appreciates the significance of all the fossils present, rather than those of a single group. The ranges of individual species are also little known, and difficult of determination from the published information. Unfavourable sea bottom conditions, the commonest one being expressed by a sandy lithologic facies, may preclude the occurrence of an organism. Again, the organism may be absent from all facies for a time, only to appear again as a recurrent element in the fauna. In discussing the range of any species, therefore, it must not be assumed that individuals of that species will be found in every bed or even in every fossiliferous horizon within its range.

It is the aim of this paper to describe most of the common microscopic fossils of a portion of the geologic column large enough to be useful in determining the ranges of the fossil species, and to include all the groups of animals which seem to be valuable in making age determinations of the strata. For this purpose the Wetumka, Wewoka and Holdenville formations of east-central Oklahoma were chosen. These formations have an aggregate thickness of about 800 feet and outcrop as a narrow belt one hundred miles in length in the central Oklahoma Pennsylvanian province. Strata of the same age lie both to the north and south, but different formational units are employed because of changing lithology. A detailed study of the microfauna of the Wetumka to Holdenville section should be of aid in making more precise correlations between these groups of contemporaneous strata.

ACKNOWLEDGMENTS

In both field work and later laboratory study the author has had the assistance of many people and organizations. He wishes to acknowledge especially his gratitude to the Gypsy Oil Company, which furnished laboratory facilities in Tulsa, and to Mr. John Fitts of Ada, Oklahoma, whose wide knowledge of the fossiliferous localities in the southern part of the area was an invaluable aid. The Faculty of the Department of Geology of Columbia University, and particularly Drs. J. J. Galloway and H. N. Coryell have given much helpful criticism and advice. The author is also indebted to Dr. R. S. Bassler and Dr. J. A. Cushman for the opportunity to examine type specimens and other important material.

STRATIGRAPHY

The Wetumka, Wewoka, and Holdenville formations outcrop in a belt which starts at the Arkansas River near Leonard, Oklahoma, and runs thence in a southwesterly direction for about one hundred miles to a point near Ada, where the outcrop is abruptly terminated by the fault marking the north edge of the Lawrence uplift. The Wewoka and Holdenville appear again five miles farther to the south in the Franks graben, but the beds there are considerably faulted and the exposure is small, so it is not included in this study.

Figure 1—Map of Oklahoma showing location of Wetumka, Wewoka and Holdenville formations.

The width of the outcrop is greatest at the north end, where it reaches 13 miles, but this decreases to an average of about 10 miles, and dwindles rapidly near Ada. The outcrop occupies parts of Tulsa, Wagoner, Okmulgee, Okfuskee, Hughes, Seminole and Pontotoc counties.

The Wetumka shale[1] is the oldest formation of the group under consideration. It is about 150 feet thick, any marked increase over this figure being usually due to the inclusion of some of the underlying Calvin sandstone. The lower and middle parts of the Wetumka are made up of a variably sandy shale, but the upper portion presents a greater diversity. In Pontotoc County it is a clay shale with non-persistent thin limestone layers, while in Hughes and Okfuskee counties it is highly arenaceous. At the north, on the Arkansas River, there is again a limestone bed in the upper Wetumka, as well as a smaller limestone layer one hundred feet below the top of the formation. None of the beds of the Wetumka offer great resistance to the attacks of the weather, and except for the upper part of the formation, which is usually protected by the basal sandstone of the Wewoka, the

1. All three formations were first described by Taff, J. A., U. S. Geol. Survey Geol. Atlas, Coalgate folio (No. 74), p. 4, 1901.

Wetumka forms gentle slopes and flats on which outcrops may be discovered only with some difficulty.

The Wewoka formation, lying conformably on the Wetumka shales is an alternation of sandstones and sandy or clay shales. Its average thickness is about 450 feet, but it reaches only half that figure in Okfuskee County. The base is well marked by a massive sandstone bed, frequently conglomeratic, about 20 feet thick, which forms a conspicuous ridge. Above this is a clay shale, occasionally fossiliferous, over 100 feet thick, succeeded in turn by a somewhat friable sandstone of like thickness. A fossiliferous blue shale about 125 feet thick occupies the middle of the formation. The upper Wewoka is composed of alternating shales and sandstones of less lateral persistence than the lower members, and is topped by a massive sandstone which is usually calcareous. Limestone layers of local extent are found in both the lower and middle shales.

The Holdenville formation overlies the Wewoka conformably, and reaches a thickness of 250 feet. Like the Wewoka, it thins a little in the central part of its exposure. The formation is chiefly shale, but it contains two thin limestone members which are fairly persistent in the southern half of the outcrop. The lower limestone, about 40 feet above the base is called the Homer member[2], and is separated by about seventy feet of shale and sandstones from the upper, or Sasakwa member[3]. Both limestones seem to have been derived from reefs in the Pennsylvanian sea, and they exhibit a faunal facies somewhat different from that occurring elsewhere in the shales. The Sasakwa member is capped by 35 feet of sandy shales and sandstones, which are overlain by the Seminole conglomerate.

The thicker sandstone and shale beds in these formations are persistent over most of the outcrop, but where the lithology alternates rapidly from shale to sandstone there is much lensing of strata, and the total thickness of the formation may change markedly in a short distance. This lensing also results in frequent variation in the distance of individual members from the top or bottom of their formations, the change being sometimes as great as 100 feet in a distance of 20 miles along the outcrop.

STRUCTURE

All three formations show a regional dip toward the west or northwest. This dip is usually one degree or less, but in some places it reaches four degrees. The direction of dip shifts slightly as one proceeds from north to south, the strike of the beds changing from N. 25° E. in Okmulgee County to N. 45° E. in Pontotoc County. In addition to the regional dip there are many small terraces, noses and domes, and the beds are also displaced occasionally by the system of *en echelon* faults prevailing in east-central Oklahoma.

2. Morgan, G. D., Bur. Geol., Norman, Okla., Bull. 2, 1924, p. 104.
3. Morgan, G. D., idem., p. 103.

CORRELATION

The Wetumka, Wewoka, and Holdenville formations have been correlated on the basis of the large fossils with formations in Texas, the Ardmore basin, northeast Oklahoma and the standard section in Kansas. In the latter region they correspond to the larger part of the Marmaton group, including the formations from the Fort Scott limestone to the Nowata shale.

On the basis of the microscopic faunas the best defined affinities seem to be between the lower Holdenville and the Wayland shale of Texas, and between the Sasakwa limestone and the upper part of the Oologah limestone in northeast Oklahoma. The upper Wetumka microfauna is closely allied to that of the upper Fort Scott limestone in the St. Louis outlier. The correspondence with the Fort Scott of the type locality in Kansas is somewhat less marked.

The faunal groups do not altogether coincide with formational boundaries erected on a lithologic basis. The upper Wetumka microfauna extends with little change for 100 feet into the lower Wewoka, and the lower Holdenville fauna is found in the calcareous beds at the top of the Wewoka. The most distinctive faunal groups of this area, together with the common or abundant fossils which characterize them are here listed.

UPPER WETUMKA—LOWER WEWOKA GROUP

Fusulinella meeki Dunbar and Condra
Septopora blanda Moore
Streblotrypa multipora n. sp.
Prismopora lobata n. sp.
Paraparchites latidorsatus n. sp.
Bairdia auricula Knight
Healdia nucleolata Knight
Healdia bythocyproidea n. sp.
Cavellina subpulchella Coryell

MIDDLE WEWOKA GROUP

Hyperamminoides glabra (Cushman and Waters)
Ammonema protea (Cushman and Waters)
Endothyra ameradaensis Harlton
Amphissites wewokanus n. sp.
Healdia formosa Harlton

LOWER HOLDENVILLE GROUP

Bradyina holdenvillensis Harlton
Fusulinella meeki var. *robusta* Dunbar and Condra
Orthonema, various species
Amphissites simplicissimus Knight
Bairdia oklahomaensis Harlton
Bairdia altifrons Knight

UPPER HOLDENVILLE GROUP (Exclusive of the Sasakwa member)

Hollinella digitata Kellett
Jonesina ampla n. sp.
Bairdia nitida Harlton
Cytherella intermedia Jones, Kirkby and Brady
Cavellina pulchella Coryell

SASAKWA LIMESTONE GROUP

Polytaxis laheei Cushman and Waters
Tuberitina bulbacea Galloway and Harlton
Thamniscus tenuiramus Rogers
Rhombocladia delicata Rogers
Bairdia pompilioides Harlton
Bythocypris sasakwaensis n. sp.

The occurrence of the species in the last group is largely influenced by the fact that they represent a limestone reef facies in the upper Holdenville. This group of fossils, therefore, should hardly be expected in shales of this age, but might occur in other reef limestones slightly younger or older than the Sasakwa.

PREVIOUS WORK

Scattered information only has been published upon the micropaleontology of these formations. The chief workers have been Cushman, Girty, Morgan, Harlton, Coryell, Knight, Roth, Waters, and Moore. References to their papers will be found under those species of their description which are here included.

METHOD OF PROCEDURE

The collections upon which this paper is based were made by the author during August and September of 1928, about one month being spent in the field. A brief trip in the summer of 1929 also provided material for the extension of the original collection. In order to secure a full series of samples from the formations studied, and to discover any lateral variations in the faunas, collections were made along the whole outcrop of the beds, starting near Broken Arrow and extending southward to Pontotoc County. All the published localities for microscopic or large fossils were visited, and a traverse was made across the strike of the beds approximately once in every township. The first collections were washed up in the laboratory and given a rapid examination in order to determine the most fossiliferous localities, and to see that fossiliferous samples were secured from all horizons. Further collecting was then undertaken to fill out gaps in the series.

Except for the primary collections little attention was paid to beds of sandstone or extremely sandy shales. These coarsely clastic beds are seldom completely devoid of fossils, but they contain only infrequent and broken remains, usually of but one or two hardy species which are of little significance stratigraphically. Shale partings in limestone, or shales directly above or below limestone layers provided excellent collections, except in the case of some highly arenaceous limestones in the central part of the area.

About 400 sacks of samples were washed and examined, representing collections from about one-fourth of the outcrops visited in the field. Collections were made from formations both above and below the section under consideration to assist in determining the ranges of species.

All the samples used in this study are outcrop samples collected by the author, and determined stratigraphically by pace and level reference to the nearest observable key horizon. Well samples were not considered because of the difficulty of determining the exact horizon from which the sample was taken, due to possible contamination, mislabeling, or crookedness of hole.

Samples were prepared for study by soaking in water and boiling until the mud particles were free and could be poured away. A few of the samples did not disintegrate readily on boiling, and had to be subjected to repeated freezing and thawing in an electric refrigerator. The fossils were separated from the washed residue by picking directly from it or first applying a little centrifugal separation to speed the process.

For the purposes of this paper, "microscopic" fossils are considered to be any fossils which either whole or in readily recognizable fragments will pass through a sieve having meshes 2.5 mm. square.

All identifications with previously described species have been made only after comparison with the original figure and description. Types and other specimens were examined at the U. S. National Museum and the Cushman Laboratory at Sharon, Massachusetts. The type specimens of most of the Foraminifera and Ostracoda here discussed have been examined by the author. Nearly all of the recently named species in these two groups that are here put into synonymy are so treated only as a result of studying the type specimens of both the original and the synonymous species. The relatively large number of synonyms made in the last five years is due not only to the rapidity with which papers on allied problems have been following each other, but also to a misinterpretation of illustrations, a hazard removed where one can have recourse to the actual type specimens.

As a concomitant to the study of the organisms from their external structures, a large number of thin sections of the fossils were prepared. In exceptional cases as many as fifty sections were made of a single species in an effort to determine what characters in the section were due to post-mortem changes. These sections were studied under the petrographic microscope at magnifications up to 500 diameters, and the conclusions drawn from such studies were confirmed in so far as possible from the petrographic standpoint by Professor R. J. Colony of Columbia University.

ILLUSTRATIONS AND TYPES

The figures for illustration were prepared by Miss L. K. Barkman, assistant in micropaleontology at Columbia University. Outlines were drawn with the aid of the camera lucida, and checked by the author before and after shading.

The holotypes and figured specimens are deposited in the Columbia University Paleontological Collection.

SYSTEMATIC DESCRIPTIONS

Phylum PROTOZOA

Order FORAMINIFERA d'Orbigny

Among the groups of microscopic fossils here discussed, the Foraminifera are surpassed only by the Ostracoda in number of species. In size they exhibit greater diversity than do the ostracods, as recognizable specimens range from about 0.1 mm. to nearly 10 mm. in length.

The geologic ranges of the Pennsylvanian Foraminifera of the Mid-Continent area are not yet well known. A compilation of the occurrences noted in earlier publications, together with data derived from this study, shows only thirty species recorded from diverse enough localities to give an approximation of their full vertical extent. These species had an average range of over 4,000 feet of sediments. Such a figure is open to two important criticisms. It takes little account of the rare species, which may have a relatively short life, and it is based on evidence so incomplete that the ranges of many species will be much extended in the future. It is probable, however, that these two factors will nearly counteract each other, and leave this average little disturbed. This average range, nevertheless, is smaller than that of the common large fossils found in the same beds, which show an average of nearly 10,000 feet. In both cases the ranges are so large that correlation is usually practical only when based on local abundance or absence of common species within their range. The appended table of occurrence is an attempt to show the relative abundance of the fossils here described.

Family ASTRORHIZIDAE H. B. Brady

Genus HYPERAMMINOIDES Cushman and Waters, 1928

Hyperamminoides Cushman and Waters, Contrib. Cushman Lab. Foram. Res., vol. 4, pt. 4, 1928, p. 112.

HYPERAMMINOIDES GLABRA (Cushman and Waters)

Plate I, fig. 1

Nodosinella glabra Cushman and Waters, Contrib. Cushman Lab. Foram. Res., vol. 3, pt. 3, 1927, p. 147, pl. 26, figs. 4, 5. (Below Gunsight limestone, Graham, Texas.)

Hyperamminoides glabra Cushman and Waters, Jour. Pal., vol. 2, 1928, p. 359, pl. 47, figs. 1, 2. (Upper Pennsylvanian, Sutton county, Texas.)

Test slender, straight or gently curved, consisting of a proloculum and a single tubular chamber; surface smooth, marked at irregular intervals by growth lines which are usually slightly depressed; wall finely arenaceous; aperture terminal, large, round, formed by a slight constriction of the end of the test. Length, up to 1 mm.; diameter at apertural end, up to 0.15 mm.

Growth is accomplished in this species by pushing out the constricted apertural end and adding more material to it, thus producing at each operation an irregular growth line in the test, which gives it the appearance of being divided into chambers. This species is distinguished from *H. minuta* (Cushman and Waters) only by the obsolescence of the growth lines in the adult stages of the latter species.

Family SPIRILLINIDAE Rhumbler

Genus AMMOVERTELLA Cushman, 1928

Ammovertella Cushman, Contrib. Cushman Lab. Foram. Res., vol. 4, pt. 1, 1928, p. 8.

AMMOVERTELLA INVERSA (Schellwien)

Plate I, fig. 2

Psammophis inversus Schellwien, Palaeontographica, vol. 44, 1898, p. 266, pl. 23, fig. 10. (Upper Pennsylvanian, Carnic Alps.)—Cushman and Waters, Contrib. Cushman Lab. Foram. Res., vol. 3, pt. 2, 1927, p. 109, pl. 22, fig. 4. (Middle Pennsylvanian, Michigan.)

Psammophis inclusus Cushman and Waters, Contrib. Cushman Lab. Foram. Res., vol. 3, pt. 3, 1927, p. 148, pl. 26, fig. 12. (Below Gunsight limestone, Young County, Texas.)

Ammovertella inversa Cushman, Contrib. Cushman Lab. Foram. Res., vol. 4, pt. 1, 1928, p. 8.

Calcitornella elongata Cushman and Waters, Contrib. Cushman Lab. Foram. Res., vol. 4, pt. 2, 1928, p. 47, pl. 6, fig. 5. (Below Gunsight limestone, Young County, Texas.) — Galloway and Ryniker, Oklahoma Geol. Surv., Circ. 21, 1930, p. 10, pl. 1, figs. 10, 11. (Atoka formation, Latimer County, Oklahoma.)

Calcitornella heathi Cushman and Waters, Contrib. Cushman Lab. Foram. Res., vol. 4, pt. 2, 1928 p. 48 pl. 6, fig. 8. (Five feet above Gunsight limestone, Young County, Texas.)

Calcivertella adherens Cushman and Waters, Contrib. Cushman Lab. Foram. Res., vol. 4, pt. 2, 1928, p. 48, pl. 6, fig. 7. (Bunger limestone, Young County, Texas.)

Ammovertella undulata Galloway and Harlton, Jour. Pal., vol. 2, 1928, p. 341, pl. 45, fig. 2. (Atoka formation, Latimer County, Oklahoma.)—Galloway and Ryniker, Oklahoma Geol. Surv., Circ. 21, 1930, p. 9, pl. 1, fig. 6. (Same locality)

Ammovertella latimerensis Galloway and Harlton, Jour. Pal., vol. 2, 1928, p. 342, pl. 45, figs. 3, 4. (Atoka formation, Latimer County, Oklahoma.)—Galloway and Ryniker, Oklahoma Geol. Surv., Circ. 21, 1930, p. 10, pl. 1, figs. 8, 9. (Same locality)

Ammovertella adherens Galloway and Ryniker, Oklahoma Geol. Surv., Circ. 21, 1930, p. 10, pl. 1, fig. 7. (Atoka formation, Latimer County, Oklahoma.)

Test adherent, irregular, consisting of a proloculum and tubular second chamber which is coiled planispirally at first and then irregularly back and forth around the early portion, frequently embracing it; wall calcareous, probably imperforate, usually covered with agglutinated material in the later stages; surface smooth in the early coils, later more or less roughened; aperture simple, the open end of the tube. Diameter of the tube, up to 1 mm.

This species is here interpreted to include all of the irregularly coiled, embracing, attached forms with probably hyaline walls found in this part of the column. The shape of each individual is determined chiefly by the proportions of the object to which it adheres. There is so much variation that if so inclined one could make a new species for almost every specimen. In identifying any species, however, a far greater amount of variation is to be allowed in forms coiled irregularly than in nearly or wholly symmetrical species.

Genus AMMONEMA Eimer and Fickert, 1899

Ammonema Eimer and Fickert, Zeitschr. wiss. zool., vol. 65, 1899, p. 685.

AMMONEMA PROTEA (Cushman and Waters)

Plate I, fig. 3

Orthovertella protea Cushman and Waters, Contrib. Cushman Lab. Foram. Res., vol. 4, pt. 2, 1928, p. 45, pl. 6, figs. 3, 4. (Moran formation, Archer County, Texas.)

Test free, consisting of a proloculum and single tubular chamber of nearly even diameter, coiled tightly and irregularly in the young, later becoming evolute and straight or irregular; wall calcareous, apparently imperforate; surface smooth; aperture simple, the open end of the tube. Total length, up to 2.5 mm.; diameter of coiled portion, 0.25 mm., diameter of tube just above coiled portion, 0.17 mm.

This species is separated from *Ammonema filum* (Schmid) by the more rapid enlargement of the tube resulting in a relatively much thicker tube at the beginning of the evolute portion than in Schmid's species.

Genus TREPEILOPSIS Cushman and Waters, 1928

Trepeilopsis Cushman and Waters, Contrib. Cushman Lab. Foram. Res., vol. 4, pt. 2, 1928, p. 38, pl. 4, figs. 12, 13.

TREPEILOPSIS SPIRANS (Cushman and Waters)

Plate I, fig. 4

Turritellella spirans Cushman and Waters, Contrib. Cushman Lab. Foram. Res., vol. 3, pt. 2, 1927, p. 109, pl. 22, figs. 5, 6. (Middle Pennsylvanian, Michigan.)

Test free, consisting of a single tubular chamber tightly coiled in a high, even spire, which enlarges rapidly in the first three volutions, and more gradually in the remaining six; wall calcareous; surface smooth, or rarely with faint traces of growth lines; aperture the open end of the tube. Length, 0.72 mm.; maximum diameter, 0.18 mm.

This species is separated from *T. grandis* (Cushman and Waters) by its more close and regular habit of coiling. The tube does not lap back over the preceding coils in any of the specimens examined.

Family MILIOLIDAE d'Orbigny

Genus RECTOCORNUSPIRA, new genus

Genoholotype, *Rectocornuspira lituiformis*, new species. (Pennsylvanian, Lower Wewoka formation, four miles west of Allen, Oklahoma.)

Test free, or attached only in the gerontic stage, consisting of a proloculum and tubular second chamber, involute and coiled planispirally or nearly so in the young stage, evolute and straight or irregular in the adult; wall porcellaneous, imperforate; aperture the open end of the tube. Length, up to 1 mm.

Habitat, shallow water sediments.

Range, Ordovician and Silurian of Oklahoma, Mississippian of Great Britain, Pennsylvanian of Great Britain, Oklahoma and Texas.

This genus evolved from *Cornuspira* by becoming evolute without greatly specializing the tube. The correct affiliations of the Paleozoic planispiral forms and their derivatives are imperfectly understood at present. Specimens with siliceous tests are usually referred to *Ammodiscus* and *Lituotuba,* and the remainder to *Cornuspira, Spirillina* and *Hemigordius.* The author's sections of siliceous specimens show a wall made up of minute, angular quartz grains, those at the surface exhibiting crystal faces. In no case was any "shadow" of a previously existing rounded grain discernible within the quartz crystal. It is believed that the siliceous specimens have all been subjected to secondary replacement, and that their walls were all originally calcareous. The occurrence of *Ammodiscus* or *Lituouba* in the Paleozoic is here regarded as questionable.

In addition to the species here discussed, *Trochammina centrifuga* H. B. Brady, (Pal. Soc. Mono., 1876, p. 74, pl. 2, fig. 20), and those species referred to *Ammodiscus* and *Lituotuba* by Moreman (Jour. Pal., vol. 4, 1930, pp. 58, 59) should be assigned to this genus.

In distinguishing the Carboniferous species the following key may prove helpful:

Coils embracing more than half of preceding coil
- Coiled part large (over 0.35 mm.) ..... *R. lituiformis*
- Coiled part small (under 0.3 mm.) ..... *R. centrifuga*

Coils embracing half or less of preceding coil
- Abruptly uncoiling, nucleoconch asymmetrical ..... *R. calcarina*
- Gradually uncoiling, nucleoconch symmetrical ..... *R. holdenvillana*

RECTOCORNUSPIRA LITUIFORMIS n. sp.

Plate I, fig. 5

Cornuspira involvens Harlton (not Reuss), Jour. Pal., vol. 1, no. 1, 1927, p. 25, pl. 5, fig. 9. (Upper Glenn formation, Love County, Oklahoma.)

Test free or infrequently attached by the later portion, consisting of a proloculum and a tubular second chamber, involute and coiled planispirally for three to five volutions and then abruptly becoming evolute and wandering; wall porcellaneous, imperforate, irregularly thickened; whorls asymmetrical; aperture simple, the open end of the tube. Length, up to 1 mm.; diameter of the free tube, up to 0.18 mm.; diameter of the coil, 0.25 to 0.50 mm., usually above 0.35 mm.

Holotype, Columbia University Pal. Coll. No. 19963.

Lower Wewoka formation, 115 feet above base, locality 38, four miles west of Allen, Oklahoma.

This species is very abundant at this single outcrop, but is not common elsewhere. The specimen described by Harlton as *Cornuspira involvens* lacks the evolute portion.

RECTOCORNUSPIRA CALCARINA (Waters)

Plate I, fig. 6

Lituotuba calcarina Waters, Jour. Pal., vol. 1, no. 4, 1928, p. 273, pl. 42, figs. 2, 3. (Below Ranger limestone, Brown County, Texas.)

Test lenticular, biconcave, consisting of a proloculum followed by a tube coiled once around the proloculum and then planispirally at right angles to the first coil for from four to six volutions, finally becoming evolute and straight or irregular; whorls only slightly embracing; tube usually with a few septa in the early portion; wall porcellaneous, imperforate; aperture simple, the open end of the tube. Diameter of the coil, 0.3 to 0.6 mm.; diameter of the free tube, up to 0.15 mm.; total length, up to 1 mm.

Specimens which have the evolute portion undeveloped or broken off may be distinguished from *Cornuspira harltoni* (Cushman and Waters) by their lack of secondary thickening in the umbilical region. The first whorl, being coiled in a different plane, often protrudes slightly into the umbilical region, making specimens which lack the uncoiled part superficially resemble *Ammodiscoides.*

RECTOCORNUSPIRA HOLDENVILLANA n. sp.

Plate I, fig. 7

Lituotuba centrifuga Harlton (not H. B. Brady), Jour. Pal., vol. 1, no. 1, 1927, p. 17, pl. 1, fig. 3. (Mineral Wells formation, near Mineral Wells, Texas.)

Test free, consisting of a proloculum and tubular chamber coiled planispirally for about four volutions, then gradually becoming evolute and irregular; wall porcellaneous, imperforate; surface smooth in the early stages, becoming highly wrinkled in the last coil and the evolute portion; aperture simple, the open end of the tube. Total length, 0.42 mm.; diameter of coil, 0.22 mm.

Holotype, Columbia University Pal. Coll. No. 19964.

Holdenville formation, ten feet above base, locality 29, three miles east of Ada, Oklahoma.

This species is distinguished from *R. calcarina* by its smaller size, lack of an asymmetrical nucleoconch and the gradual rather than abrupt assumption of the evolute habit of growth.

Genus APTERRINELLA Cushman and Waters, 1928

Apterrinella Cushman and Waters, Contrib. Cushman Lab. Foram. Res., vol. 4, pt. 3, 1928, p. 64.

APTERRINELLA GRAHAMENSIS (Harlton)

Plate I, fig. 8

Tolypammina grahamensis Harlton, Jour. Pal., vol. 1, no. 4, 1928, p. 305, pl. 52, fig. 1. (Graham formation, Jack County, Texas.)

Apterrinella grahamensis Cushman and Waters, Contrib. Cushman Lab. Foram. Res., vol. 4, pt. 3, 1928, p. 64.—Cushman, ibid., p. 68, pl. 9, figs. 1-4.

Test attached, consisting of a proloculum followed by a flattened tubular chamber which coils once or twice in the microspheric form or doubles back and forth in the megaspheric form and then becomes irregularly wandering; wall calcareous, imperforate; surface smooth in the microspheric young, in other stages more or less completely covered with fine to coarse puncta; aperture simple, the open end of the tube. Length, up to 4 mm.

This form resembles *Ammovertella inversa* very markedly, but the wall structure and the surface ornamentation seem to be distinctive characters.

Family ENDOTHYRIDAE Rhumbler

Genus ENDOTHYRA Phillips, 1846

Endothyra Phillips, Rep. Proc. Geol. Poly. Soc. West Riding Yorks., 1844-45 (1846), p. 277, pl. 7, fig. 1.

This genus is abundantly represented in the Pennsylvanian of the Mid-Continent region, but there is no general agreement either as to its wall structure or its place in the classification of Foraminifera. It is especially important to determine the wall structure of *Endothyra* because it is the potential ancestor of several of the later families of Foraminifera. Most of the disagreement is due to the fact that it is extremely difficult to find specimens well enough preserved to show the original structure of the walls. Out of one hundred specimens picked out especially for sectioning only two showed under the petrographic microscope that they were not badly recrystallized, the rest having a granular appearance in the wall which has led to its being interpreted as made up of agglutinated grains. The best sections studied showed a thin calcareous wall with a small proportion of included rounded grains of non-secreted matter. The wall also showed faint structures running at right angles to its surface. These are interpreted as traces of fine, sparse perforations in the wall. The amount of agglutinated matter in the wall does not approach that in most Recent "arenaceous" Foraminifera, so *Endothyra* can not be assigned to the Lituolidae, and it is here placed, together with *Bradyina* and *Globivalvulina,* in the Endothyridae of Rhumbler.

ENDOTHYRA ROTHROCKI Harlton

Plate I, figs. 9a, 9b

Endothyra rothrocki Harlton, Jour. Pal., vol. 1, no. 4, 1928, p. 306, pl. 52, fig. 3. (Graham formation, Jack County, Texas.)—Galloway and Ryniker, Oklahoma Geol. Surv., Circ. 21, 1930, p. 12, pl. 2, fig. 1-3. (Atoka formation, Latimer County, Oklahoma.)

Test nautiloid, asymmetrical, with small umbilici; periphery slightly lobulate; back rounded; sutures straight, radial, slightly depressed; chambers gradually enlarging, eight or nine in the last whorl; wall calcareous; surface punctate; aperture a low slit at the base of the last septal face. Diameter, up to 0.45 mm.

This species differs from *E. ovata* Waters in having a lower slit for an aperture, and from *E. bowmani* Phillips in having a smaller umbilicus and in being more symmetrically coiled.

ENDOTHYRA OVATA Waters

Plate I, figs. 10a, 10b

Endothyra ovata Waters, Jour. Pal., vol. 1, no. 4, 1928, p. 274, pl. 42, fig. 6. (Below Ranger limestone, Brownwood, Texas.)

Test nautiloid, almost planispiral, involute, umbilicate, periphery very little lobulate; back rounded, chambers closely appressed, usually nine in the last whorl; sutures slightly depressed, appearing limbate in the umbilical region; wall calcareous, with suggestions of fine perforation; aperture a high arched slit at the base of the last septal face, extending half way to the periphery. Diameter, up to 0.8 mm.

It is possible that the height of the aperture on the septal face is dependent only on the size which the individual has attained. In this event *E. rothrocki* Harlton would be included here as a synonym.

ENDOTHYRA ROTALIFORMIS n. sp.

Plate I, figs. 11a, 11b

Test coiled with strong asymmetry so that about two of the volutions show on the flat side and only the last one on the opposite convex side; young specimens with a narrow, deep umbilicus on the convex side, adults embracing completely on that side, forming an umbo; chambers appressed, about nine in the last whorl; periphery nearly smooth; back rounded; wall calcareous; surface finely punctate; aperture a slit at the base of the last septal face, on the convex side. Diameter, up to 0.5 mm.

Holotype, Columbia University Pal. Coll. No. 19965.

Upper Wetumka formation, 30 feet below top, locality 57, 2.5 miles west of Steedman, Oklahoma.

This species may be separated from asymmetrical specimens of *Endothyranella powersi* (Harlton), which lack the evolute portion, by its smooth periphery and smaller size. It parallels some forms of Rotaliidae very closely, and it may represent a stage near to the ancestor of that family.

ENDOTHYRA AMERADAENSIS Harlton

Plate I, fig. 12

Endothyra ameradaensis Harlton, Jour. Pal., vol. 1, no. 1, 1927, p. 19, pl. 2, fig. 4. (Upper Glenn, Carter County, Oklahoma.)

Haplophragmoides ciscoensis Harlton, Jour. Pal., vol. 1, no. 4, 1928, p. 307, pl. 52, fig. 5. (Cisco formation, Eastland County, Texas.)

Test nearly planispiral, nautiloid; umbilici very large, shallow; back rounded; chambers inflated, ten to twelve in the last coil; sutures deeply depressed; wall calcareous; surface smooth; aperture a high arched opening arising from the base of the last septal face and extending over half or more of the face. Diameter, up to 0.45 mm.

This species may be recognized by its large umbilici, nearly planispiral coil, and numerous inflated chambers.

Genus ENDOTHYRANELLA Galloway and Harlton, 1930

Endothyranella Galloway and Harlton, Oklahoma Geol. Surv., Circ. 21, 1930, p. 13.

ENDOTHYRANELLA POWERSI (Harlton)

Plate I, figs. 13, 14

Ammobaculites powersi Harlton, Jour. Pal., vol. 1, no. 1, 1927, p. 21, pl. 3, fig. 3. (Lower Glenn, Love County, Oklahoma.)

Endothyranella powersi Galloway and Harlton, Oklahoma Geol. Surv., Circ. 21, 1930, p. 13.

Test umbilicate, nearly planispiral and involute in the young stages, becoming evolute and straight in adult specimens; periphery slightly lobulate; back rounded; chambers moderately appressed, enlarging gradually, eight to twelve visible in the last whorl; sutures straight, depressed, radial or oblique or both; wall calcareous, with a small amount of agglutinated matter, probably finely perforate, the pores opening to the surface in small pits; aperture an arched slit at the base of the last septal face, growing higher in the later chambers and becoming terminal and round in the evolute chambers. Diameter of the coil, up to 0.7 mm., total length, 1 mm.; up to 2 mm., according to Harlton.

A study of thin sections shows that the wall is predominantly calcareous and not arenaceous. Considerable variation is apparent in this form, but the different types are not considered worthy of separate names. As observed in the formations under consideration, the differences may be summarized as follows:

Lower Wetumka: large forms, coiled quite asymmetrically, and tending to have a large number of chambers in the last whorl; evolute specimens common. This form is most like the holotype.

Upper Wetumka and Lower Wewoka: small specimens, more symmetrically coiled, chambers less numerous than in the preceding; evolute adults common.

Middle Wewoka: numerous, like the preceding except in that the sutures are often slightly oblique, particularly in weathered specimens.

Upper Wewoka: specimens small and rare, particularly as evolute adults.

Holdenville: specimens small, with radial sutures; evolute adults very rare.

Genus OROBIAS Eichwald, 1860

Orobias Eichwald, Lethaea Rossica, vol. 1, 1860, p. 352.

OROBIAS CISCOENSIS (Harlton)

Plate II, fig. 1

Staffella ciscoensis Harlton, Jour. Pal., vol. 1, no. 4, 1928, p. 307, pl. 52, fig. 9. (Cisco formation, Eastland County, Texas.)

Orobias ciscoensis Galloway and Harlton, Jour. Pal., vol. 2, 1928, p. 350, pl. 45, fig. 11. (Atoka formation, Latimer County, Oklahoma.)—Galloway and Ryniker, Oklahoma Geol. Surv., Circ. 21, 1930, p. 15, pl. 2, fig. 9. (Same locality)

Test lenticular, gently biconvex, closely and symmetrically coiled; back acute or slightly rounded; umbilici depressed in young specimens, faint or absent in adults; chambers 16-25 in the last whorl; sutures distinct, curved, thickened; wall calcareous; surface smooth; aperture a triangular opening on the last septal face. Diameter, up to 0.5 mm.

Specimens secured from the Homer limestone at locality 54 only reached the stage of development where they possessed about 17 chambers in the last whorl, and a diameter of 0.35 mm. Adults collected from the Oologah limestone at locality 1 reached a diameter of 0.5 mm., and had about 24 chambers in the last whorl. The smaller specimens may be distinguished from *O. formosa* (Harlton) by the absence of the very strongly limbate sutures characteristic of that species.

Genus BRADYINA Möller, 1878

Bradyina Möller, Mem. Acad. Imp. Sci. St. Petersbourg, ser. 7, vol. 25, no. 9, 1878, p. 78, pl. 3, fig. 4.

The genotype is found in the Pennsylvanian of Russia, and although the author has been unable to study topotypes it is unlikely that they differ in any important points from the species which occur in Texas and Oklahoma. These species have a calcareous wall showing a fairly well developed keriotheca, the walls including rounded grains of agglutinated matter which may make up as much as one third of the wall material.

Cushman and Waters have separated off the genus *Glyphostomella* on the basis of the arenaceous character of the walls and the presence of a "funnel-shaped" vestibule into which the apertures open, but as the latter character is visible in sections of *Bradyina* as figured by Möller, and the former character is probably present in the same sections, *Glyphostomella* can hardly be regarded as anything but a synonym of *Bradyina*.

BRADYINA HOLDENVILLENSIS Harlton

Plate I, figs. 15a, 15b

Bradyina holdenvillensis Harlton, Jour. Pal., vol. 1, no. 1, 1927, p. 18, pl. 2, fig. 1. (Anadarche limestone, Carter County, Oklahoma.)

Ammochilostoma ? triloculina Cushman and Waters, Contrib. Cushman Lab. Foram. Res., vol. 3, pt. 3, 1927, p. 152, pl. 27, fig. 5. (Below Gunsight limestone, Young County, Texas.)

Glyphostomella triloculina Cushman and Waters, Contrib. Cushman Lab. Foram. Res., vol. 4, pt. 2, 1928, p. 53, pl. 6, figs. 11-13, pl. 7, fig. 1.

Test nautiloid, unsymmetrically coiled, especially in the young, umbilicate; periphery slightly lobulate; back rounded; chambers inflated, three to five, usually four, visible in the last whorl, rapidly increasing in size, the last chamber the least embracing; wall calcareous, alveolar as in the keriotheca of *Fusulina,* no tectum visible; keriotheca built partially of agglutinated grains, chiefly calcite; surface smooth, speckled with closely appressed maculae about 0.025 mm. in diameter, the ends of the keriotheca tubuli; apertures in the form of one to many straight or curved narrow slits, at the base of the last septal face and also at the top of, or completely covering, the face. Diameter, up to 2 mm., usually about 1 mm.

This species exhibits some variation in the number and position of the apertures. The young stage (that on which Cushman and Waters founded the species *Ammochilostoma ? triloculina*) has only three chambers in the last whorl and a few apertures parallel to, or at the base of, the last septal face. Older individuals have more apertures, usually located at right angles to the septa, and extending all around the chamber. The apertures along the septa open into a vestibule which in turn leads into the chamber.

Genus GLOBIVALVULINA Schubert, 1920

Globivalvulina Schubert, Pal. Zeitschr., vol. 3, pt. 2, 1920, p. 153.

GLOBIVALVULINA BULLOIDES (H. B. Brady)

Plate I, figs. 16a, 16b

Valvulina bulloides Brady, Pal. Soc. Mono., 1876, p. 89, pl. 4, figs. 12-15. (Upper Coal Measures of Iowa.)

Globivalvulina bulloides Harlton, Jour. Pal., vol. 1, no. 1, 1927, p. 23, pl. 5, fig. 2. (Upper Glenn, Carter County, Oklahoma.)—Galloway and Ryniker, Oklahoma Geol. Surv., Circ. 21, 1930, p. 16, pl. 3, fig. 1. (Atoka formation, Latimer County Oklahoma.)

Globivalvulina cora Harlton, Jour. Pal., vol. 1, no. 4, 1928, p. 309, pl. 53, fig. 4. (Gaptank formation, near Marathon, Texas.)

Globivalvulina ovata Cushman and Waters, Contrib. Cushman Lab. Foram. Res., vol. 4, pt. 3, 1928, p. 65, pl. 8, fig. 8. (Below Gunsight limestone, Graham, Texas.)

Test subquadrate, chambers added in a roughly biserial plan, slightly overlapping, the last one extending farther across the axis and breaking the biserial pattern; sutures depressed, distinct; wall calcareous; surface smooth; aperture a slit in the broad depression on the ventral surface. Length, 0.4 mm.

The author has examined the type specimens of all the species listed in the above synonymy, and despite the apparent differences in some of the illustrations can see no reason for distinguishing more than the one species. This species differs from *G. gaptankensis* Harlton in not being as perfectly biserial, and in not showing the tendency to coil exhibited in the latter species.

GLOBIVALVULINA GAPTANKENSIS Harlton

Plate I, figs. 17a, 17b

Globivalvulina gaptankensis Harlton, Jour. Pal., vol. 1, no. 4, 1928, p. 308, pl. 53, fig. 3. (Gaptank formation, near Marathon, Texas.)

Globivalvulina biserialis Cushman and Waters, Contrib. Cushman Lab. Foram. Res., vol. 4, pt. 3, 1928, p. 64, pl. 8, fig. 7. (Bunger limestone, Young County, Texas.)—Galloway and Ryniker, Oklahoma Geol. Surv., Circ. 21, 1930, p. 16, pl. 2, figs. 10, 11, pl. 3, fig. 2. (Atoka formation, Latimer County, Oklahoma.)

Test roughly hemispherical, chambers rapidly enlarging, considerably overlapping, added in a distinct diserial arrangement, the structure thus formed coiled planispirally so that the last chambers cover the early part of the coil; about ten chambers visible in the last coil; sutures faintly depressed, distinct; wall calcareous; surface finely punctate; aperture a slit on the inner side of the last chamber, on the flat or slightly concave ventral surface. Diameter, up to 0.4 mm.

This species probably developed from *G. bulloides* by an advance in the perfection of the biserial arrangement.

Genus TETRATAXIS Ehrenberg, 1843

Tetrataxis Ehrenberg, Bericht k. preuss. Ak. Wiss., Berlin, 1843, p. 106.

TETRATAXIS PLICATA (H. B. Brady)

Plate I, fig. 18

Valvulina plicata H. B. Brady, Mem. Geol. Surv. Scotland Expl. Sheet 23, 1873, p. 66; Pal. Soc. Mono., 1876, p. 88, pl. 4, figs. 10, 11. (Mississippian, Great Britain; Pennsylvanian, Great Britain, Southern Iowa.)

Test occurring free, flat or slightly concave on the ventral side, gently convex on the dorsal side; periphery slightly lobulate; edge of test rounded; chambers spirally arranged; all the whorls showing on the dorsal surface, only the last whorl distinguishable on the ventral side; about seven arcuate chambers in the last whorl; sutures strongly recurved, not deeply depressed; wall calcareous; surface smooth; aperture on the ventral edge of the chamber. Diameter, up to 0.45 mm.

This beautiful species has apparently not been recognized in this country since Brady listed it from a "fusulina-limestone from the Upper Carboniferous of Southern Iowa". It may represent an intermediate stage between *Tetrataxis* and an *Endothyra* or primitive *Globivalvulina.*

TETRATAXIS LATA Spandel

Plate I, figs. 19a, 19b

Tetrataxis conica Ehrenberg, var. *lata* Spandel, Naturhist. Gesell. Nűremberg, Festschrift, 1901, p. 186, fig. 6. (Upper Carboniferous, Hooser, Kansas.)

Tetrataxis lata Galloway and Ryniker, Oklahoma Geol. Surv., Circ. 21, 1930, p. 17, pl. 3, figs. 3, 4. (Atoka formation, Latimer County, Oklahoma.)

Test free or rarely attached, a high cone with a slightly concave base; chambers three or four in the last whorl, each with a rounded or pointed flap extending into the umbilicus on the ventral side; sutures little depressed, usually obscure; wall calcareous; surface smooth; aperture on the ventral side, beneath the flap of each chamber. Diameter at base, up to 0.9 mm.; height of cone, up to 0.6 mm.

Spandel's original figures were drawn from thin sections which did not cut the apex of the spire, and thus show fewer whorls than the specimens really possessed. This species differs from *T. conica* Ehrenberg only in being smaller and probably in having a lower spire.

TETRATAXIS CORONA Cushman and Waters, var. PAUPERATA n. var.

Plate I, figs. 20a, 20b

Test a moderately high cone in the young portion, later becoming much depressed; ventral side slightly concave; chambers in the adult two to a whorl, each succeeding whorl moving about 60 degrees around the periphery, the last whorl not embracing the two preceding whorls completely, so that two chambers appear complete on the ventral side of the periphery, together with portions of four earlier chambers; wall calcareous; surface smooth; apertures on the inner edges of the chambers. Diameter, up to 0.5 mm.; height of cone, up to 0.2 mm.

Holotype, Columbia University Pal. Coll. No. 19966.

Holdenville formation, Homer limestone member, locality 54, three miles east of Ada, Oklahoma.

This form differs from *T. corona* only in not having reached the stage where the two chambers in the last whorl become larger and embrace the two preceding whorls completely. It is perhaps merely a stunted form.

Genus POLYTAXIS Cushman and Waters, 1928

Polytaxis Cushman and Waters, Contrib. Cushman Lab. Foram. Res., vol. 4, pt. 2, 1928, p. 51.

POLYTAXIS LAHEEI Cushman and Waters

Plate I, figs. 21a, 21b

Polytaxis laheei Cushman and Waters, Contrib. Cushman Lab. Foram. Res., vol. 4, pt. 2, 1928, p. 51, pl. 7, fig. 7. (Kickapoo Falls limestone, Parker County, Texas.)

Test extremely depressed conical, especially in the adult, the ventral side concave; periphery slightly lobulate; chambers numerous, appressed, increasing from two in a whorl in the nucleoconch to seven or eight shorter, marginally arranged, scale-like chambers in the last whorl; sutures distinct, depressed; wall calcareous, smooth; aperture on the inner margin of the chamber, not covered by succeeding chambers in that whorl. Diameter, up to 2 mm.

This species is distinguished from *P. multiloculata* (Cushman and Waters), which occurs in slightly higher beds in Texas, by being thin edged and possessing depressed, unthickened sutures.

Family NODOSINELLIDAE Rhumbler

Genus NODOSINELLA H. B. Bady, 1876

Nodosinella H. B. Brady, Pal. Soc. Mono., 1876, p. 102.

The following species are doubtfully referred to *Nodosinella,* their walls being made up of coarse particles instead of the fine grains characteristic of the genotype, *N. digitata* H. B. Brady. The genus *Reophax,* to which they might be referred, is probably not present in the Paleozoic.

NODOSINELLA ? FITTSI n. sp.

Plate II, fig. 7

Test carrot-shaped, consisting of from four to six chambers, circular in cross section, uniserially arranged, regularly increasing; sutures slightly depressed, somewhat obscure; wall coarsely arenaceous, except near the aperture where the secreted cement predominates; surface rough; aperture terminal, round, with a faintly produced neck. Length, up to 0.9 mm.; length of fifth chamber, 0.38 mm.; diameter of same chamber, 0.23 mm.

Holotype, Columbia University Pal. Coll. No. 19967.

Lower Wewoka formation, 115 feet above base, locality 38, four miles west of Allen, Oklahoma.

This species probably developed from *Bigenerina ciscoensis* Cushman and Waters by the loss of the biserial portion. It is distinguished from *N. ? arenata* Cushman and Waters by being more slender and having a greater number of chambers, and it differs from *N. ? delicatula* n. sp. in having the aperture at the end of a slightly produced neck.

The specific name is given for Mr. John Fitts, of Ada, Oklahoma.

NODOSINELLA ? ARDMORENSIS Harlton

Plate II, fig. 5

Nodosinella ardmorensis Harlton, Jour. Pal., vol. 1, no. 1, 1927, p. 18, pl. 1, fig. 5. (Lower Dornick Hills formation, Love County, Oklahoma.)

Nodosinella brevis Waters, Jour. Pal., vol. 1, no. 2, 1927, p. 131, pl. 22, fig. 9. (Dornick Hills formation, Carter County, Oklahoma.)

Test slender, straight or nearly so, consisting of from two to five pyriform chambers, uniserially arranged, slightly embracing, rather rapidly increasing in size; sutures depressed, distinct; wall coarsely arenaceous, with large rounded and angular quartz grains embedded in a ferrugino-argillaceous cement; surface rough; aperture terminal, large, round. Length, up to 1.8 mm.; length of last chamber, 1.12 mm. in a four-chambered form; diameter of same chamber, 0.6 mm.

The original figures of the two species here united have little in common, but a comparison of the holotypes leaves no doubt as to their identity. This species is distinguished from the others here discussed by its much larger size.

NODOSINELLA ? ARENATA Cushman and Waters

Plate II, fig. 8

Nodosinella arenata Cushman and Waters, Contrib. Cushman Lab. Foram. Res., vol. 3, pt. 3, 1927, p. 147, pl. 26, figs. 2, 3. (Upper Strawn, Palo Pinto County, Texas.)

Test short, composed of two inflated chambers, round in transverse section, slightly longer than broad; sutures conspicuously depressed; wall coarsely arenaceous, most of the grains being siliceous; surface rough; aperture large, round, with a slightly produced neck. Length, up to 0.9 mm.; diameter of the last chamber, up to 0.45 mm.

None of the specimens collected in Oklahoma had more than two chambers, although from the lower beds of the type locality in Texas come specimens with a maximum of four chambers.

NODOSINELLA ? DELICATULA n. sp.

Plate II, fig. 6

Test slender, nodosariform; chambers six or seven in number, regularly enlarging, the early ones appressed, the later ones becoming slightly inflated; surface rough; wall arenaceous; aperture terminal, round, large. Length, up to 0.55 mm.

Holotype, Columbia University Pal. Coll. No. 19968.

Holdenville formation, Sasakwa limestone member, locality 46, three miles east of Ada, Oklahoma.

This species is distinguished by its small size and regularly increasing chambers. It probably developed from a small *Ammobaculites* by losing the coiled early stage.

Genus MONOGENERINA Spandel, 1901

Monogenerina Spandel, Naturhist. Gesell. Nürnberg, Festscrift, 1901, p. 181, fig. 3.

The genus *Monogenerina* was founded to include uniserial Foraminifera observed in thin sections of silicified limestone from Cowley County, Kansas. No indication as to the original structure of the wall is found in the description or illustration, but the proportions of the figures tally closely with those of the calcareous or very slightly agglu-

tinated forms found elsewhere in the Mid-Continent region, some of which have already been placed under *Monogenerina* by Cushman and Waters (Jour. Pal., vol. 2, 1928, p. 363.) The calcareous uniserial forms are here placed in this genus, while the distinctly agglutinated species are referred to *Nodosinella.*

MONOGENERINA GRANDIS n. sp.

Plate II, fig. 4

Test slender, slightly curved, nodosariform; chambers inflated, wider than long, appressed but not embracing, up to eleven in number; sutures strongly depressed, distinct; wall calcareous, with an inner transparent layer and a thin outer apparently agglutinated layer mottled with white spots of secondarily deposited calcite; surface moderately smooth, with short obscure longitudinal costae, about nine in number, around the top of the adult chambers; aperture on the terminal flat face of the chamber, large and irregularly rounded. Length, up to 2.2 mm.; 11th chamber of holotype 0.27 mm. long, 0.51 mm. wide.

Holotype, Columbia University Pal. Coll. No. 19969.

Ologah limestone, upper part, locality 1, one mile northeast of Broken Arrow, Oklahoma.

This form is recognized by its large size, gradually increasing inflated chambers and the obscure ornamentation. The aperture is filled with foreign material in all the specimens examined. Broken specimens only were found in the Holdenville formation, so the holotype was taken from a correlated horizon in the Ologah limestone.

Genus TUBERITINA Galloway and Harlton, 1928

Tuberitina Galloway and Harlton, Jour. Pal., vol. 2, 1928, p. 346, pl. 45, fig. 8.

TUBERITINA BULBACEA Galloway and Harlton

Plate I, fig. 22

Tuberitina bulbacea Galloway and Harlton, Jour. Pal., vol. 2, 1928, p. 346, pl. 45, fig. 8. (Anadarche limestone, Carter County, Oklahoma.)—Galloway and Ryniker, Oklahoma Geol. Surv., Circ. 21, 1930, p. 20, pl. 4, figs. 10-12. (Atoka formation, Latimer County, Oklahoma.)

Test attached, monothalmous or in colonies of two or more bulbous chambers separated by thick necks, in an irregular uniserial arrangement; wall calcareous, apparently perforate; surface smooth or punctate; aperture unknown or absent. Diameter of chambers, up to 0.35 mm.; length of test, up to 0.85 mm.

This organism has no clear relationship to any family of Foraminifera, and perhaps belongs in some other order.

Family LITUOLIDAE Reuss

Genus AMMOBACULITES Cushman, 1910

Ammobaculites Cushman, U. S. Nat. Mus. Bull. 71, pt. 1, 1910, p. 114, fig. 176.

AMMOBACULITES STENOMECA Cushman and Waters

Plate II, fig. 9

Ammobaculites stenomeca Cushman and Waters, Contrib. Cushman Lab. Foram. Res., vol. 4, pt. 2, 1928, p. 39, pl. 5, fig. 1. (Below Gunsight limestone, Young County Texas.)

Test slender, the early portion compressed, close coiled, of about four chambers, followed by a straight or slightly curved evolute portion containing three to five chambers, round in cross section; chambers one half wider than long; sutures slightly depressed; surface rough; wall coarsely arenaceous, of agglutinated quartz grains; aperture terminal, round. Length, up to 0.6 mm.

These specimens collected from the Holdenville are somewhat smaller than those originally described from Texas, averaging only 0.4 mm. in length. This species is rather rough in outline because of the large relative size of the agglutinated grains. The roughness of the surface and the small size of the test serve to distinguish it from *A. nitida* Waters.

Family TEXTULARIIDAE d'Orbigny

Genus BIGENERINA d'Orbigny, 1826

Bigenerina d'Orbigny, Ann. Sci. Nat., vol. 7, 1826, p. 261, pl. 11, figs. 9-11.

BIGENERINA CISCOENSIS Cushman and Waters

Plate II, fig. 10

Bigenerina ciscoensis Cushman and Waters, Contrib. Cushman Lab. Foram. Res., vol. 4, pt. 3, 1928, p. 63, pl. 8, fig. 5. (Below Gunsight limestone, Graham, Texas.)

Test slender, the early portion compressed, consisting of about twelve chambers biserially arranged, followed by from three to five uniserially arranged chambers, round in cross section; chambers one third wider than long; sutures slightly depressed; surface rough; wall coarsely arenaceous, of agglutinated quartz grains; aperture terminal, elliptical. Length, up to 0.4 mm.

Genus DECKERELLA Cushman and Waters, 1928

Deckerella Cushman and Waters, Jour. Pal., vol. 2, 1928, p. 128, pl. 19, figs. 1, 2, 5.

DECKERELLA LAHEEI Cushman and Waters

Plate II, figs. 3a, b

Deckerella laheei Cushman and Waters, Jour. Pal., vol. 2, 1928, p. 130, pl. 18, figs. 1-14, pl. 19, figs. 3, 4, 6. (Above Gunsight limestone, Young County, Texas.)

Test elongate, slender, subcylindrical; biserial chambers 10-16 in number, with slightly depressed sutures, followed by three to five subequal chambers uniserially arranged, one half wider than long, with more strongly depressed sutures; wall composed of two layers, an inner apparently perforate calcareous layer, and an outer agglutinated layer; aperture textularian in the early biserial stage, progressively advancing up the septal face, and in the uniserial chambers consisting of two parallel slits occupying a terminal position. Length, up to 2.25 mm.; diameter, 0.6 mm.

The relative thickness of the two layers of the wall apparently depends chiefly on the character of the sea bottom where the organisms lived. Specimens from the Homer limestone had the calcareous part developed nearly to the exclusion of the agglutinated layer, while in the Holdenville shales but 30 feet below this condition was reversed.

Genus CLIMACAMMINA H. B. Brady, 1873

Climancammina H. B. Brady, Mem. Geol. Surv. Ecotland, Expl. Sheet 23, 1873, p. 94; Pal. Soc. Mono., 1876, p. 67, pl. 2, figs. 1-9.

CLIMACAMMINA LUCILLEAE (Harlton)

Plate II, figs. 2a, b

Cribrostomum lucilleae Harlton, Jour. Pal., vol. 1, no. 1, 1927, p. 22, pl. 4, fig. 2. (Arnold limestone ? Carter County, Oklahoma.)

Climacammina antiqua Harlton (not H. B. Brady), Jour. Pal., vol. 1, no. 1, 1927, p. 22, pl. 4, fig. 3. (Hoxbar formation, Love County, Oklahoma.)

Test robust, a rough rectangular pyramid, the biserial suture appearing on the broader sides of the pyramid; biserial chambers about ten in number, slightly appressed, followed by from one to three uniserial chambers; sutures depressed, distinct; wall thick, composed of an inner, possibly perforate calcareous layer, and an outer partly agglutinated layer covered with splotches of secreted calcite; surface some-

what roughened, usually with several obscure vertical costae just below the upper sutures of the later chambers; aperture in the first uniserial chamber consisting of about ten triangular or polygonal holes on the top of the chamber, loosely grouped in an oval around a central hole of the same size. Length, up to 1.7 mm.

As in *Deckerella,* the relative thickness of the two layers of the wall is dependent upon the environment in which the individual lived. The figured specimen, from the Homer limestone, almost completely lacks the agglutinated layer.

Family FUSULINIDAE Moller

Genus FUSULINELLA Möller, 1877 [3a]

Fusulinella Möller, Neues Jahrb., 1877, p. 144.

The fusulinids are the most highly specialized Foraminifera found in the Pennsylvanian, and as such have the smallest vertical range. Furthermore, where they occur at all they are usually present in abundance, which makes them most important as stratigraphic markers. *Fusulina* itself is not found in beds as low as these under consideration (at least not in North America), but several species of *Fusulinella* are present. In identifying these species it was found that the two most significant criteria for quick determination were the length-diameter ratio and the tunnel angle. The latter factor must be employed with some care as the chomata do not diverge at a uniform rate, but flare somewhat in the outer coils so that measurements on adults and young of the same species will show a large discrepancy.

FUSULINELLA MEEKI Dunbar and Condra

Plate II, fig. 11

Fusulinella meeki Dunbar and Condra, Nebraska Geol. Surv., ser. 2, Bull. 2, 1927, p. 78, pl. 2, figs. 12-14, pl. 15, figs. 4-6. (Above Lower Rich Hill Coal, Rich Hill, Missouri.)

Fusulinella n. sp. Henbest, Jour. Pal., vol. 2, 1928, p. 79, pl. 10, figs. 2, 4. (Stonefort limestone, Illinois.)

Test fusiform, inflated in the center, making the lateral slopes slightly concave; proloculum small, followed by chambers coiled symmetrically and increasing regularly; septa strongly folded, not porous; chomata not strongly developed; wall thin, composed of tectum, thin diaphanotheca and inner and outer deposition layers; aperture narrow, half the height of the antetheca.

3a. Recent studies by C. O. Dunbar show that the genotype of Fusulina lacks the conspicuous tubules in the keriotheca. In consequence, all the species here described as Fusulinella should be called Fusulina instead.

Measurements:

Length, up to 5.9 mm.
Length-diameter ratio in adults, 2.41:1
Septa: 2nd coil, 21; 3rd, 26; 4th, 28
Proloculum diameter, 100 microns
Tunnel angle 16-20 degrees

FUSULINELLA MEEKI var. ROBUSTA Dunbar and Condra

Plate II, fig. 12

Fusulinella meeki var. *robusta* Dunbar and Condra, Nebraska Geol. Surv., ser. 2, Bull. 2, 1927, p. 80, pl. 15, figs. 7, 8. (Pawnee limestone, near Pawnee, Kansas.)

Test large, elongate fusiform; proloculum of moderate size; chambers coiled symmetrically, increasing regularly; septa strongly folded, without pores; chomata well developed; wall thin, composed of tectum, thick diaphanotheca and deposition layers; aperture narrow, one half the height of the antetheca.

Measurements:

Length, up to 9.5 mm.
Length-diameter ratio in adults, 3.4: 1
Septa: 2nd coil, 22; 3rd, 24; 4th, 28; 5th, 33
Proloculum diameter, up to 160 microns
Tunnel angle 16-20 degrees; mean 17 degrees

This variety is readily distinguished in the adult by its great size and large length-diameter ratio. The young specimens are very difficult to separate from the true *F. meeki,* but the proloculum of the variety seems to be slightly larger. This variety attains a growth of nine volutions.

FUSULINELLA HAWORTHI (Beede)

Plate II, figs. 13a, b

Girtyina haworthi Beede, Indiana Univ. Studies, vol. 3, no. 29, 1916, p. 14. (Lower Fort Scott limestone, Fort Scott, Kansas.)

Fusulinella haworthi Dunbar and Condra, Nebraska Geol. Surv., ser. 2, Bull. 2, 1927, p. 82, pl. 2, figs. 6-11.

Test fusiform, tending to become subcyclindrical with age; proloculum moderately large, followed by chambers usually symmetrically arranged; septa strongly folded, without pores; wall thin, composed of tectum, well developed diaphanotheca and internal and external deposition layers; aperture wide, in the later stages less than one half the height of the antetheca.

Measurements:

Length up to 7.2 mm.
Length-diameter ratio: 3rd whorl, 2.53:1, adult, 3.4:1
Septa: 2nd coil, 16; 3rd, 20; 4th, 22; 5th, 24.
Proloculum diameter, up to 150 microns; mean 132
Tunnel angle, 32-37 degrees; mean, 34 degrees

In the upper Wewoka limestones of Okfuskee County at locality 23 a few small specimens were collected which differed from typical *F. haworthi* in having the first coil wound asymmetrically around the proloculum. These are apparently identical with the specimens referred to *Schubertella transitoria* Staff and Wedekind by Galloway and Ryniker (Oklahoma Geol. Surv., Circ. 21, 1930, p. 23). These specimens may possibly be miscrospheric forms of *F. haworthi.*

FUSULINELLA INCONSPICUA (Girty)

Fusulina inconspicua Girty, Ann. N. Y. Acad. Sci., vol. 21, 1911, p. 120; U. S. Geol. Surv., Bull. 544, 1915, p. 15, pl. 1, figs. 1-8. (Lower Wewoka formation, Coalgate Quadrangle, Oklahoma.)

Fusulinella inconspicua Dunbar and Condra, Nebraska Geol. Surv., ser. 2, Bull. 2, 1927, p. 83, pl. 15, figs. 1-3.

Test small, fusiform; proloculum small, followed by chambers symmetrically coiled; septa strongly folded, without pores; chomata weak; wall thin; aperture moderately wide, at least one half the height of the antetheca.

Measurements:

Length, up to 4 mm.
Length-diameter ratio: 3rd whorl, 3.3:1
Septa, 3rd coil, 20; 4th, 23
Proloculum diameter, up to 100 microns
Tunnel angle, mean 29 degrees

The affinity of this species with *F. haworthi* has been discussed by Dunbar and Condra, who based their conclusions on specimens from the type locality. Individuals collected by the author from a shale in the same locality, but below the "white limestone" of Girty were found to have highly folded septa and to be more perfectly fusiform than the specimens originally figured. In both sets of specimens, however, a measurement of the length-diameter ratio at the end of the third coil (3.2-3.5:1) quickly separates these forms from *F. haworthi* (2.5-3.0:1). The tunnel angle in *F. inconspicua* is also somewhat smaller. This species is apparently a local, short-lived derivative from *F. haworthi.*

Phylum PORIFERA

Siliceous sponge spicules were occasionally found, but they proved to have little stratigraphic value, as samples taken from one bed at distances of six to ten feet apart showed them to be very local in their distribution. Specific determination from the spicules alone is probably impossible. Samples particularly rich in spicules were collected from the Wewoka at localities 42 and 47.

Phylum ANNELIDA

The small fossils usually lumped together as "conodonts", including among other things the jaws of worms, occur scattered through all the beds studied. They are most common in the blue shales. Specific identification necessitates the study of unbroken specimens, which because of their fragility are rarely found in washed samples. As their stratigraphic value is apparently slight in these beds the author has made no attempt to describe the fragmentary remains in his collections.

Genus SPIRORBIS Lamarck, 1801

Spirorbis Lamarck, Syst. Animaux sans Vert., 1801, p. 326.

SPIRORBIS ANTHRACOSIA Whitfield

Plate II, figs. 14a, b

Spirorbis anthracosia Whitfield, Am. Jour. Sci., ser. 3, vol. 21, 1881, p. 128; Geol. Surv. Ohio, vol. 7, 1895, p. 492, pl. 12, figs. 18, 19. (Upper Coal Measures, Marietta, Ohio.)

Shell a round tube coiled so that all three whorls may be seen on the ventral (attached) side, and only the last whorl on the dorsal side; surface ornamented with extremely conspicuous growth lines; aperture simple, the open end of the tube. Diameter, up to 2 mm.

These little worms apparently lived only in the very shallow waters, and are here found only in the reef facies of the Sasakwa limestone member.

Phylum MOLLUSCOIDEA

Class BRYOZOA

Although the services of a microscope are required for the identification of nearly all Bryozoa, not all of them fall within the limits of the term "microscopic" as used here. The zoaria of *Stenopora* and some of the more robust species of *Rhombopora,* for example, reach considerable size and cannot be considered here.

The bryozoan species appear to have slightly more restricted ranges than the Foraminifera, and thus are more important as index fossils. Specific distinctions, while clearly outlined, are usually a matter of measurements of apertures, fenestrules, pinnae etc., and a micrometer eye-piece or a camera lucida is a necessary adjunct for the identification of these species.

Family FENESTELLIDAE King

Genus FENESTELLA Lonsdale, 1839

Fenestella Lonsdale, in Murchison, Sil. Syst., 1839, p. 677.

FENESTELLA SASAKWAENSIS n. sp.

Plate III, fig. 2

Zoarium a finely reticulate expansion; branches 0.2 mm. wide, 8.5 in 5 mm.; dissepiments thin, 7.5 in 5 mm.; zooecia with pyriform apertures, one at the base of each dissepiment and one in between, 21 in 5 mm.; obverse side with a low mesial keel which bears spinose tubercles at intervals of 0.28 mm.; fenestrules moccasin-shaped; reverse side of the branches marked by four granulose longitudinal striae.

Holotype, Columbia University Pal. Coll. No. 19970.

Holdenville formation, Sasakwa limestone member, locality 49, Sasakwa, Oklahoma.

This species is distinguished from *F. mimica* Ulrich and its varieties by the greater distance between the spines on the median keel.

Genus POLYPORA McCoy, 1844

Polypora McCoy, Syn. Carb. Limestone Foss. Ireland, 1844, p. 206.

POLYPORA SUBMARGINATA Meek

Plate III, fig. 3

Polypora submarginata Meek, U. S. Geol. Surv. Nebraska, 1872, p. 154, pl. 7, fig. 7. (Table Creek shale, Nebraska City, Nebraska.)

Zoarium infundibuliform; branches 0.7 mm. wide, gently convex on the obverse surface, sharply carinate at the edge; reverse side angled except at the junction of the dissepiments, where the back is flattened; dissepiments 0.57 mm. wide; fenestrules oval, smooth in outline, 1.1 by 1.6 mm.; apertures round or somewhat oval, 0.12 mm. in diameter, arranged in five alternating longitudinal rows; seven rows are usually

found just before the division of a branch, and four in the newly divided portions; the central row of apertures is raised slightly above the rest, and is marked with small tubercles between the openings; apertures 14.5 in 5 mm. longitudinally.

This species is best distinguished by the raised middle line of apertures, the smooth outline of the fenestrules and the sharp edges on the branches and dissepiments.

POLYPORA HEXAGONA Moore

Plate 3, fig. 1

Polypora hexagona Moore, Jour. Pal., vol. 3, 1929, p. 122, pl. 15, figs. 13, 17. (Wayland shale, Eastland County, Texas.)

Zoarium flabellate, the branches and dissepiments nearly flat on the obverse side; fenestrules elliptical, 0.6 by 0.9 mm.; apertures circular, 0.09 mm. in diameter, arranged in four alternating rows, 15 to 17 in 5 mm. longitudinally; blunt spines arise from the interspaces between some of the apertures; reverse side robustly keeled, giving hexagonal appearance to the fenestrules; the lower sides of the keel are longitudinally striated on the branches but not on the dissepiments.

POLYPORA HIRSUTA Moore

Polypora hirsuta Moore, Jour. Pal., vol. 3, 1929, p. 25, pl. 3, figs. 17-19. (Wayland shale, Eastland County, Texas.)

A few fragments of this species were found in the upper Holdenville shales, but it was nowhere abundant.

Genus THAMNISCUS King, 1848

Thamniscus King, Ann. Mag. Nat. Hist., ser. 2, vol. 2, 1848, p. 389.

THAMNISCUS TENUIRAMUS Rogers

Plate III, fig. 4

Thamniscus tenuiramus Rogers, Kansas Univ. Quart., ser. A, vol. 9, 1900, p. 9, pl. 2, fig. 5. (Pennsylvanian, Kansas City, Missouri.)

Zoarium a small branching frond, very rarely with dissepiments; branches elliptical in section, thickest in the old portions, about 0.5 mm. wide; obverse face convex, with about four rows of irregularly alternating apertures, arranged on indistinct transverse V-shaped ridges; apertures round, 16 in 5 mm. longitudinally; reverse side smooth, convex.

This species resembles *T. divaricans* Ulrich, but has more closely crowded apertures.

Family ACANTHOCLADIIDAE Zittel

Genus PINNATOPORA Vine, 1883

Pinnatopora Vine, Rep. Brit. Assoc. Adv. Sci., vol. 53, 1883, p. 191.

PINNATOPORA OCULATA Moore

Plate III, fig. 5

Pinnatopora oculata Moore, Jour. Pal., vol. 3, 1929, p. 125, pl. 15, figs. 4, 5, 10. (Wayland shale, Eastland County, Texas.)

Zoarium a pinnate frond with infrequent lateral midribs; primary midrib 0.31 to 0.55 mm. in width, with a rounded mesial carina on the obverse face, bearing small nodes at intervals of 0.6 to 1 mm.; reverse side evenly rounded, granulose; pinnae short, usually alternating, 7 in 5 mm. on each side; apertures oculiform, one located on the anterior side of the base of each pinna, with one in the space between pinnae.

The specimens examined are somewhat smaller in most measurements than the Texas forms, but otherwise agree well with them.

PINNATOPORA BELLULA Ulrich

Plate III, fig. 6

Pinnatopora bellula Ulrich, Geol. Surv. Illinois, vol. 8, 1890, p. 619, pl. 66, fig. 8. (Pennsylvanian, Seville, Illinois.)

Zoarium a pinnate frond with rather frequent lateral midribs; primary midrib 0.3 mm. wide; pinnae alternating, 6.8 in 5 mm. on each side, given off at an angle of 55 degrees; apertures round, with a raised peristome, one at the foot of each pinna and one in between; obverse side ornamented with two central striae which curve slightly from side to side in order to pass between the apertures; other less conspicuous striae occupy the sides of the midrib between the apertures; reverse side with eight granulose longitudinal striae.

This species is separated from *P. whitei* Foerste by the less closely spaced pinnae and the smaller angle at which they diverge from the primary midrib.

PINNATOPORA PUSTULOSA Moore

Plate III, fig. 7

Pinnatopora pustulosa Moore, Jour. Pal., vol. 3, 1929, p. 125, pl. 15, figs. 1-3. (Wayland shale, Eastland County, Texas.)

Zoarium pinnate; midrib 0.6 mm. wide, nearly round in section, strongly pustulose; obverse face with a weak mesial carina, irregularly nodose; pinnae alternating, 4.5 in 5 mm. on each side; apertures 0.07 by 0.1 mm. in diameter, arranged with one at the base of each pinna and two in between.

Genus SEPTOPORA Prout, 1859

Septopora Prout, Trans. St. Louis Acad. Sci., vol. 1, 1859, p. 448, pl. 18, fig. 2.

SEPTOPORA BLANDA Moore

Plate III, figs. 8a, b

Septopora blanda Moore, Jour. Pal., vol. 3, 1929, p. 130, pl. 16, figs. 6, 12, pl. 17, fig. 2. (Wayland shale, Eastland County, Texas.)

Zoarium reticulate; branches straight, 0.55 mm. wide; dissepiments short, curved, 8.8 in 10 mm.; apertures round, 0.13 mm. in diameter, 20 in 5 mm. in each row; accessory pores 0.1 diameter, half as numerous as the apertures, occurring along the sides of the branches, but practically restricted to the bases of the dissepiments on the reverse side; the low mesial carina of the obverse side carries short spines at intervals averaging 0.6 mm.; both obverse and reverse sides longitudinally striate except around the apertures, where the ornamentation is transverse.

SEPTOPORA ? ELLIPTICA n. sp.

Plate III, fig. 9

Zoarium apparently irregularly reticulate; branches up to 1 mm. in width; obverse surface gently convex, entirely covered with about five rows of alternating elliptical apertures, 0.12 by 0.22 mm., each with a separate strong peristome; the spaces between the peristomes superficially resemble mesopores; apertures 11.2 in 5 mm. longitudinally; the zooecia arise directly from the basal lamina on the smooth, flat reverse side.

Holotype, Columbia University Pal. Coll. No. 19971.

Wewoka formation, 75 feet above base, locality 37, seven miles southeast of Ada, Oklahoma.

This species is doubtfully referred to *Septopora,* and probably should be placed in a separate genus. The lack of acanthopores and the different form of the zoarium prevent its inclusion under *Rhombocladia.*

Family RHABDOMESONTIDAE Vine

Genus RHOMBOPORA Meek, 1872

Rhombopora Meek, U. S. Geol. Surv. Nebraska, 1872, p. 141, pl. 7, fig. 2.

RHOMBOPORA PILULA Moore

Plate III, fig. 10

Rhombopora pilula Moore, Jour. Pal., vol. 3, 1929, p. 137, pl. 17, fig. 14. (Wayland shale, Eastland County, Texas.)

Zoarium infrequently branching; stems cylindrical, about 1.5 mm. in diameter; apertures elliptical, 5 in 2.9 mm. longitudinally; the diagonal series of apertures make an angle of about 80 degrees; interspaces thick, beaded with two rows of large micracanthopores, with a few inconspicuous megacanthopores at the intersections; depressions resembling mesopores sometimes occur between interspaces.

The beaded character of the thick interspaces and the high angle of divergence of the diagonal series of apertures serve best to distinguish this species.

RHOMBOPORA CONSTANS Moore

Plate III, fig. 11

Rhombopora constans Moore, Jour. Pal., vol. 3, 1929, p. 140, pl. 17, fig. 13. (Wayland shale, Eastland County, Texas.)

Zoarium slender; stems cylindrical, 0.7 to 0.9 mm. wide; apertures 0.26 by 0.15 mm., 5 in 2.9 mm. longitudinally; interspaces thin, with a single row of micracanthopores; the diagonal series of apertures diverge at an angle of 55 degrees.

The stems and apertures are slightly smaller than those of the original specimens, and these forms may represent a distinct variety, but there is no apparent need for a separate name.

Genus RHABDOMESON Young and Young, 1874

Rhabdomeson Young and Young, Ann. Mag. Nat. Hist., ser. 4, vol. 13, 1874, p. 337.

RHABDOMESON MAGNUM n. sp.

Plate III, figs. 17a, 17b

Zoarium cylindrical, ramose at infrequent intervals, 1 to 2.5 mm. in diameter; about 20 alternating longitudinal ranges of apertures compose each stem; apertures subrhombic, 0.17 by 0.28 mm., 10 in 5 mm. longitudinally; lateral walls of the apertures moderately thick, with a

single row of micracanthopores; interspaces at the ends of apertures long, usually with a megacanthopore at each end; axial tube circular, 0.26 mm. in diameter, without diaphragms; the zooecia diverge from the tube at an angle of 31 degrees.

Holotype, Columbia University Pal. Coll. No. 19973.

Holdenville formation, 15 feet above base, locality 29, three miles east of Ada, Oklahoma.

This species most closely resembles *R. simulatum* Moore, from which it differs in having a more robust stem, more rapidly diverging zooecia, and two megacanthopores on each longitudinal interspace.

RHABDOMESON PROCERUM Moore

Plate III, fig. 12

Rhabdomeson procerum Moore, Jour. Pal., vol. 3, 1929, p. 146, pl. 17, fig. 25. (Wayland shale, Eastland County, Texas.)

Zoarium cylindrical, occasionally branching at right angles, about 0.45 mm. in diameter; apertures long, narrow, pointed at the anterior end, 5 longitudinally in 2.7 mm.; interspaces moderately thick, scattered with acanthopores of both sizes; axial tube 0.12 mm. in diameter, the zooecia diverging from it at about 22 degrees.

The extremely long apertures with moderately thick interspaces distinguish this species.

RHABDOMESON BELLUM var. MINUS Moore

Plate III, fig. 13

Rhabdomeson bellum var. *minus* Moore, Jour. Pal., vol. 3, 1929, p. 146, pl. 17, figs. 18, 19. (Wayland shale, Eastland County, Texas.)

Zoarium slender, cylindrical, branching frequently; stems 0.45 mm. in diameter, with about twelve alternating rows of zooecia; apertures long, oval, 5 in 2.5 mm. longitudinally; interspaces thick, with abundant acanthopores of both sizes.

This form is distinguished by its slender stem and thick interspaces surmounted by numerous prominent acanthopores.

RHABDOMESON FILUM Moore

Plate III, fig. 14

Rhabdomeson filum Moore, Jour. Pal., vol. 3, 1929, p. 147, pl. 17, fig. 5, pl. 18, figs. 6, 7. (Wayland shale, Eastland County, Texas.)

Zoarium slender, cylindrical, branching infrequently; stems 0.3 to 0.45 mm. in diameter, with about ten alternating longitudinal rows of zooecia; apertures long, rounded posteriorly and pointed anteriorly, 5 in 2.75 mm. longitudinally; interspaces extremely narrow, crested with a single row of micracanthopores, somewhat hooded over the posterior end of the apertures.

This form is readily recognized by its small size and the extreme narrowness of the interspaces, which are reduced to mere crests between the apertures.

Genus STREBLOTRYPA Ulrich, 1890

Streblotrypa Ulrich, Geo. Surv. Illinois, vol. 8, 1890, p. 403, pl. 71, fig. 9.

STREBLOTRYA MULTIPORA n. sp.

Plate III, fig. 15

Zoarium cylindrical, infrequently ramose; stems 0.5 to 1.5 mm. in diameter; zooecia arranged in 14 to 17 regularly alternating rows; apertures oval, widest at the posterior end, 0.14 by 0.12 mm.; each aperture is separated from its neighbor by a peristome ridge, strongest just above the aperture, enclosing both it and the group of mesopores below in a bluntly rhombic unit, 0.38 by 0.2 mm.; mesopores in three transverse rows, that nearest the aperture having three to five pores, the middle one two or occasionally three, and the lowest one two pores; acanthopores absent.

Holotype, Columbia University Pal. Coll. No. 19974.

Wewoka formation, 75 feet above base, locality 37, seven miles southeast of Ada, Oklahoma.

This beautiful species is separated from *S. prisca* (Gabb and Horn) by the rhombic outline of each aperture with its mesopores, and from other forms by the large number of mesopores. It is one of the most conspicuous species of the Upper Wetumka - Lower Wewoka faunal group.

Genus RHOMBOCLADIA Rogers, 1900

Rhombocladia Rogers, Kansas Univ. Quart., ser. A, vol. 9, 1900, p. 11.

RHOMBOCLADIA DELICATA Rogers

Plate III, fig. 18

Rhombocladia delicata Rogers, Kansas Univ. Quart., Ser. A, vol. 9, 1900, p. 12, pl. 1, fig. 1. (Middle and Upper Pennsylvanian, Kansas and Missouri)—Moore, Jour. Pal., vol. 3, 1929, p. 149, pl. 17, figs. 26-32. (Wayland shale, Eastland County, Texas.)

Zoarium ramose at irregular and infrequent intervals; branches acutely elliptical in transverse section, the zooecia appearing on one side only; apertures arranged as in *Rhombopora,* six to eight in each diagonal row; interspaces angled in young, rounded in adult portions, with a megacanthopore at each intersection and micracanthopores in between; reverse side smooth or with curved growth lines, forming the base from which the zooecia arise.

This species is readily recognized by the resemblance of the apertures on the obverse side to those of *Rhombopora.*

Family CYSTODICTYONIDAE Ulrich

Genus PRISMOPORA Hall, 1883

Prismopora Hall, Trans. Albany Inst., vol. 10, 1883, p. 193.

PRISMOPORA LOBATA n. sp.

Plate III, fig. 16

Zoarium unbranched, sharply triangular in cross section; each side flat or slightly concave, 1.5 to 4 mm. wide, covered with seven or eight irregular rows of pustulose apertures; apertures circular, 0.12 mm. in diameter, 14 in 5 mm. longitudinally; the space between the zooecia is filled with vesicles about 0.1 mm. in diameter, which appear at the surface only in weathered specimens; the three edges of the zoarium have blunt to spinose scallops at intervals of 1.5 to 3 mm.; the apertures approach the edge of the zoarium more closely on these points than in the intervening sinuses.

Holotype, Columbia University Pal. Coll. No. 19972.

Wewoka formation, 75 feet above base, locality 37, seven miles southeast of Ada, Oklahoma.

This species differs from *P. sereata* (Meek) in having less regularly scalloped margins, and in having the pustulose apertures more closely crowded together. *P. triangulata* (White) has less prominent scallops, and only five or six rows of apertures.

Class BRACHIOPODA

Young Brachiopoda, although readily recognizable as such, do not admit of specific determination when still small enough to come within the limits of "microscopic" fossils. Generic discrimination is possible, but hardly useful even for correlation by faunal groups.

Brachiopod mouth parts, resembling calcareous sponge spicules with a single or double loop on the end, are not uncommon throughout all three formations.

Phylum MOLLUSCA

Young examples of Pelecypoda, Scaphopoda, Gastropoda and Cephalopoda were secured from the screened samples, but of these four classes only the Gastropoda could be specifically identified, as the finer characters used in specific determination do not appear in the small specimens of the other groups.

Class GASTROPODA

A large variety of megascopic gastropods occurs in the beds under consideration, but only part of these are recognizable in microscopic form. It will be noticed that almost all the species here discussed are distinctly high-spired forms. The specific characters, chiefly surface ornamentation, seem to appear earliest in those shells in which the tube increases slowly in diameter and coils in a high spire. The species here described are little if at all dwarfed, and represent young specimens of gastropods which do not reach great size even as adults in any locality in which they are found.

Family BELLEROPHONTIDAE McCoy

Genus EUPHEMITES nom. nov.

Euphemus McCoy (not Laporte, 1836), Syn. Carb. Limestone Foss. Ireland, 1844, p. 25.

The name *Euphemus* was first used, without description, by Rafinesque in 1815. It was subsequently employed by Laporte in 1836 for a genus of Coleoptera, preoccupying it, and making its use for the gastropod impossible. The name *Euphemites* is here proposed for the gastropod genus, this name being chosen because of its resemblance to that used by McCoy.

EUPHEMITES CARBONARIUS (Cox)

Plate VII, fig. 7

Bellerophon carbonarious Cox, Kentucky Geol. Surv., Rep. 3, 1857, p. 562. (Coal Measures, Kentucky.)

Euphemus carbonarius Ulrich, Minnesota Geol. Nat. Hist. Surv., vol. 3, pt. 2, 1897, p. 855.—Girty, U. S. Geol. Surv., Bull. 544, 1915, p. 174, pl. 21, figs. 1-3. (Wewoka formation, Oklahoma.)

Shell nautiliform, rapidly enlarging, closely coiled, umbilicate in the young, more embracing in the adult; surface ornamented with subequal revolving striae, rarely nodose near the umbilici, about 18-25 in number, in the very young shell sometimes transversed by faint

striae of a like size; three striae usually loosely grouped into a mesial band; in complete specimens the youngest part of the body whorl is unornamented except for a mesial band; aperture the width of the shell, compressed, oval.

This form may be separated from *Bucanopsis meekiana* (Swallow) in the young stages by the absence of strong transverse striae, and the small number of revolving striae. Specimens as small as 0.75 mm. in diameter are recognizable if well preserved.

Genus BUCANOPSIS Ulrich, 1897

Bucanopsis Ulrich, Minnesota Geol. Nat. Hist. Surv., vol. 3, pt. 2, 1897, p. 853.

BUCANOPSIS MEEKIANA (Swallow)

Plate VII, fig. 8

Bellerophon Meekianus Swallow, Trans. St. Louis Acad. Sci., vol. 1, 1858 (1859), p. 204. (Coal Measures, Missouri.)

Bucanopsis meekiana Girty, U. S. Geol. Surv., Bull. 544, 1915, p. 169, pl. 20, figs. 4-6. (Wewoka formation, Oklahoma.)

Shell nautiliform, involute, the coil enlarging rapidly so that the aperture appears somewhat flaring; umbilici reniform; surface ornamented with subequal revolving costae, about 24 in number on a specimen 1.5 mm. in diameter; mesial band slightly elevated, usually with three costae; transverse costae numerous, strongest on the side of the coil, in size and spacing nearly like the revolving costae, and slightly nodose at their intersection; aperture roughly reniform. Diameter, about 1.5 mm.

The minute forms have fewer revolving costae than typical adults, but as the microscopic examples seem to be merely young and not dwarfs this is not a specific difference.

Family PLEUROTOMARIIDAE d'Orbigny

Genus PLEUROTOMARIA Defrance, 1826

Pleurotomaria Defrance, Dict. Sci. Nat., vol. 41, 1826, p. 381.

PLEUROTOMARIA CARBONARIA Norwood and Pratten

Pleurotomaria carbonaria Norwood and Pratten, Jour. Acad. Nat. Sci. Philadelphia, ser. 2, vol. 3, 1855, p. 75, pl. 9, fig. 8. (Pennsylvanian, Illinois.)— Girty, U. S. Geol. Surv., Bull. 544, 1915, p. 163, (Wewoka formation, Oklahoma.)

Shell low spired, composed of four or five rapidly enlarging volutions, each one embracing from one third to one half of the preceding coil; surface smooth in the first two whorls, then ornamented with fine, angled, revolving costae, about eight on the unembraced part of the coil, with about ten more on its lower surface; costae in adult coils transversed by growth lines which are strongest on the lower surface of the coil; slit band inconspicuous; aperture semicircular. Diameter, 1.5 mm.

The microscopic specimens differ from typical *P. carbonaria* in having only very faint revolving costae on the upper third of the coil, a character probably due to the youth of the specimens.

Genus PHANEROTREMA Fischer, 1885

Phanerotrema Fischer, Manual Conchy., 1885, p. 851.

PHANEROTREMA GRAYVILLENSIS (Norwood and Pratten)

Plate VII, fig. 9

Pleurotomaria grayvillensis Norwood and Pratten, Journ. Acad. Nat. Sci., Philadelphia, ser. 2, vol. 3, 1855, p. 75, pl. 9, fig. 7. (Pennsylvanian, Indiana and Illinois.) — Meek, U. S. Geol. Surv. Nebraska, 1872, p. 233, pl. 11, fig. 9. (Table Creek shale, Nebraska City, Nebraska.)

Phanerotrema grayvillensis Girty, U. S. Geol. Surv., Bull. 544, 1915, p. 149, pl. 23, figs. 2-8. (Wewoka formation, Oklahoma.)

Shell low spired, usually with about four whorls, rapidly enlarging; whorls not completely embracing; surface smooth in the first two coils, then ornamented with transverse series of nodes, strongest at the upper suture; slit band conspicuous, a little below the upper suture, forming a marked shoulder below which the shell drops away abruptly; aperture subtriangular, the inner lip thick. Apical angle variable, about 115 degrees. Specimens of three coils are about 2 mm. in diameter.

This species, although apparently not dwarfed, exhibits its ornamentation early enough in life to permit identification of well preserved specimens only 1.5 mm. in diameter. The revolving costae develop later, and are not visible in the minute shells.

Genus MURCHISONIA d'Archiac and de Verneuil, 1841

Murchisonia d'Archiac and de Verneuil, Bull. Soc. Geol. France, vol. 12, 1841, p. 159.

MURCHISONIA TEREBRA White ?

Plate VII, fig. 10

Murchisonia terebra White, U. S. Geol. Geogr. Surv. Terr., vol. 5, 1879, p. 219. (Carboniferous, Arizona.) — Keyes, Missouri Geol. Surv., vol. 5, 1894, p. 146, pl. 49, fig. 4. (Pennsylvanian, Kansas City, Missouri.)

Shell high spired, consisting of eight or more appressed volutions; suture shallow; surface ornamented with a single large angular revolving carina, placed slightly below the center of the coil; slit band apparently on the lower slope of the carina; under surface of last coil smooth, separated from the lateral surface by a distinct shoulder. Apical angle, 25 degrees. Length of a specimen with seven coils, 3 mm.

These forms have a larger apical angle than White's original specimens, and the slit band is not distinct. In view of the rather poor preservation of all the specimens examined, however, it was deemed unwise to erect a new name for the Oklahoma specimens.

Family NERITOPSIDAE Fischer

Genus NATICOPSIS McCoy, 1844

Naticopsis McCoy, Syn. Carb. Limestone Foss. Ireland, 1844, p. 33.

NATICOPSIS sp.

Fragments of young shells belonging to this genus are common, but there seem to be no dwarfed adults. As the specific characters are not visible in the young stages all those forms are included under this designation which have a very low spired, rapidly enlarging, highly embracing shell, ornamented only with fine transverse growth lines.

Family PYRAMIDELLIDAE Gray

Genus MACROCHILINA Bayle, 1880

Macrochilina Bayle, Jour. Conchy., ser. 3, vol. 20, 1880, p. 241.

The involved nomenclature of this group has been best discussed by Girty in his paper on the Wewoka fauna.

MACROCHILINA DANVILLENSIS Girty

Plate VII, fig. 11

Actaeonina minuta Meek and Worthen (not *Loxonema minuta* Stevens), Geol. Surv. Illinois, vol. 5, 1873, p. 594, pl. 29, fig. 2*. (Pennsylvanian, Danville, Illinois.)

Macrochilina ? danvillensis Girty, Missouri Bur. Geol. Mines, ser. 2, vol. 13, 1915, p. 363.

Shell moderately high spired, comprising about five whorls which increase rapidly in length so that the last coil is about half the length of the shell; suture moderately deep, its appearance accentuated by a marked shelf on each coil immediately below the suture; surface smooth or with growth lines; aperture long, narrow. Length, 1.25 mm.

This species may be separated from the similar *Bulimorpha minuta* (Stevens) by the presence of the small but conspicuous shelf just below the suture. It is somewhat less globose than *M. angulifera* (White) from the Carboniferous of Nevada.

Genus BULIMORPHA Whitfield, 1882

Bulimorpha Whitfield, Bull. Am. Mus. Nat. Hist., vol. 1, 1882, p. 74.

BULIMORPHA MINUTA (Stevens)

Plate VII, fig. 12

Loxonema minuta Stevens, Am. Jour. Sci., ser. 2, vol. 25, 1858, p. 260. (Pennsylvanian, Danville, Illinois.)

Bulimorpha minuta Girty, Missouri Bur. Geol. Mines, ser. 2, vol. 13, 1915, p. 362, pl. 29, fig. 4. (Cherokee shale, Garland, Missouri.)

Shell moderately high spired, pyriform, composed of about four volutions, tightly coiled, the volutions enlarging rapidly in length so that the last coil is over half the length of the shell; suture shallow; surface smooth or with faint growth lines; aperture long, narrow, nearly half the length of the shell; inner lip not folded. Length 1.5 mm.

Stevens' original description is practically unrecognizable, and Girty's interpretation of it is here followed.

Genus LOXONEMA Phillips, 1841

Loxonema Phillips, Figs. Pal. Foss. Cornwall, 1841, p. 98.

LOXONEMA ZYGOPLEUROIDES n. sp.

Plate VII, fig. 13

Shell high spired, consisting of four or five whorls, enlarging rather slowly; coils inflated; sutures deep; first coil smooth, the later ones ornamented with numerous curved, transverse striae, concave toward the aperture, but becoming slightly reflexed just above the lower suture; sutures apparently traversed by the striae, which seem to be continuous with those of the previous whorl; about 18 striae on the last coil, continuing down across the under surface to the umbilical

region; aperture semioval, the reflexed inner lip forming a conspicuous straight callus, widest anteriorly, along the columella, not quite reaching to the minute umbilical depression. Apical angle, 36 degrees. Length, 1 mm.

Holotype, Columbia University Pal. Coll. No. 19975.

Holdenville formation, ten feet above base, locality 29, three miles east of Ada, Oklahoma.

This species is closely allied to *L. cerithiformis* Meek and Worthen, from which it may be distinguished by its wider apical angle and more pronounced ornamentation. The striae on the fifth whorl show signs of changing into the transverse plications characteristic of *Zygopleura,* and this species is probably close to the ancestor of that genus.

Genus ZYGOPLEURA Koken 1892[4]

Zygopleura Koken, Neues Jahrb., 1892, vol. 2, p. 30.

The Zygopleurae form one of the best defined and most important groups of microscopic Pennsylvanian gastropods. None of them reach great size under any condition, and microscopic study is required to make out the early stages and thus determine their relations.

ZYGOPLEURA RUGOSA (Meek and Worthen)

Plate VII, fig. 14

Loxonema rugosa Meek and Worthen, Proc. Acad. Nat. Sci. Philadelphia, 1860, p. 465; Geol. Surv. Illinois, vol. 2, 1866, p. 378, pl. 31, fig. 11. (Pennsylvanian, Springfield, Illinois.)

Zygopleura rugosa Girty, U. S. Geol. Surv., Bull. 544, 1915, p. 183, pl. 25, fig. 1. (Wewoka formation, Oklahoma.)

Shell high spired, consisting of seven or eight volutions, gradually enlarging, moderately convex; suture deep; surface smooth in the first whorl, the next one or two covered with sigmoid striae, thereafter ornamented with large, gently convex transverse costae, reaching almost to the suture on each side of the coil, and with gently concave interspaces slightly narrower than the costae; costae about 18 on the last whorl, each one tending to lie directly under one in the previous volution; under surface of the last whorl smooth or with faint growth lines; aperture suboval, the inner and outer lips meeting at a slight notch in the anterior border of the aperture; inner lip with a poorly developed callus extending about half way up the columella. Length, up to 3 mm. Apical angle about 27 degrees.

4. The Pennsylvanian species of **Zygopleura** are revised by J. Brookes Knight in a paper to be published soon. New subgeneric names will be given to most of the species here included directly under **Zygopleura.**

This species may be quickly told by its broad costae and small apical angle.

ZYGOPLEURA TRIMERA n. sp.

Plate VII, fig. 15

Shell high spired, consisting of about eight coils, the first three enlarging less rapidly than the later ones; volutions moderately convex in the early part, in the adult stages becoming distinctly flattened, with shallow sutures; surface of the first whorl smooth, the next two being ornamented with transverse sigmoid striae, followed by three whorls each with about 14 low transverse costae, which are wider than the interspaces; final whorls smooth; aperture oval, not entire posteriorly, the inner lip reflected to form a callus extending about two thirds of the way up the columella. Apical angle (adult) 28 degrees. Length, up to 3.5 mm.

Holotype, Columbia University Pal. Coll. No. 19976.

Holdenville formation, ten feet above base, locality 29, three miles east of Ada, Oklahoma.

This species shows beautifully three stages of the ornamentation of the Zygopleurae. The young are scarcely distinguishable from those of *Zygopleura rugosa,* but the adults of that species have from four to six costate whorls and no later smooth coils.

ZYGOPLEURA PARVA (Cox)

Plate VII, fig. 16

Chimnitzia parva Cox, Kentucky Geol. Surv., Rep. 3, 1857, p. 567, pl. 8, fig. 3. (Pennsylvanian, Daviess County, Kentucky.)

Zygopleura parva ? Girty, U. S. Geol. Surv., Bull. 544, 1915, p. 184, pl. 25, fig. 3. (Wewoka formation, Oklahoma.)

Shell high spired, consisting of about six volutions with convex sides; surface of the first two whorls smooth, the later ones ornamented with straight, transverse, gently convex costae, closely spaced, the costal interspaces being mere furrows; costae not quite extending to the suture on either the upper or lower side of each whorl, about 34 on the last whorl; aperture oval, the inner lip with a small callus extending about one fourth of the way up the columella. Apical angle, 38 degrees. Length, 1.5 mm.

This species is distinguished from *Z. rugosa* by the abundance of the transverse costae.

ZYGOPLEURA OBSOLETA n. sp.

Plate VII, fig. 17

Shell high spired, comprising about six slowly enlarging volutions; coils slightly compressed convex; suture deep; surface smooth, with faint signs of transverse costae on the last whorl; aperture suboval, peristome not entire posteriorly, with a straight outer lip which is met anteriorly by the broadly curved inner lip; callus thin, curved, enrirely anterior to the minute umbilical depression. Apical angle, 27 degrees. Length, 2 mm.

Holotype, Columbia University Pal. Coll. No. 19978.

Holdenville formation, ten feet above base, locality 29, three miles east of Ada, Oklahoma.

The faint traces of costae on the later whorls of this species indicate that it has probably descended from *Zygopleura.*

Genus HEMIZYGA Girty, 1915

Hemizyga Girty, Missouri Bur. Geol. Mines, ser. 2, vol. 13, 1915, p. 361.

HEMIZYGA NODOSA n. sp.

Plate VII, fig. 18

Shell moderately high spired, consisting of six or seven coils, enlarging rather rapidly; suture deep; the first coil smooth, the second with faint curved transverse costae separated by interspaces slightly smaller than the costae; last whorl with about 20 strong costae; the lower half of the costae marked by a few incomplete revolving lirae in the form of nodes on the costae; under surface of the last whorl smooth. Apical angle, about 40 degrees. Average length, 1.35 mm.

Holotype, Columbia University Pal. Coll. No. 19977.

Holdenville formation, ten feet above base, locality 29, three miles east of Ada, Oklahoma.

This species may be separated from *H. grandicostata* Girty by the early appearance of the revolving ornamentation and the strength of the transverse costae in the late whorls. In poorly preserved material, where the revolving lirae may not be apparent, this species may be told from *Zygopleura rugosa* by its persistently larger apical angle.

Genus MEEKOSPIRA Ulrich, 1897

Meekospira Ulrich, Minnesota Geol. Nat. Hist. Surv., vol. 3, pt. 2, 1897, p. 1079.

MEEKOSPIRA PERACUTA var. CHOCTAWENSIS Girty

Plate VII, fig. 19

Meekospira peracuta (Meek and Worthen) var. *choctawensis* Girty, Ann. N. Y. Acad. Sci., vol. 21, 1911, p. 139; U. S. Geol. Surv., Bull. 544, 1915, p. 216, pl. 25, figs. 5-8. (Wewoka formation, Oklahoma.)

Shell slender, high spired, consisting of ten or eleven closely appressed, gradually enlarging volutions; coils flattened, slightly but sharply depressed at the suture; surface smooth or ornamented with scarce faint growth lines; aperture oval, well rounded anteriorly, with the inner lip reflexed for about half its length along the columella, forming a small callus. Apical angle, 23 degrees.

The length of forms with ten volutions is about 2.5 mm., but the variety is recognizable in specimens or fragments less than half that size.

Genus ORTHONEMA Meek and Worthen, 1861

Orthonema Meek and Worthen, Proc. Acad. Nat. Sci. Philadelphia, 1861, p. 146.

ORTHONEMA CARBONARIUM Worthen

Plate VII, fig. 20

Orthonema carbonaria Worthen, Bull. Illinois State Mus. Nat. Hist., no. 2, 1884, p. 7. (Pennsylvanian, Peoria County, Illinois.); Geol. Surv. Illinois, vol. 8, 1890, p. 145, pl. 34, fig. 4.

Shell very high spired, consisting of about twelve flat sided coils, enlarging extremely slowly; suture slightly depressed; surface ornamented by two revolving costae, one broad, low and indistinct, just below the suture, and one distinct, narrow and subangular, just above the lower suture; costae separated by a depressed zone just above the lower costa, and of about its width in the early coils, later increasing more rapidly; under side of the last coil with faint growth lines; aperture indeterminable. Apical angle, 18 degrees. Length, up to 6 mm.

The character of the depressed band between the costae is not clear, and there is a possibility that it may represent a slit band.

ORTHONEMA NEBRASCENSE (Geinitz)

Plate VII, fig. 21

Murchisonia nebrascensis Geinitz, Nova Acta k. Leop.-Carol. Ak. Nat., vol. 33, no. 4, 1866, p. 12, pl. 1, fig. 17.—Meek, U. S. Geol. Surv. Nebraska, 1872, p. 234, pl. 11, fig. 6. (Table Creek shale, Nebraska City, Nebraska.)

Shell high spired, consisting of about six volutions; suture deep; surface ornamented with revolving costae, one along the center of the coil appearing in the second volution, and being supplemented by others so that the adult coils have one small costa just below the upper suture, a very large angled carina in the center of the coil, and two smaller costae just above the lower suture, one of the lower pair sometimes being obscured by the overlapping of the next coil; inner lip slightly reflexed. Apical angle, about 31 degrees. Length, up to 1.9 mm.

ORTHONEMA QUADRICARINATUM (Worthen)

Plate VII, fig. 22

Loxonema quadri-carinatus Worthen, Illinois State Mus. Nat. Hist., Bull. 2, 1884, p. 7. (Pennsylvanian, Peoria County, Illinois.)

Murchisonia quadricarinata Keyes (not McCoy, 1844), Proc. Acad. Nat. Sci. Philadelphia, 1891, p. 254. (Pennsylvanian, Des Moines, Iowa.)

Shell high spired, enlarging gradually, composed of about nine tightly appressed volutions with flat sides; suture almost flush with the surface; ornamentation in the form of four revolving costae, gently convex in section; the two upper costae small, subequal and with a gently rounded interspace, the two lower costae being heavier, equal in size, situated closer together, and separated from the upper pair by a small, more sharply incised interspace; the lowest costa of some whorls is overlapped by the top one on the succeeding coil. Apical angle, about 20 degrees. Length, 2 mm.

ORTHONEMA STRIGATUM n. sp.

Plate VII, fig. 23

Shell high spired, consisting of about ten appressed whorls, gradually enlarging; suture not conspicuous; first two coils smooth, the next two ornamented with three rounded subequal revolving costae, with interspaces of equal size; in later coils the middle costa decreases to a faint line on the lower slope of the uppermost costa, which itself increases in size and angularity; the lower costa also becomes angular, but it increases in size less rapidly than the upper, and has in the later coils a subsidiary line on its lower flank, usually covered by the succeeding coil; aperture indeterminable, probably small and subquadrate. Apical angle, about 30 degrees. Length, 2.4 mm.

Holotype, Columbia University Pal. Coll. No. 19979.

Holdenville formation, 15 feet above base, locality 29, three miles east of Ada, Oklahoma.

This species may be best recognized by the two major costae, the upper one the larger, each with a fine subsidiary line on its lower slope.

Family CERITHIIDAE Menke

Genus ACLISINA de Koninck, 1881

Aclisina de Koninck, Ann. Mus. Belgique, vol. 6, 1881, p. 86.

ACLISINA STEVENSANA (Meek and Worthen)

Plate VII, fig. 24

Turritella ? stevensana Meek and Worthen, Geol. Surv. Illinois, vol. 2, 1866, p. 382. pl. 27, fig. 8. (Upper Coal Measures, Gallatin County, Illinois.)

Aclisina stevensana Keyes, Missouri Geol. Surv., vol. 5, 1894, p. 202. (Pennsylvanian, Kansas City, Missouri.)

Shell slender, high spired, composed of up to thirteen very loosely appressed volutions, enlarging slowly, especially in the young; coils convex; suture deep; surface smooth in the first four or five coils, then ornamented with fine revolving costae, up to six in number, situated on the lower two thirds of the coil, equally spaced; costae transversed by fine growth lines in adults; aperture simple, quadrilateral. Apical angle, 10-15 degrees.

The first volution is coiled heterostrophically, and forms a little crest on the top of the spire. In the adult stages the coil enlarges more rapidly, so that the apical angle measured on a broken adult may be as high as 25 degrees.

ACLISINA STEVENSANA var. GIBBOSA n. var.

Plate VII, fig. 25

Shell high spired, consisting of about four rather rapidly enlarging whorls; coils convex; surface ornamented by four equal revolving costae, which begin on the third whorl, and are located below a slight shoulder on the coil about one-fourth of the distance below the suture; under side of the last volution smooth. Apical angle 25 degrees. Length, 0.9 mm.

Holotype, Columbia University Pal. Coll. No. 19980.

Holdenville formation, 15 feet above base, locality 29, three miles east of Ada, Oklahoma.

This variety differs from the typical *A. stevensana* in the more rapid enlargement of the coil and in having fewer revolving costae.

Phylum ARTHROPODA

Class CRUSTACEA

Order OSTRACODA Latreille

For stratigraphic work the Ostracoda are the most important single group of the small fossils here described. They occur in greater abundance and in a greater variety of lithologic facies than the Foraminifera or Bryozoa. In addition to this the species, although often separated by seemingly minor characters, exhibit very little intergradation. In the genera *Hollinella and Healdia,* the only exceptions, there are variations within the species which are probably due to differences in age and sex, and these variable characters must be ignored in making identifications.

About one fifth of the following species have the long time ranges characteristic of most Pennsylvanian fossils. The remaining forms, however, have a more limited vertical range, and are valuable index fossils.

Family APARCHITIDAE Ulrich and Bassler

Genus PARAPARCHITES Ulrich and Bassler, 1906

Paraparchites Ulrich and Bassler, Proc. U. S. Nat. Mus., vol. 30, 1906, p. 149, pl. 11, figs. 1-4.

PARAPARCHITES LATIDORSATUS n. sp.

Plate IV, figs. 1a, b

Carapace suboval in lateral view, with pronounced backward swing; hinge line short and straight; greatest posterior extension of shell near the center line; greatest anterior extension one-fourth of the height from the dorsal border; maximum thickness midway between the center of the shell and the blunt antero-dorsal spines; valves swollen along the hinge line, concealing its anterior half from lateral view. Length, 0.57 mm.; height, 0.42 mm.; thickness, 0.33 mm.

Holotype, Columbia University Pal. Coll. No. 19981.

Lower Wewoka formation, 75 feet above base, locality 37, seven miles southeast of Ada, Oklahoma.

This species is distinguished from *P. claytonensis* Knight by being blunter anteriorly in dorsal aspect, and from *P. wapanuckaensis* Harlton by having much of its hinge line concealed in lateral view.

PARAPARCHITES CUNEATUS n. sp.

Plate IV, figs. 2a, b

Carapace small, subtriangular in lateral view; greatest height one third of the length from the posterior end; hinge line straight, long; anterior end low, the ventral border sloping back rapidly from the acute cardinal angle to the strong postero-ventral enlargement of the shell; posterior cardinal angle obtuse; antero-dorsal spines long, rising abruptly from the surface of the shell. Length, 0.31 mm.; height, 0.21 mm.; thickness, 0.12 mm.

Holotype, Columbia University Pal. Coll. No. 19982.

Holdenville formation, Sasakwa limestone member, locality 46, three miles east of Ada, Oklahoma.

This species is best distinguished from *P. wapanuckaensis* Harlton by its acute anterior cardinal angle.

Family BEYRICHIIDAE Jones

Genus HOLLINELLA Coryell, 1928

Hollinella Coryell, Jour. Pal., vol. 2, 1928, p. 378, pl. 51, fig. 1.

There is little doubt as to the usefulness of a separate generic name for the binodate Hollinae. The author is also in agreement with the idea already propounded elsewhere that the frilless and frilled forms of otherwise similar Hollinae represent not different species but sex and age variants of the same species. It is usually rash to make such assumptions where we know so little of the life history or soft parts of an organism, but there is one important justification for this move. Grouping the forms with regard to characters other than the frill greatly simplifies the problem of classification into species, and does away with the necessity for erecting a tremendous number of names to designate the manifold variations in the development of the frill.

Hollinella, the first generic name applied to the binodate forms, originally included only those with incomplete frills. As this name was, however, the first to apply to even a stage of these forms, it must be used for the entire group, and later names for that group become synonyms.

HOLLINELLA ULRICHI (Knight)

Plate IV, figs. 6a, b

Hollina granifera Harlton (not *Bollia granifera* Ulrich), Jour. Pal., vol. 1, no. 3, 1927, p. 204, pl. 32, fig. 3. (Upper Glenn, Carter County, Oklahoma.)

Hollina ulrichi Knight, Jour. Pal., vol. 2, 1928, p. 237, pl. 31, fig. 4. (Upper Fort Scott limestone, St. Louis County, Missouri.)

Carapace semiovate to semicircular in lateral view; hinge line straight or slightly concave; cardinal angles most prominent in narrow-frilled forms; anterior node conspicuous, hemispherical; posterior node two thirds the height of the anterior, oval, merging more gradually with the posterior slope of the carapace; median sulcus widest in narrow-frilled forms; surface of the carapace, except for the frills, thickly covered with low papillae and an irregular scattering of short, blunt spines; frill terminated anteriorly by a hollow spine.
Productive female: length, 0.9 mm.; height, 0.55 mm.
Frilless male: length, 0.72 mm.; height, 0.50 mm.

This species is best distinguished from *H. digitata* Kellett by its more nearly equal length and height and its slightly less prominent nodes. The number of spines varies from five to fifty on a valve, and therefore is not helpful in separating these two species.

HOLLINELLA DIGITATA Kellett

Plate IV, fig. 5

Beyrichia radiata Ulrich and Bassler (not Jones and Kirby), Proc. U. S. Nat. Mus., vol. 30, 1906, p. 156, pl. 11, fig. 5. (Cottonwood shale, Chase County, Kansas.)

Hollinella digitata Kellett, Jour. Pal., vol. 3, 1929, p. 209, pl. 26, fig. 1.

Carapace roughly semiovate in lateral view; greatest length just above center line; hinge line straight, curved up anteriorly to the beak of the cardinal angle; anterior node hemispherical, conspicuous; posterior node oval, less than one half the height of the anterior; median sulcus distinct, spreading out equally below both nodes; front end of the frill with a well developed hollow spine; surface, except frills, finely papillose and also covered with a scattering of stout spines which appear on both the shell proper and the frill.

Productive female: length, 1.28 mm.; height, 0.74 mm.

This species is distinguished from *H. ulrichi* (Knight) by its smaller proportionate height and its more conspicuous anterior nodes. *Basslerina recurva* Moore probably includes this species as well as some other forms.

No males were recognized in the material examined.

HOLLINELLA BASSLERI (Knight)

Plate IV, figs. 3a, b

Hollina bassleri Knight, Jour. Pal., vol. 2, 1928, p. 240, pl. 31, fig. 3, pl. 34, fig. 7. (Upper Fort Scott limestone, St. Louis County, Missouri.)

Hollina buehleri Knight, Jour. Pal., vol. 2, 1928, p. 236, pl. 31, fig. 1, pl. 34, fig. 8. (Upper Fort Scott limestone, St. Louis County, Missouri.)

Hollina fortscottensis Knight, Jour. Pal., vol. 2, 1928, p. 237, pl. 31, fig. 2. (Upper Fort Scott limestone, St. Louis County, Missouri.)

Hollinella dentata Coryell, Jour. Pal., vol. 2, 1928, p. 378, pl. 51, fig. 1. (Wewoka formation, Seminole County, Oklahoma.)

Basslerina regularis Moore, Jour. Sci. Lab. Denison Univ., vol. 24, 1929, p. 108, pl. 6, fig. 3, pl. 8, figs. 7, 8, 15. (South Bend shale, Graham, Texas.)

Hollinella bassleri Kellett, Jour. Pal., vol. 3, 1929, p. 204, pl. 25, fig. 5.

Carapace roughly semiovate in lateral view; greatest length just above center line; hinge line straight; cardinal angles prominent in frilled stages, with a slight upward beak at the anterior angle; anterior node prominent, slightly elongated parallel to the hinge line; posterior node smaller, nearly hemispherical except postero-ventrally where it merges evenly with the slope of the carapace; median sulcus distinct, extending farther under the posterior node than the anterior; frill terminated anteriorly by a hollow spine; frilless forms with a row of spines, largest ventrally, extending along the free margins between the cardinal angles; entire surface, except for frills, covered with low papillae, a few of which are about twice the size of the rest.

Productive female: ..... length, 1.15 mm.; height, 0.71 mm.
Frilless male: ..... length, 0.83 mm.; height, 0.51 mm.

This form is separated from *H. ulrichi* (Knight) and *H. digitata* Kellett by the lack of spines on the carapace. It differs from *H. limbata* (Moore) in the proportions of the nodes, the less thickly crowded papillae and the greater proportionate length. The frilless form is recognized by the shape of the median sulcus and the continuity of the row of spines between the cardinal angles.

HOLLINELLA LIMBATA (Moore)

Plate IV, fig. 4

Basslerina limbata Moore, Jour. Sci. Lab. Denison Univ., vol. 24, 1929, p. 110, pl. 6, fig. 7, pl. 7, figs. 11, 12, pl. 8, figs. 13, 14. (Wewoka formation, Pontotoc County, Oklahoma.)

Carapace nearly semicircular in lateral view if frill is ignored, otherwise with marked posterior obliquity; hinge line straight; anterior cardinal angle beaked in the widest frilled forms; anterior node

very prominent, hemispherical; posterior node low, indistinctly oval, merging smoothly into the posterior surface; median sulcus narrow, extending somewhat under the posterior node and containing at its deepest point a smooth round depressed pit much like that in the Kirkbyidae; ridge below the median sulcus unusually prominent; surface of the carapace, except the frills, covered with closely packed papillae; frills exceptionally broad, particularly in the post-ventral portion, and usually showing the characteristic radiations.

Productive female: length 1.07 mm.; height, 0.73 mm.

This handsome species is recognized best by its broad frill and its very closely papillose surface. Male specimens have been only doubtfully recognized.

Genus CORNIGELLA new genus

Genoholotype, *Cornigella minuta,* new species. (Pennsylvanian, Upper Wetumka, two miles west of Steedman, Oklahoma.)

Carapace minute, subquadrate; greatest height in posterior half; greatest thickness central; hinge line straight, slightly less than the greatest length of the carapace; valves equal; surface ornamented by about eight prominent spines on each valve, one of which extends well above the hinge line. Length, up to 0.35 mm.

Habitat, shallow water sediments.

Range, Pennsylvanian of Great Britain and Oklahoma.

This genus resembles *Mauryella* Ulrich and Bassler in the prominent ornamentation, but lacks the reticulate surface and kirkbyan pit of that group, and is more extreme in the development of the spines. *Beyrichia tuberculospinosa* Jones and Kirkby (Ann. Mag. Nat. Hist., ser. 5, vol. 18, 1886, p. 258, pl. 8, fig. 8.) should also be referred to this genus, being distinguished from the genotype only in having but six spines.

CORNIGELLA MINUTA n. sp.

Plate IV, figs. 7a, b, c

Carapace subquadrate in lateral view, ends smoothly rounded; cardinal angles obtuse, inconspicuous; hinge line straight, slightly more than three quarters of the total length; surface granulose, ornamented by eight thick spines on each valve, spaced at nearly equal intervals just inside the margins; spines variable in size, the two smallest being hardly more than papillae near the cardinal angles, and the two largest being prominent along the hinge line; the anterior of the large pair is the best developed, extending up and out well above the hinge. Length, 0.35 mm.; height, 0.20 mm. thickness, 0.11 mm.

Holotype, Columbia University Pal. Coll. No. 19983.

Upper Wetumka formation, 20 feet below top, locality 39 two miles west of Steedman, Oklahoma.

Family KLOEDENELLIDAE Ulrich and Bassler

Genus JONESINA Ulrich and Bassler, 1908

Jonesina Ulrich and Bassler, Proc. U. S. Nat. Mus., vol. 35, 1908, p. 324.

JONESINA GREGARIA (Ulrich and Bassler)

Plate IV, fig. 11

Beyrichiella gregaria Ulrich and Bassler, Proc. U. S. Nat. Mus., vol. 30, 1906, p. 157, pl. 11, fig. 18. (Coal Measures, Kansas City, Missouri.)

Jonesina gregaria Knight, Jour. Pal., vol. 2, 1928, p. 241, pl. 31, fig. 5e. (Upper Fort Scott limestone, St. Louis County Missouri.)

Carapace little inflated, nearly semicircular in lateral view; greatest height just back of center; hinge line straight, nearly as long as the shell; sulcus long, straight, shallow, at the position of greatest height; a short spine is located one fifth of the distance from the anterior end on the dorsal border of each valve; surface smooth. Length, 0.5 mm.; height, 0.32 mm.

JONESINA TEXANA Harlton

Plate IV, fig. 10

Jonesina texana Harlton, Univ. Texas Bull. 2901, 1929, p. 146, pl. 1, fig. 14. (Canyon, Menard County, Texas.)

Carapace suboval in lateral view; hinge line gently convex; ventral margin straight for one third its length, meeting the posterior end more smoothly than the anterior; sulcus slightly in front of the middle, shallow and narrow in its upper part, ending abruptly in a circular pit just above the median line of the carapace; anterior portion thick, truncated abruptly a short distance from the end, producing a transverse ridge resembling that of *Healdia;* margins very slightly carinate at both ends; surface smooth. Length, 0.55 mm.; height, 0.3 mm.; thickness, 0.25 mm.

The specimens examined lack the swelling which rises above the hinge line anteriorly, but agree in other respects with the originals.

JONESINA AMPLA n. sp.

Plate IV, figs. 8a, b

Carapace subrhomboidal in lateral view; greatest thickness one fifth of the length from the anterior end; hinge line short, straight, its anterior half concealed in lateral view by the inflation of the carapace; anterior cardinal angle distinct, nearly a right angle; posterior angle poorly defined, very obtuse; ventral border gently convex, meeting the posterior end less abruptly than the anterior; sulcus just back of the middle line of the shell, broad and shallow in its upper part, becoming constricted and better defined at its lower end, where it dies out in an obscure pit; left valve rabbeted marginally to fit over the edge of the right, this overlap being most conspicuous at the posterior end of the hinge line; surface smooth. Length, 0.73 mm.; height, 0.47 mm.; thickness, 0.38 mm.

Holotype, Columbia University Pal. Coll. No. 19984.

Holdenville formation, ten feet above base, locality 29, three miles east of Ada, Oklahoma.

The extreme inflation of the anterior end distinguishes this form from *J. acuneata* n. sp.

JONESINA ACUNEATA n. sp.

Plate IV, figs. 9a, b

Carapace subquadrate in lateral view; greatest thickness slightly in front of the center; hinge line short, straight, its anterior half concealed in lateral view by the inflation of the carapace; anterior cardinal angle distinct, less obtuse than the poorly defined posterior angle; ventral border gently convex; sulcus shallow, just back of the middle of the shell, best defined in its constricted central portion; overlap of the left valve most conspicuous at the posterior end of the hinge line; surface smooth. Length, 0.69 mm.; height, 0.40 mm.; thickness, 0.29 mm.

Holotype, Columbia University Pal. Coll. No. 19985.

Wetumka formation, 30 feet below top, locality 57, two miles west of Steedman, Oklahoma.

This species lacks the high inflation of the anterior end which is found in *J. ampla* n. sp.

Genus KIRKBYINA Ulrich and Bassler, 1908

Kirkbyina Ulrich and Bassler, Proc. U. S. Nat. Mus., vol. 35, 1908, p. 322, pl. 43, figs. 11-14.

KIRKBYINA LAEVIS n. sp.

Plate IV. figs. 12a, b

Carapace subquadrate in lateral view; greatest thickness one quarter of the length from the anterior end; hinge line straight, about two thirds of the total length; cardinal angles distinct, the anterior one slightly more obtuse than the posterior; ventral margin evenly convex for its entire length, joining the ends smoothly; sulcus broad and shallow, not distinctly delineated, just above and posterior to the center of the shell; a low ridge marks the anterior limit of the inflation of the shell in the dorsal part of the left valve; the thickened free margin of the right valve is rabbeted to receive the edge of the left valve, this overlap being strongest at the cardinal angles; surface smooth. Length, 0.74 mm.; thickness, 0.47 mm.

Holotype, Columbia University Pal. Coll. No. 19986.

Wewoka formation, 75 feet above base, locality 37, seven miles southeast of Ada, Oklahoma.

The median sulcus and the low ridge across the anterodorsal part of the left valve are both inconspicuous features, usually invisible except in dorsal view.

Family KIRKBYIDAE Ulrich and Bassler

Genus ULRICHIA Jones, 1890

Ulrichia Jones, Quart. Journ. Geol. Soc. London, vol. 46, 1890, p. 543, fig. 2.

ULRICHIA MONTOSA Knight

Plate IV, fig. 13

Ulrichia montosa Knight, Jour. Pal., vol. 2, 1928, p. 252, pl. 32, fig. 1, pl. 33, fig. 1. (Fort Scott limestone, St. Louis County, Missouri.)

Carapace nearly semicircular in lateral view; cardinal angles prominent, the anterior barely acute and the posterior slightly obtuse; ends smoothly curved to meet the gently flattened ventral border; hinge line straight, marking the greatest length of the carapace; valves subequal, the left grooved to receive the edge of the right; margin smooth, bordered by a low carina which is separated by three to four rows of reticulations from the heavily carinate main flange extending between the cardinal angles, nearly paralleling the ventral border; anterior node bean-shaped, more prominent than the posterior, rising above the hinge line; posterior node subtriangular, with greater relief ventrally, not reaching above the hinge line; anterior slope of

both nodes steep; kirkbyan pit circular, the size of four reticulations, located at the antero-ventral corner of the posterior node; surface, except for margin and carinae, finely reticulate, the pits being largest along the inner carina, and smallest on the nodes. Length, 1.0 mm.; height, 0.55 mm.

This handsome species agrees well with Knight's description except for the greater size of the kirkbyan pit, a character of some variability in the whole family.

Genus AMPHISSITES Girty, 1910

Amphissites Girty, Ann. N. Y. Acad. Sci., vol. 20, 1910, p. 235.

As used here the genus *Amphissites* includes the Kirkbyae which have obtuse, usually obscure cardinal angles and articulate the valves by means of two teeth on the hinge line of the left valve which fit into sockets on the right valve. The valves are essentially equal, but the free margin of the left valve is rabbeted to receive the edge of the right. Carinae are usually present on the keels and nodes.

The relation of *Amphissites* to *Kirkbya* is admittedly very close, but there seems to be no important reason for not recognizing them as separate genera.

AMPHISSITES ROUNDYI Knight

Plate IV, fig. 14

Amphissites roundyi Knight, Jour. Pal., vol. 2, 1928, p. 262, pl. 32, fig. 8, pl. 34, fig. 5. (Upper Fort Scott limestone, St. Louis County, Missouri.)

Carapace small, suboblong in lateral view; height slightly greater in posterior half; thickness greatest in anterior third; ends rounded, joining the straight hinge line with subequal angles; ventral margin slightly concave in the central portion; margin narrow, smooth, bordered by a low carina extending all the way around between the cardinal angles; inner flange poorly developed, rarely carinate, separated from the outer by two to three rows of reticulations, strongest in the antero-ventral region and dying out just inside the postero-ventral angle; anterior node in the form of a non-carinate ridge with steeper anterior slope, arising just behind the anterior cardinal angle and proceeding downward and backward, dying out just below the middle line of the carapace; posterior node faint or absent; median node subcentral, extending obliquely upward and forward in a low ridge, steepest on the anterior side where it overhangs the reniform kirkbyan pit; entire surface, except for the margin and the narrow dorsal plate, covered with irregular reticulations. Length, 0.67 mm.; height, 0.38 mm.; thickness, 0.37 mm.

This species may be distinguished by its oblique, non-carinate nodes and the obsolescence of the posterior ridge. It is closely allied to *A. dattonensis* Harlton, from which it may be distinguished by the extension of the inner flange nearly to the antero-cardinal angle.

AMPHISSITES DATTONENSIS Harlton

Plate IV, fig. 15

Amphissites dattonensis Harlton, Jour. Pal., vol. 1, no. 3, 1927, p. 206, pl. 32, fig. 9. (Upper Deese, Carter County, Oklahoma.); Univ. Texas Bull. 2901, 1929, p. 149, pl. 1, fig. 9. (Canyon, Menard County, Texas.)

Carapace suboblong in lateral view; height slightly greater in posterior half; ventral outline straight or slightly concave in the central portion; margin narrow, smooth, separated by a single row of reticulations from a well developed carina which extends upward to both cardinal angles; an inner carina parallels the ventral margin proper, ending anteriorly just below the carina on the anterior node; a further prolongation of this carina is marked in adults by two or three spines on the reticulation; anterior node carinate, arising just behind the cardinal angle and extending down nearly to the inner marginal keel; median node small, non-carinate, rounded except antero-ventrally where it overhangs a small kirkbyan pit; surface, except cardinal plate and margin, evenly reticulated. Length, 0.62 mm.; height, 0.34 mm.; thickness, 0.32 mm.

This species is very close to *A. roundyi* Knight, from which it may be distinguished by the dying out of the inner keel at the lower end of the carinate anterior node.

AMPHISSITES GENEAE Roth

Plate V, fig. 2

Amphissites pinguis Knight (not Ulrich and Bassler), Jour. Pal., vol. 2, 1928, p. 263, pl. 32, fig. 9, pl. 34, fig. 3. (Fort Scott limestone, St. Louis County, Missouri.)

Amphissites geni Roth, Pub. Wagner Free Inst., vol. 1, 1929. p. 42, pl. 2, fig. 12. (Francis shale, Pontotoc County, Oklahoma.)

Amphissites geneae Roth, Jour. Pal., vol. 3, 1929, p. 292.

Carapace subquadrate in lateral view; greatest length and thickness both central; ends evenly rounded, joining the straight dorsal and ventral margins smoothly; free margin smooth, narrow, bordered ventrally by a faint carina; anterior node large but low, thickening the carapace markedly just back of the cardinal angle, and dying out grad-

ually toward the center of the valve; median node central, low, rounded except for its ventral side where it overhangs a comma-shaped kirkbyan pit; surface, except margin and cardinal plate, evenly and coarsely reticulated. Length, 0.9 mm.; height, 0.57 mm.; thickness, 0.51 mm.

This species is a close relative (probably the ancestor) of *A. ciscoensis* Harlton, which differs only in having a larger median node and a stronger marginal carina.

AMPHISSITES WEWOKANUS n. sp.

Plate V, figs. 5a, b

Carapace elongate, subquadrate in lateral view; cardinal angles subequal; dorsal margin straight, nearly parallel to the gently curved lower margin; greatest thickness in the anterior quarter; hinge line depressed, straight; margin smooth, narrow on the ventral surface and broader on the cardinal plate, particularly at the cardinal angles; marginal carina absent, indicated only by two parallel rows of reticulations along the ventral side; anterior node rounded, not carinate, rising slightly back of the antero-cardinal angle, its anterior limits sharply defined, but posteriorly descending evenly to the level of the carapace; posterior node weak, elongate, arising at the postero-cardinal angle and proceeding downward and slightly forward for a distance of six reticulation pits before disappearing; median node absent; kirkbyan pit a little below the center of the valve, oval, the size of four reticulations; entire surface except for the margin finely and evenly reticulated. Length, 0.52 mm.; height, 0.34 mm.; thickness, 0.30 mm.

Holotype, Columbia University Pal. Coll. No. 19987.

Wewoka formation, 100 feet below top, locality 42, six miles east of Ada, Oklahoma.

This species is best separated from *A. simplexus* Roth by its straight sided, somewhat cuneate outline as seen from above. It differs from *A. pinguis* (Ulrich and Bassler) in its longer carapace and the presence of a posterior node.

AMPHISSITES GIRTYI Knight

Plate V, fig. 3

Amphissites girtyi Knight, Jour. Pal., vol. 2, 1928, p. 260, pl. 32, fig. 7, pl. 34, fig. 1. (Upper Fort Scott limestone, St. Louis County, Missouri.)

Amphissites mesocosta Roth, Pub. Wagner Free Inst., vol. 1, 1929, p. 48, pl. 3, fig. 15. (Wetumka shale, Pontotoc County, Oklahoma.)

Carapace small, subquadrate in lateral view; ends evenly rounded, meeting the straight hinge line with nearly identical, somewhat con-

spicuous angles; ventral margin terminated more abruptly at the posterior end; margin smooth, narrowest at the cardinal angles, separated from the lateral surface by a low carina; three to four rows of reticulations separate this carina from the stronger, smoothly curved inner carina which joins the marginal keel at the cardinal angles; anterior and posterior nodes slight, well marked by carinae, the anterior arising near the cardinal angle and proceeding obliquely downward and backward in a nearly straight line for a distance of five or six reticulations before dying out; the posterior carina arises from the dorsal carina and travels downward until it reaches the level of the median node, toward which it turns abruptly in a straight line paralleling the dorsal border; central node small, round, with a small elongate kirkbyan pit lying antero-ventrally of it; entire surface, except for the margin and carinae, evenly reticulated. Length, 0.73 mm.; height, 0.4 mm.; thickness, 0.30 mm.

This species is quickly distinguished by the conspicuous carina extending posteriorly from the median node. In juvenile forms this carina, together with the one bordering the dorsal margin, are poorly developed, giving the specimen a superficial resemblance to *A. centronotus*.

AMPHISSITES CENTRONOTUS (Ulrich and Bassler)

Plate V, figs. 4a, b, c

Kirbya centronota Ulrich and Bassler, Proc. U. S. Nat. Mus. vol. 30, 1906, p. 159, pl. 11, figs. 16, 17. (Cottonwood shale, Chase County, Kansas.)

Amphissites centronotus Knight, Jour. Pal., vol. 2, 1928, p. 259, pl. 32, fig. 6, pl. 34, fig. 2. (Fort Scott limestone and Labette shale, St. Louis County, Missouri.)

Carapace subquadrate in lateral view; cardinal angles slightly obtuse; height usually greater in the anterior half; hinge line depressed, straight; margin smooth, narrow on the ventral surface, increasingly so toward the ends and becoming almost extinct at the cardinal angles; marginal carina with a single row of reticulations on its ventral side; inner carina separated on the ventral border by three or four rows of reticulations from the marginal carina; cardinal plate smooth, bordered by a dorsal carina; anterior and posterior nodes carinate, the carinae arising from the dorsal keel at a distance of three pits in from the cardinal angle, and running downward to about two pits above the inner marginal keel before disappearing; median node large, central, nearly hemispherical; kirkbyan pit on the antero-ventral side of the median node; entire surface, except for the cardinal plate and the margins strongly reticulated, the reticulations being smaller, but without special arrangement, on the median node; rudimentary spines occur in adults at the junctures of some reticulations. Length, 0.75 mm.; height, 0.44 mm.

This species is recognized by its conspicuous median node flanked by subequal carinae. The specimens examined agree well with the types from the Permian of Kansas except for the margins, which pinch out more rapidly and completely toward the cardinal angles than in the types.

AMPHISSITES SIMPLICISSIMUS Knight

Plate V, figs. 1a, b

Amphissites simplicissimus Knight, Jour. Pal., vol. 2, 1928, p. 266, pl. 32, fig. 11, pl. 34, fig. 6. (Upper Fort Scott limestone, St. Louis County, Missouri.)

Carapace small, suboblong in lateral view; ends almost alike, meeting the straight hinge line smoothly; ventral margin gently convex; height and thickness slightly greater in the anterior half; surface without nodes or keels, but finely reticulated with the exception of the margin, which is finely striate; kirkbyan pit round or oval, subcentral, slightly larger than a reticulation pit; short rounded spines arise from the junctures of some of the reticulations. Length, 0.66 mm.; height, 0.4 mm.

The lack of keels and nodes is probably a specialized character in this species, as an examination of a series of carapaces shows traces of carinae in the juvenile stages.

Family GLYPTOPLEURIDAE Girty

Genus GLYPTOPLEURINA Coryell, 1928

Glyptopleurina Coryell, Jour. Pal., vol. 2, 1928, p. 381, pl. 51, fig. 4.

GLYPTOPLEURINA ? MINUTA n. sp.

Plate V, figs. 6a, b

Carapace minute, subquadrate in lateral view; greatest height one-fifth of the length from the posterior end; greatest thickness central; hinge line straight, about four fifths of the total length; cardinal angles distinct, the posterior one the more obtuse; ventral border concave slightly in front of the center, meeting both ends smoothly; free margins thickened into a conspicuous flange, strongest on the ends; the left valve overlaps the right on the ventral margin; each valve is ornamented with a complexly folded inosculating costa; surface, except for the costa and the marginal flange, finely reticulated. Length 0.4 mm.; height, 0.2 mm.; thickness, 0.17 mm.

Holotype, Columbia University Pal. Coll. No. 19988.

Holdenville formation, Sasakwa limestone member, locality 46, three miles east of Ada, Oklahoma.

The generic affinities of this small species are rather obscure. It lacks the central pit of the Kirkbyae, and is nodeless and much smaller than other species of *Glyptopleurina,* with which genus it is doubtfully placed.

Family BAIRDIIDAE Brady and Norman

Genus BAIRDIA McCoy, 1844

Bairdia McCoy, Syn. Carb. Limestone Foss. Ireland, 1844, p. 165, pl. 23, fig. 6.

This genus is present in most of the fossiliferous beds, and because of the large number of species that may be distinguished it is a valuable index form.

Most of the specific characters of Bairdiae can be seen in a lateral view of the right valve. In the following descriptions, therefore, the remarks about the slopes and borders of the carapace all refer to the profile of a specimen mounted to show the right side of the shell. It is important that the specimen be mounted exactly at right angles to the line of sight, as a small deviation from the proper position will make an important difference in the profile.

Subgenus BAIRDIA s. s.

BAIRDIA AURICULA Knight

Plate V, figs. 7a, b

Bairdia auricula Knight, Jour. Pal., vol. 2, 1928, p. 319, pl. 43, fig. 3. (Fort Scott limestone, St. Louis County, Missouri.)

Bairdia dornickhillensis Harlton (*B. pottsvillensis* in explanation of pl. 2), Am. Jour. Sci., ser. 5. vol. 18, 1929, p. 268, pl. 2, fig. 12. (Dornick Hills formation, Carter County, Oklahoma.)

Carapace large, subrhomboidal in lateral view; greatest thickness near the center or posterior to it; greatest height just anterior to center; postero-dorsal slope conspicuous, with a slight concavity near the beak and an equally slight convexity midway of the slope; antero-dorsal slope short, straight; anterior end rounded, the curve becoming very flat before meeting the gently convex ventral border; dorsal overlap greatest at point of greatest height, decreasing slowly toward the front; ventral overlap greatest at the same point, fading away slowly toward the beak. Length, 1.25 mm.; height, 0.70 mm.; thickness, 0.51 mm.

This species is close to *B. oklahomaensis* Harlton and was included in one paper (Univ. Texas Bull. 2901, 1929) under that name. Harlton later proposed a distinct name for this form, already described by Knight. The chief difference between the two species is in the width of the carapace, a feature visible only in dorsal or ventral views.

BAIRDIA OKLAHOMAENSIS Harlton

Plate V, figs. 8a, b

Bairdia oklahomaensis Harlton, Jour. Pal., vol. 1, no. 3, 1927, p. 209, pl. 33, fig. 7. (Upper Deese, Carter County, Oklahoma.)

Carapace large, subrhomboidal in lateral view; greatest thickness in the central third; greatest height just anterior to the center; postero-dorsal slope conspicuous, with a slight outward bend in the middle; antero-dorsal slope short, straight; anterior end broadly rounded, particularly where its curve approaches the long, slightly convex ventral border; posterior end acuminate; both dorsal and ventral overlaps are strongest at the point of greatest height. Length, 1.13 mm.; height, 0.72 mm.; thickness, 0.61 mm.

This species is almost indistinguishable in lateral view from *B. auricula* Knight, which occurs in lower beds. If the carapace is viewed in dorsal aspect, however, the difference in the thickening of the shell is apparent.

BAIRDIA BEEDEI Ulrich and Bassler

Plate V, figs. 9a, b

Bairdia beedei Ulrich and Bassler, Proc. U. S. Nat. Mus., vol. 30, 1906, p. 161, pl. 11, figs. 19, 20. (Cottonwood shale, Chase County Kansas.)

Carapace subrhomboidal in lateral view; greatest thickness central; greatest height just anterior to the center; dorsal slopes equal, nearly straight; anterior end evenly rounded, located on the center line of the shell; ventral border about as convex as the dorsal; posterior beak blunt, below the center line; dorsal overlap stronger centrally, equal on the two slopes; ventral overlap conspicuously strong at the center. Length, 1.34 mm.; height, 0.79 mm.; thickness, 0.56 mm.

This form is distinguished from *B. ardmorensis* Harlton by having a more convex ventral border, and from *B. hispida* Harlton by the greater central overlap on that border.

BAIRDIA ALTIFRONS Knight

Plate V, figs. 10a, b

Bairdia altifrons Knight Jour. Pal., vol. 2, 1928, p. 324, pl. 43, fig. 6. (Fort Scott limestone, St. Louis County, Missouri.)

Bairdia hoxbarensis Harlton, Univ. Texas Bull. 2901, 1929, p. 154, pl. 3, fig. 1. (Canyon, Menard County, Texas.)

Carapace suboblong in lateral view; greatest thickness one fourth of the length from the posterior end; greatest height slightly anterior to the center; postero-dorsal slope short, concave, joined smoothly to the unbroken curve of the dorsal border and antero-dorsal slope; anterior end high, broad, its curve terminated abruptly below; ventral border concave in the middle portion; overlap strongest on the post-dorsal slope. Length, 1.11 mm.; height, 0.65 mm.; thickness, 0.41 mm.

The specimens described by Harlton from Menard County and referred to his *B. hoxbarensis* have little resemblance either to his original figure of that species or to the holotype in the National Museum, and should be referred to *B. altifrons.*

BAIRDIA POMPILIOIDES Harlton

Plate V, figs. 11a, b

Bairdia pompilioides Harlton, Jour. Pal., vol. 2, 1928, p. 140, pl. 21, fig. 13. (Upper Glenn, Carter County, Oklahoma.); Univ. Texas Bull. 2901, 1929, p. 154, pl. 2, fig. 7, pl. 3, fig. 8. (Canyon, Menard County, Texas.)

Carapace subfusiform; greatest height just anterior to the center; greatest thickness one fourth of the length back of the center; postero-dorsal slope abrupt, forming a marked concavity in lateral view where it meets the small beak; antero-dorsal slope faintly concave; anterior end thin, bluntly pointed, curved slightly upward; ventral border with a small concavity at the middle of the shell; overlap extensive on both slopes, nowhere very great, weakest antero-ventrally. Length, 1.29 mm.; height, 0.62 mm.; thickness, 0.5 mm.

This form is distinguished from *B. subcitriformis* Knight by its more pointed anterior end and the concavity in the central part of the ventral border.

BAIRDIA GRAHAMENSIS Harlton

Plate V, figs. 12a, b

Bairdia grahamensis Harlton, Jour. Pal., vol. 2, 1928, p. 139, pl. 21, fig. 11. (Below Gunsight limestone, Graham, Texas.); Univ. Texas Bull. 2901, 1929, p. 156, pl. 3, fig. 4. (Canyon, Menard County, Texas.)

Bairdia citriformis Knight, Jour. Pal., vol. 2, 1928, p. 321, pl. 43, fig. 4. (Pawnee limestone, St. Louis County, Missouri.)

Carapace inflated, subtriangular in lateral view; greatest length just below the center; greatest height and thickness central; posterior and anterior dorsal slopes nearly equal, the posterior slightly more concave; anterior end rounded in a low curve which blends smoothly into the ventral border; beak bluntly pointed, close to the ventral margin; overlap of left valve small and even on dorsal border, strong at the center of the ventral border. Length, 1.07 mm.; height, 0.72 mm.; thickness, 0.55 mm.

This species is distinguished from *B. crassa* Harlton by having its greatest thickness central, and from *B. nitida* Harlton in being less gibbous.

BAIRDIA MENARDENSIS ? Harlton

Bairdia hoxbarensis Harlton, Univ. Texas Bull. 2901, 1929, p. 158, pl. 4, fig. 1. (Canyon, Menard County, Texas.)

Several poorly preserved carapaces are doubtfully referred to this species. Some of them may belong to the closely allied *B. subcitriformis* Knight, a form having a somewhat thinner posterior beak.

BAIRDIA CRASSA Harlton

Plate VI, figs. 1a, b

Bairdia crassa Harlton, Univ. Texas Bull. 2901, 1929, p. 158, pl. 4, fig. 3. (Canyon, Menard County, Texas.)

Carapace inflated, subrhomboidal in lateral view; greatest height central; greatest thickness one third of the length from the posterior end; postero-dorsal slope straight, joining a smooth dorsal curve which extends without break to the thin, rather high anterior end; ventral border nearly straight, rising only slightly at the posterior end to the pointed beak; overlap even, without distinctive feature. Length, 1.13 mm.; height, 0.54 mm.; thickness, 0.56 mm.

This form is recognizable by its extreme dorso-posterior inflation which hides part of the hinge line in lateral view.

BAIRDIA PERACUTA n. sp.

Plate VI, figs. 2a, b

Carapace elongate, slender; greatest height and thickness central; postero-dorsal slope markedly concave near the beak, becoming convex near the dorsal border; antero-dorsal slope straight; anterior end thin, bluntly pointed, a little below the center line of the shell; ventral border gently convex except at the center where there is a small but distinct depression; posterior beak pointed, thin, lower than the anterior end; dorsal overlap weak, confined to the antero-dorsal slope and a little near the beak; ventral overlap restricted to the central depression of the lower border; surface smooth. Length, 1.19 mm.; height, 0.48 mm.; thickness, 0.34 mm.

Holotype, Columbia University Pal. Coll. No. 19989.

Holdenville formation, ten feet above base, locality 29, three miles east of Ada, Oklahoma.

The dorsal overlap of the left valve is very slight, and this species marks one of the transitions toward *Bairdianella.*

BAIRDIA HAWORTHI Knight

Plate VI, figs. 4a, b

Bairdia haworthi Knight, Jour. Pal., vol. 2, 1928, p. 325, pl. 43, fig. 7. (Fort Scott limestone, St. Louis County, Missouri.)

Bairdia subelongata Harlton (not Jones and Kirkby), Univ. Texas Bull. 2901, 1929, p. 157, pl. 3, fig. 6a. (Canyon, Menard County, Texas.)

Carapace elongate, subovate in lateral view; greatest height central; greatest thickness of right valve one fourth of the length from the posterior end; left valve thickest centrally; posterior dorsal slope convex, more sharply curved than the dorsal border and anterior slope; anterior end central, gently rounded, merging smoothly with the ventral border, which is faintly concave in the median part; postero-ventral slope nearly straight; posterior beak blunt, below the center of the shell; dorsal overlap extends almost from end to end, slightly greater at and just in front of the center; ventral overlap greatest in the median concavity of the border, dying out abruptly just anterior to it, but extending posteriorly nearly to the beak. Length, 1.12 mm.; height, 0.48 mm.; thickness, 0.41 mm.

This species is distinguished from *B. glennensis* Harlton by having a shorter straight ventral border. It is much more robust than *B. subelongata* Jones and Kirkby, in which the length is more than three times the height.

BAIRDIA NITIDA Harlton

Plate VI, figs. 3a, b

Bairdia nitida Harlton, Jour. Pal., vol. 2, 1928, p. 139, pl. 21, fig. 12. (Hoxbar formation, Love County, Oklahoma.); Univ. Texas Bull. 2901, 1929, p. 155, pl. 3, fig. 3. (Canyon Menard County, Texas.)

Carapace highly inflated, subtriangular in lateral view; greatest height central; greatest thickness just posterior to the center; posterior and anterior dorsal slopes nearly equal, the posterior slightly steeper; anterior end sharply rounded, just below the center line of the shell; ventral border gently convex, rising slightly at the posterior end to the small pointed beak; overlapping edges of the left valve thick. Length, 0.97 mm.; height, 0.64 mm.; thickness, 0.62 mm.

This species is much more gibbous than *B. grahamensis* Harlton, and is thickest near the center rather than dorso-posteriorly as in *B. crassa* Harlton.

Subgenus BAIRDIANELLA Harlton, 1929

Bairdianella Harlton, Univ. Texas Bull. 2901, 1929, p. 160, pl. 4, fig. 5.

BAIRDIANELLA ELEGANS Harlton

Bairdianella elegans Harlton, Univ. Texas Bull. 2901, 1929, p. 160, pl. 4, fig. 5. (Canyon, Menard County, Texas.)

Carapace small, subovate; greatest height and thickness central; postero-dorsal slope markedly concave; anterior end broadly rounded, below the center of the shell; ventral border slightly convex; posterior beak narrow, pointed; dorsal overlap absent; ventral overlap small, central. Length, up to 0.7 mm.

This ostracod is not uncommon, but it has thin valves and usually occurs in a badly crushed state.

Genus BYTHOCYPRIS G. S. Brady, 1880

Bythocypris G. S. Brady, Rep. Voy. *Challenger,* Zool., vol. 1, 1880, p. 45, pl. 5, fig. 1.

BYTHOCYPRIS SASAKWAENSIS n. sp.

Plate VI, figs. 5a, b

Carapace reniform in lateral view; greatest height central or slightly posterior to the center; dorsal border convex, smoothly curved from end to end except for a slight flattening at the point of greatest height; anterior end one third of the height above the ventral border, meeting that border with a distinct angularity; greatest concavity of the ventral border one third of the length of the shell from the anterior end; posterior end beakless, about the same height as the anterior; overlap of the left valve along the dorsal margin even, fading out smoothly toward the ends, and absent on the ventral side of each end; ventral overlap even, about one half as great as the dorsal; surface smooth. Length, 1.11 mm.; height, 0.62 mm.; thickness, 0.36 mm.

Holotype, Columbia University Pal. Coll. No. 19990.

Holdenville formation, Sasakwa limestone member, locality 49, Sasakwa, Oklahoma.

This species is distinguished from *B. rotunda* by its more concave ventral border and its narrowness in dorsal aspect.

BYTHOCYPRIS ROTUNDA n. sp.

Plate VI, figs. 7a, b

Carapace reniform in lateral view; greatest height central; greatest thickness one fourth of the length from the posterior end; dorsal border gently convex, symmetrically curved; anterior end broadly rounded, slightly above the center of the shell; ventral border slightly convex, the margin of the right valve being straight; posterior end truncated abruptly in dorsal aspect, its thickest point being close to the postero-ventral corner; overlap of the left valve subequal on the dorsal and ventral margins, weak antero-ventrally and nearly absent postero-ventrally; surface smooth. Length, 0.72 mm.; height, 0.41 mm.; thickness, 0.36 mm.

Holotype, Columbia University Pal. Coll. No. 19991.

Wewoka formation, 90 feet below top, locality 51, seven miles east of Okemah, Oklahoma.

This species is distinguished by the symmetry of its dorsal border and its extreme thickness.

BYTHOCYPRIS PEDIFORMIS Knight

Plate VI, figs. 6a, b

Bythocypris pediformis Knight, Jour. Pal., vol. 2, 1928, p. 326, pl. 44, fig. 3. (Upper Fort Scott limestone, St. Louis County, Missouri.)

Bythocypris parallela Knight, Jour. Pal., vol. 2, 1928, p. 327, pl. 44, fig. 2. (Upper Fort Scott limestone, St. Louis County, Missouri.)

Carapace semiovate in lateral view; greatest height approximately central; greatest thickness at or slightly behind the center of the shell; dorsal border curved evenly from the postero-ventral beak to the highest part of the shell, the curve then flattening toward the anterior end; ventral border straight, slightly angled upward to the pointed beak; overlap of the left valve subequal all around; surface smooth. Length, 0.54 mm.; height, 0.30 mm.; thickness, 0.21 mm.

Series of specimens in the author's collection show no definite break between the arched type of carapace and that with more nearly parallel sides and margins, and both types are included under this name. The shell material is readily distorted, producing forms with apparent anomalies in outline and overlap.

Genus HEALDIA Roundy, 1926

Healdia Roundy, U. S. Geol. Surv., Prof. Paper 146, 1926, p. 8, pl. 1, fig. 11.

HEALDIA NUCLEOLATA Knight

Plate VI, figs. 9a, b

Healdia nucleolata Knight, Jour. Pal., vol. 2, 1928, p. 329, pl. 44, fig. 4. (Upper Fort Scott limestone, St. Louis County, Missouri.)

Carapace very bluntly triangular in lateral view; greatest height central; dorsal slopes subequal, nearly straight; anterior end slightly lower and sharper than the posterior; ventral border straight for about one half its length; posterior ridge spineless, gently convex toward the posterior end of the carapace, running nearly to the dorsal border before turning forward toward the highest part of the shell; surface smooth. Length, 0.45 mm.; height, 0.28 mm.; thickness, 0.20 mm.

This species is recognized best by its smooth posterior ridge which curves dorsally toward the top of the shell. It was not found above the lower Wewoka and it is probably a good index fossil for that horizon and the top of the Fort Scott limestone.

HEALDIA CISCOENSIS Harlton

Plate VI, figs. 8a, b

Healdia ciscoensis Harlton, Jour. Pal., vol. 1, no. 3, 1927, p. 208, pl. 33, fig. 4. (Below Sedwick limestone, Coleman County, Texas); Am. Jour. Sci., ser. 5, vol. 18, 1929, p. 265, pl. 2, fig. 6.

Carapace suboval in lateral view; greatest height just in front of the center; dorsal border high arched, the posterior slope straight or slightly concave; ventral border gently convex; posterior ridge sharp, concave posteriorly between the two angulations which mark the usual position of the spines in this genus; the dorsal end of the ridge runs anteriorly for a short distance beyond the upper rudimentary spine; central muscle spot conspicuously reticulate in well-preserved specimens; surface smooth. Length, 0.58 mm.; height, 0.41 mm.; thickness, 0.30 mm.

This species is distinguished from *H. nucleolata* Knight by the posteriorly concave curve of the ridge. It is relatively much higher than *H. caneyensis* Harlton.

HEALDIA LONGA Knight

Plate VI, figs. 10a, b

Healdia longa Knight, Jour. Pal., vol. 2, 1928, p. 332, pl. 44, fig. 6. (Upper Fort Scott limestone, St. Louis County, Missouri.)

Carapace subelliptical in lateral view; greatest height just back of the center; postero-dorsal slope flat or slightly concave; antero-dorsal slope gently convex; ventral border of the shell convex, the ventral margin of the right valve straight or concave; posterior ridge spineless, convex posteriorly, extending nearly to the middle of the dorsal margin; surface smooth. Length, 0.58 mm.; height, 0.40 mm.; thickness, 0.26 mm.

This species is distinguished from *H. nucleolata* Knight by its greater relative length, and from *H. formosa* Harlton by its lack of spines on the posterior ridge.

HEALDIA BYTHOCYPROIDEA n. sp.

Plate VI, figs. 12a, b

Carapace suboval to subquadrate in lateral view; greatest height central; posterior and anterior dorsal slopes equally gently convex; ventral border of the shell slightly convex, the ventral margin of the right valve being straight or slightly concave; posterior ridge developed on the ventral corner only, with or without a short spine at that corner on each valve; surface smooth. Length, 0.67 mm.; height, 0.40 mm.; thickness, 0.29 mm.

Holotype, Columbia University Pal. Coll. No. 19992.

Wewoka formation, 75 feet above base, locality 37, seven miles southeast of Ada, Oklahoma.

The forms which have the spine developed on the postero-ventral corner show a more convex dorsal profile than those in which the ridge is spineless. This may be a difference of specific importance, but as the two forms were always found together they are considered to be merely different sexes of the same species.

HEALDIA ELEGANS n. sp.

Plate VI, figs. 11a, b

Carapace suboval in lateral view; greatest height just back of the center; greatest thickness one third of the distance from the posterior end; dorsal margin arched, the postero-dorsal slope distinctly concave and the antero-dorsal slope gently convex; the left valve rises conspicuously above the right at the top of the post-dorsal slope; anterior end broadly rounded; ventral margin of the right valve straight for half its length; ventral border of left valve evenly convex; posterior end compressed, smaller than the anterior, located near the center line of the shell; posterior ridge indistinct or absent between the two spines on each valve, but sometimes traceable for a short distance antero-dorsally from the small upper spine; surface ornamented near the center of each valve by two sets of fine parallel striae which cross each other near the spines. Length, 0.8 mm.; height, 0.5 mm.; thickness, 0.4 mm.

Holotype, Columbia University Pal. Coll. No. 19993.

Wetumka formation, 100 feet below top, locality 5, Conjada Mt., Wagoner County, Oklahoma.

This species is distinguished from the closely related *H. formosa* Harlton by the greater compression of the posterior end (best seen in a lateral view of the left valve) and the greater thickness of the carapace. The surface striations are visible only in well preserved adults.

HEALDIA FORMOSA Harlton

Plate VI, figs. 13a, b

Healdia formosa Harlton, Jour. Pal., vol. 2, no. 2, 1928, p. 135, pl. 21, fig. 7. (Gaptank ? formation, Pecos County, Texas.)

Healdia limacoidea Knight, Jour. Pal., vol. 2, no. 4, 1928, p. 333, pl. 44, fig. 5. (Upper Fort Scott limestone, St. Louis County, Missouri.)

Carapace elongate oval in lateral view; greatest height just posterior to the center; postero-dorsal slope flat, the antero-dorsal gently convex; ventral border nearly straight for half the length of the shell; posterior end narrower than the anterior; two spines, usually well developed, on each valve, close to the posterior end, their connecting ridge indistinct or absent; muscle spot central, appearing reticulated in transparent well preserved specimens; surface smooth. Length, 0.70 mm.; height, 0.38 mm.; thickness, 0.32 mm.

This species is more elongate than *H. elegans* n. sp. and has the spines located nearer to the posterior end than in *H. ampla* Roundy.

Family CYTHERELLIDAE Sars

Genus CYTHERELLA Jones, 1849

Cytherella Jones, Pal. Soc. Mono., 1849, p. 28.

CYTHERELLA WEWOKANA n. sp.

Plate VII, figs. 2a, b

Carapace suboval in lateral view; greatest height central; greatest thickness a little back of the center, the most inflated part of the right valve being slightly posterior to the greatest inflation of the left; dorsal border convex, the posterior slope being longer and more nearly straight than the anterior; posterior end subangular, below the median line; ventral border evenly convex, smoothly joined to the broadly rounded anterior end; anterior end located on the median line of the shell; overlap of the right valve equally strong on the dorsal and ventral margins,

becoming very weak about half way out to the posterior end on both the dorsal and ventral slopes; surface smooth. Length, 1.28 mm.; height, 0.82 mm.; thickness, 0.48 mm.

Holotype, Columbia University Pal Coll. No. 19994.

Wewoka formation, limestone at top, locality 47, four miles east of Ada, Oklahoma.

This species is distinguished from *C. intermedia* Jones, Kirkby and Brady by having only one angulation on its posterior end. This prominent angulation also separates it from *C. subreniformis* of the same authors.

CYTHERELLA INTERMEDIA Jones, Kirkby and G. S. Brady

Plate VII, figs. 1a, b

Cytherella benniei var. *intermedia* Jones, Kirkby and Brady, Pal. Soc. Mono., 1884, p. 78, pl. 7, fig. 7. (Upper Coal Measures, Iowa.)

Carapace subelliptical in lateral view; greatest height just in front of the center; greatest thickness slightly posterior to the center; postero-dorsal border nearly straight from the highest part of the shell to the centrally placed posterior end; ventral border gently convex, meeting the posterior end in a blunt angle; anterior end broadly rounded, its center lower than that of the posterior end; overlap of the right valve greatest on the dorsal and ventral margins, fading out toward the posterior more rapidly on the ventral margin; overlap almost absent on the postero-ventral corner; surface smooth. Length, 1.09 mm.; height, 0.64 mm.; thickness, 0.42 mm.

This species is best recognized by the subangular outline of the posterior end and the position of the greatest and least overlaps of the right valve.

Genus CAVELLINA Coryell, 1928

Cavellina Coryell, Jour. Pal., vol. 2, 1928, p. 89.

CAVELLINA PULCHELLA Coryell

Plate VII, figs. 3a, b

Cavellina pulchella Coryell, Jour. Pal., vol. 2, 1928, p. 90, pl. 11, fig. 5. (Seminole and Holdenville formations, Oklahoma.)

Carapace suboval in lateral view; greatest height of right valve central; of the left valve, posterior to the center; dorsal border gently and evenly convex; posterior end more sharply rounded than the anterior, slightly angled in its profile just above the median line; ventral border less convex than the dorsal and more abruptly terminated at its

posterior end; ventral margin of the left valve concave; anterior end broadly rounded; dorsal and ventral overlaps of the right valve strong, the position of greatest overlap on the dorsal margin being slightly anterior to that on the ventral edge; surface smooth. Length, 1.16 mm.; height, 0.68 mm.; thickness, 0.48 mm.

The most distinctive characters of this species are the acuminate posterior end, the positions of greatest overlap and the ventral profile of the left valve.

CAVELLINA SUBPULCHELLA Coryell

Plate VII, figs. 4a, b

Cavellina subpulchella Coryell, Jour. Pal., vol. 2, 1928, p. 93, pl. 11, fig. 9. (Boggy shale, Oklahoma.)

Carapace oval in lateral view; greatest height central; dorsal border convex, evenly curved; posterior end thick, curved most sharply above the median line; ventral border less convex than the dorsal; ventral margin of the left valve straight; anterior end broadly rounded; overlap of the right valve best developed on the dorsal and ventral margins, the greatest overlap dorsally being distinctly anterior to the greatest ventral overlap; surface smooth. Length 1.11 mm.; height, 0.71 mm.; thickness, 0.5 mm.

This species is separated from both *C. lata* Coryell and *C. pulchella* Coryell by its much greater antero-dorsal overlap.

CAVELLINA LATA Coryell

Plate VII, figs. 5a, b

Cavellina lata Coryell, Jour. Pal., vol. 2, 1928, p. 94, pl. 11, fig. 11. (Seminole and Holdenville formations, Oklahoma.)

Carapace broadly oval in lateral view; greatest height central or just posterior to the center; dorsal border convex, somewhat flattened on its posterior slope; posterior end rounded, central; ventral border slightly less convex than the dorsal; ventral margin of the left valve slightly convex, becoming straight in large specimens; anterior end very broad; overlap of the right valve decreases more rapidly toward the anterior end on the dorsal margin; surface smooth. Length, 0.90 mm.; height, 0.67 mm.

This species is distinguished from *C. subpulchella* Coryell, which it most closely resembles, by its smaller relative thickness and the less rapid convergence of the dorsal and ventral margins of the left valve toward the anterior end.

CAVELLINA REVERSA Coryell

Plate VII, figs. 6a, b

Cavellina reversa Coryell, Jour. Pal., vol. 2, 1928, p. 92, pl. 11, fig. 7. (Boggy shale, Oklahoma.)

Carapace ovate in lateral view; greatest height just anterior to the center; dorsal border gently convex; dorsal margin of the left valve straight; posterior end bluntly angled, slightly above the median line; ventral border more convex than the dorsal; anterior end narrowly rounded; overlap of the right valve subequal on dorsal and ventral margins; surface smooth. Length, 1.14 mm.; height, 0.62 mm.; thickness, 0.50 mm.

This species is separated from other members of the genus by being somewhat angled posteriorly and having the ventral border more convex than the dorsal border.

REGISTER OF LOCALITIES

1. Oologah limestone, near top, shale bed in limestone, top of hill, NE. ¼ of NE. ¼, sec. 11, T. 18 N., R. 14 E.

5. Wetumka formation, 100 feet below top, shale below thin limestone, Conjada Mt., two miles east of Leonard, 150 feet above main road, SW. ¼, sec. 31, T. 17 N., R. 15 E.

7. Wetumka formation, top, shale two feet above siliceous limestone, Conjada Mt., two miles east of Leonard, 250 feet above main road, SW. ¼, sec. 31, T. 17 N., R. 15 E.

12. Wewoka formation, upper middle part, shales below cone-in-cone layer, road cut on hill, 800 feet south of center, sec. 25, T. 15 N., R. 12 E.

23. Wewoka formation, 25 feet below top, shale above limestone, road cut 300 feet west of creek, 1,300 feet west of the SE. corner. sec. 7, T. 11 N., R. 11 E.

29. Holdenville formation, 10 to 20 feet above base, shale in creek valley, 600 feet west of road corner, NE. ¼ of NW. ¼ sec. 1, T. 3 N., R. 6 E.

31. Francis formation, lower part, shale in quarry of Ada Brick Company, southeast part of Ada.

32. Seminole formation, upper part, shale in road cut 1,300 feet south of NW. corner, sec. 10, T. 3 N., R. 6 E.

37. Wewoka formation, 75 feet above base, shale on hill, 1,300 feet north and 200 feet east of SW. corner, sec. 4, T. 3 N., R. 7 E.

38. Wewoka formation, 105 to 115 feet above base, shale on slope above tank, 800 feet north and 200 feet east of SW. corner, sec. 32, T. 5 N., R. 8 E.

39. Wetumka formation, 20 to 30 feet below top, shale on hill above main road, 1,300 feet east of SW. corner, sec. 24, T. 4 N., R. 7 E.

42. Wewoka formation, 100 feet below top, shale in road cut on west slope of hill, SW. corner, sec. 29, T. 4 N., R. 7 E.

43. Holdenville formation, two feet below Sasakwa member, bank of creek, 1,500 feet east of SW. corner, sec. 18, T. 4 N., R 7 E.

44. Holdenville formation, ten feet above Sasakwa member, shale in gully, 1,250 feet east of SW. corner, sec. 18, T. 4 N., R. 7 E.

46. Holdenville formation, Sasakwa member, shale partings in limestone, top of hill, 2,100 feet west of SE. corner, sec. 25, T. 4 N., R. 6 E.

47. Wewoka formation, top. sandy limestone in creek bed, 200 feet SE. of NW. corner, sec 6. T., 3, N., R. 7 E.

49. Holdenville formation, Sasakwa member, limestone and shale partings in old quarry in south part of Sasakwa.

51. Wewoka formation, 90 feet below top, concretionary shale in road cut, 300 feet south of the center of the north line, NW. ¼, sec. 17, T. 11 N., R. 11 E.

53. Wewoka formation, 250 feet below top, shale on round hill, center of NW. ¼, sec. 31, T. 7 N., R. 9 E.

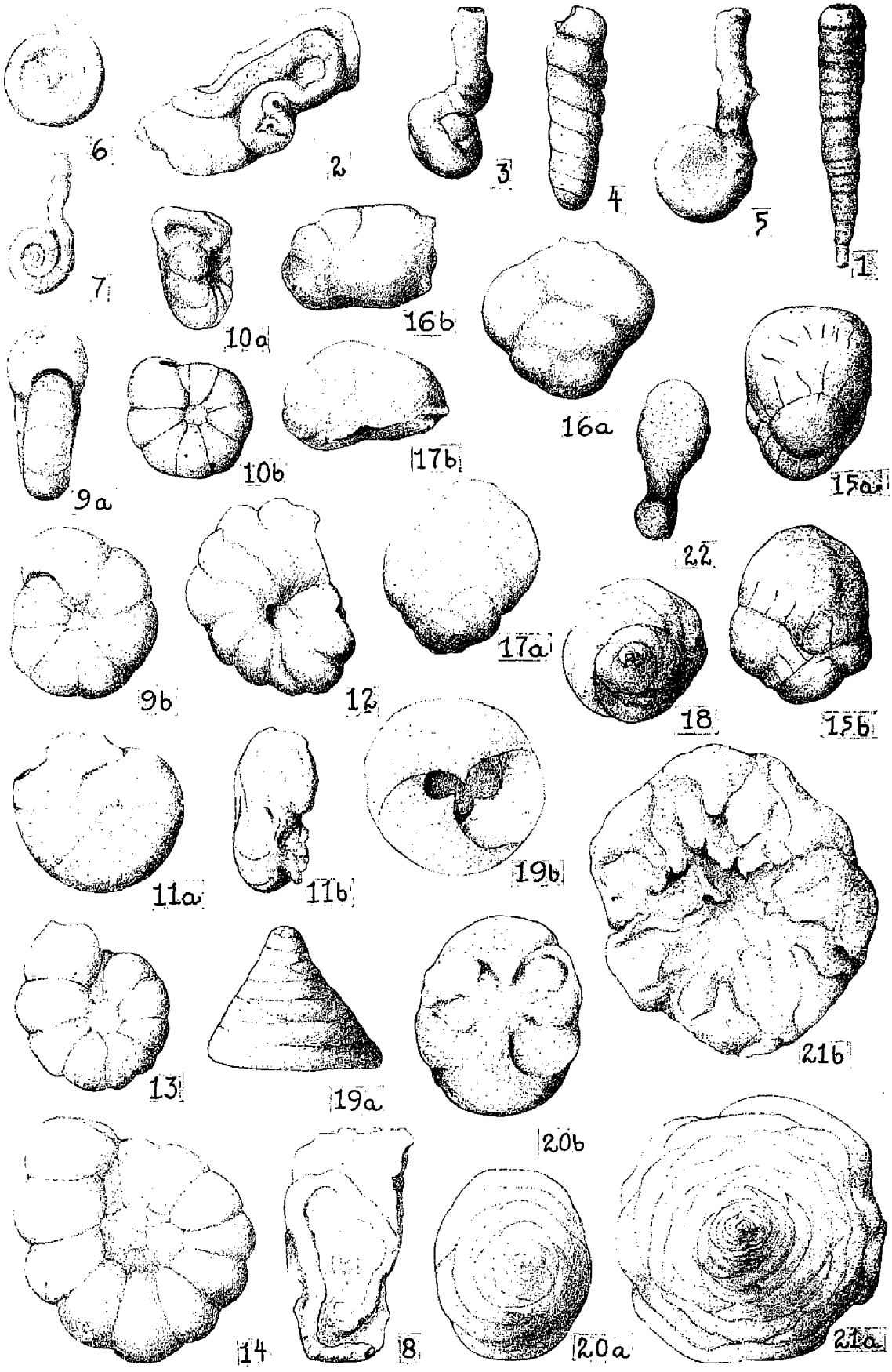
54. Holdenville formation, Homer member, fusulinid limestone in gully, 200 feet NW. of center, sec. 36, T. 4 N., R. 6 E.

57. Wetumka formation, 30 feet below top, shale along old road, center of north line, sec. 24, T. 4 N., R. 7 E.

58. Wetumka formation, 25 feet below top, crinoid layer, 1,100 feet south of the center of the north line, sec. 24, T. 4 N., R. 7 E.

59. Belle City limestone, shale from under lower layer, road cut on south bank of Sandy Creek, center of sec. 8, T. 4 N., R. 6 E.

EXPLANATION OF PLATE I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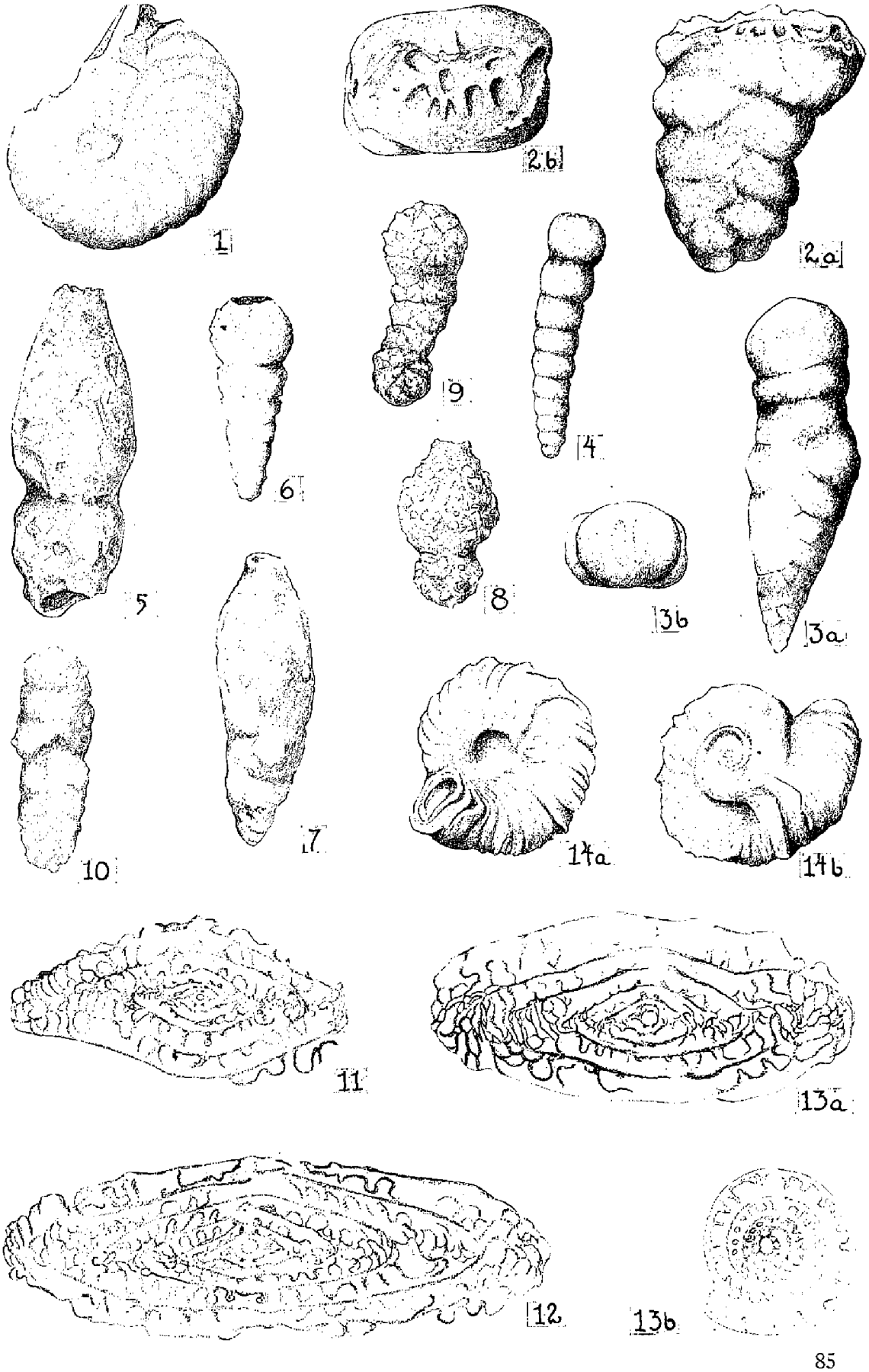
EXPLANATION OF PLATE II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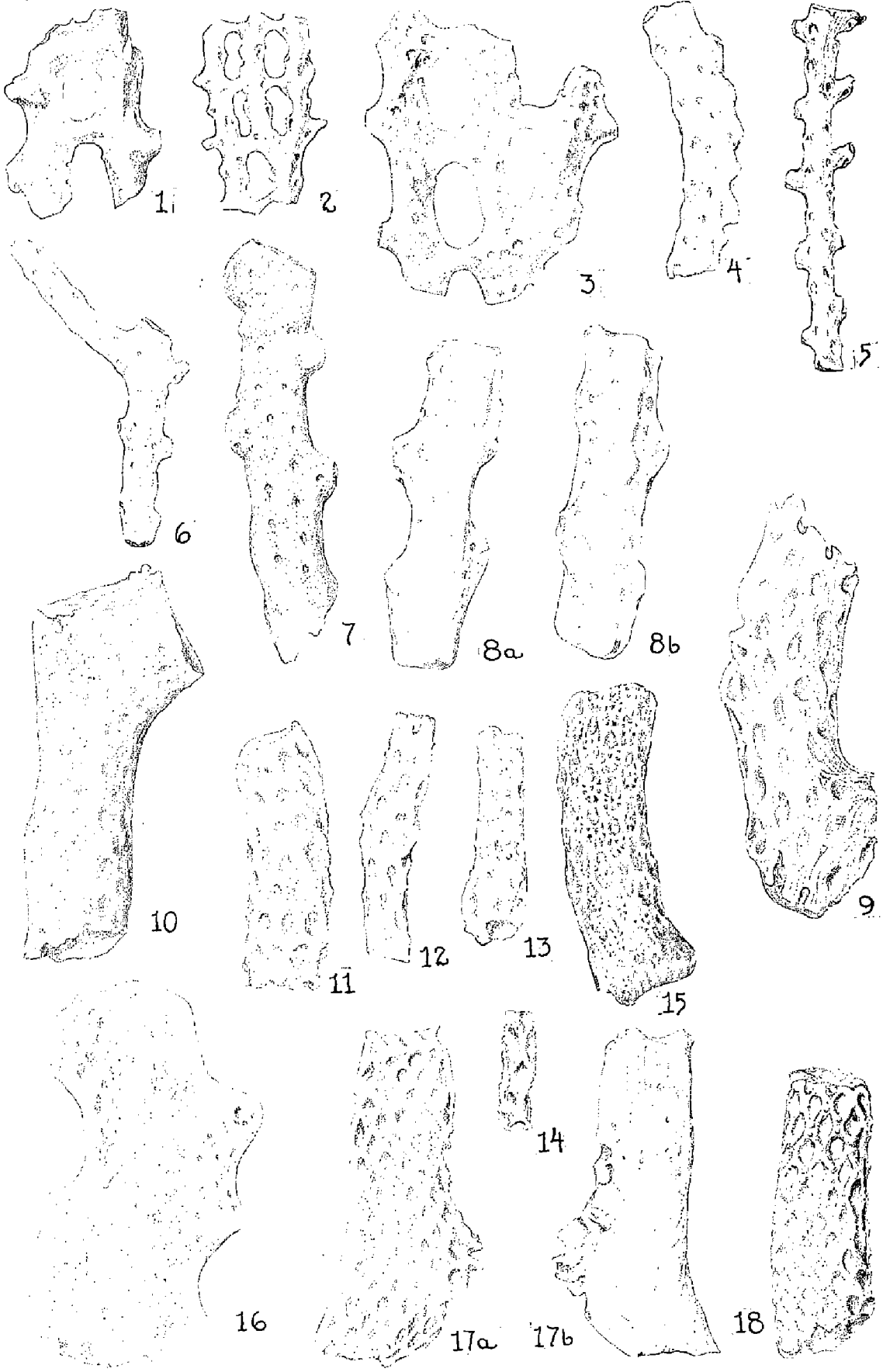
EXPLANATION OF PLATE III

			Page
FIGURE	1.	*Polypora hexagona* Moore. reverse. ×7, loc. 37	37
	2.	*Fenestella sasakwaensis* n. sp. obverse. ×7, loc. 49	36
	3.	*Polypora submarginata* Meek. reverse. ×7, loc. 57	36
	4.	*Thamniscus tenuiramus* Rogers. ×15, loc. 49	37
	5.	*Pinnatopora oculata* Moore. ×7, loc. 49	38
	6.	*Pinnatopora bellula* Ulrich. ×10, loc. 56	38
	7.	*Pinnatopora pustulosa* Moore. ×15, loc. 29	38
	8.	*Septopora blanda* Moore. *a,* reverse face; *b,* obverse face. ×20, loc. 37	39
	9.	*Septopora ? elliptica* n. sp. obverse face. ×7, loc.37	39
	10.	*Rhombopora pilula* Moore. ×7, loc. 29	40
	11.	*Rhombopora constans* Moore. ×15, loc. 49	40
	12.	*Rhabdomeson procerum* Moore. ×7, loc. 29	41
	13.	*Rhadbomeson bellum var. minus* Moore. ×7, loc. 29	41
	14.	*Rhabdomeson filum* Moore. ×7, loc. 49	41
	15.	*Streblotrypa multipora* n. sp. ×7, loc. 37	42
	16.	*Prismopora lobata* n. sp. ×7, loc. 37	43
	17.	*Rhombocladia delicata* Rogers. *a,* obverse face; *b,* reverse face. ×7, loc. 49	42
	18.	*Rhabdomeson magnum* n. sp. ×7, loc. 29	40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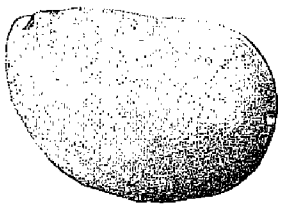
EXPLANATION OF PLATE IV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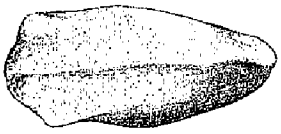
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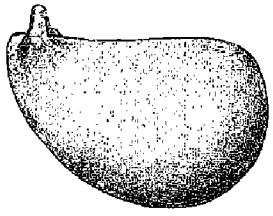
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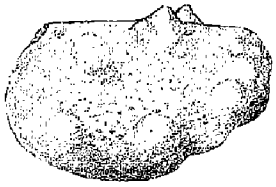
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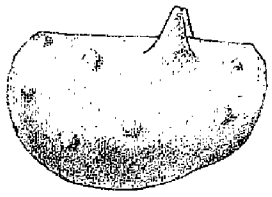
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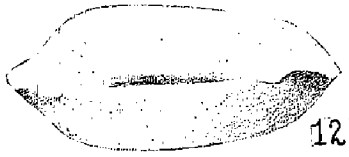
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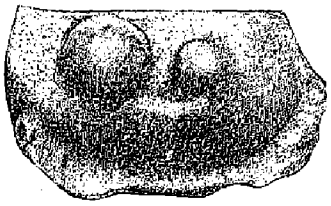
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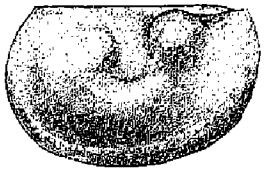
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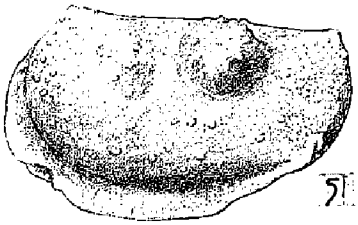
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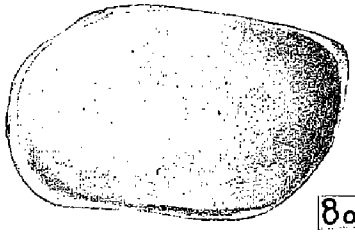
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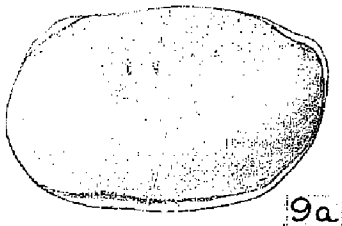
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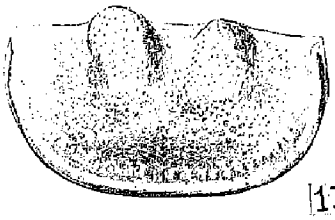
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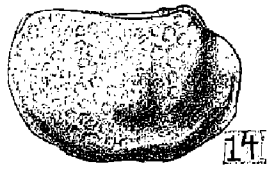
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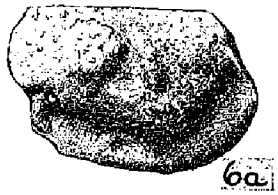
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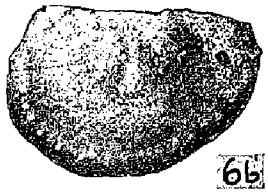
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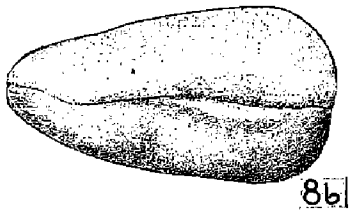
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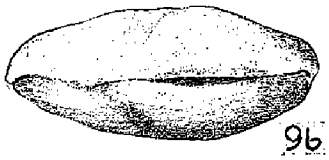
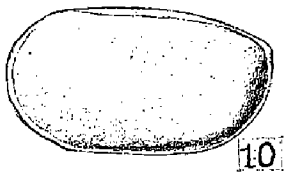

9b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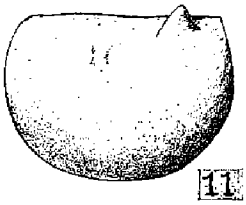
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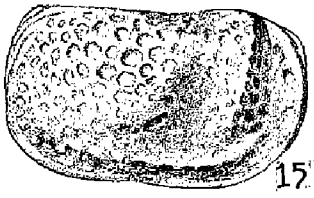
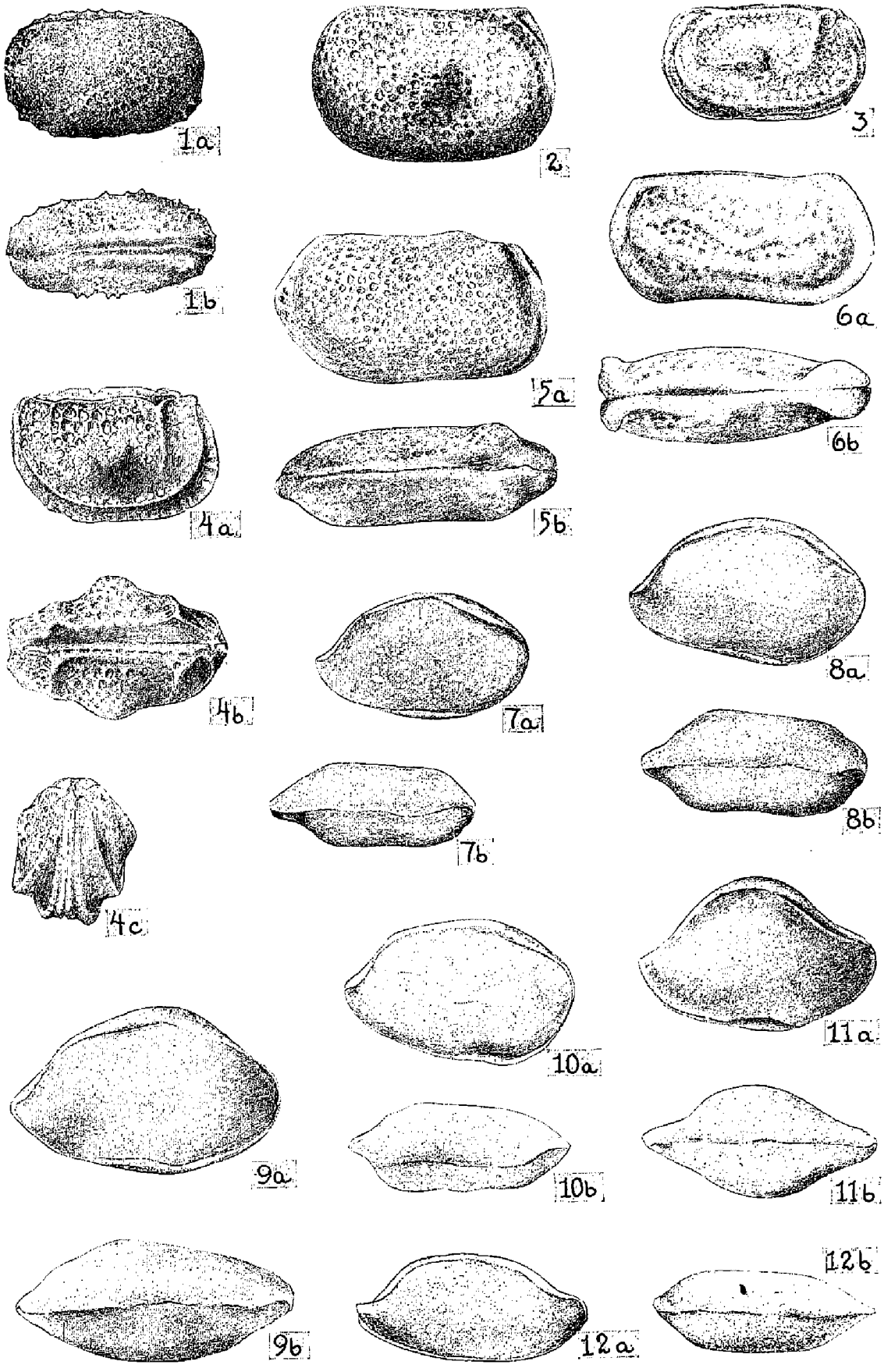
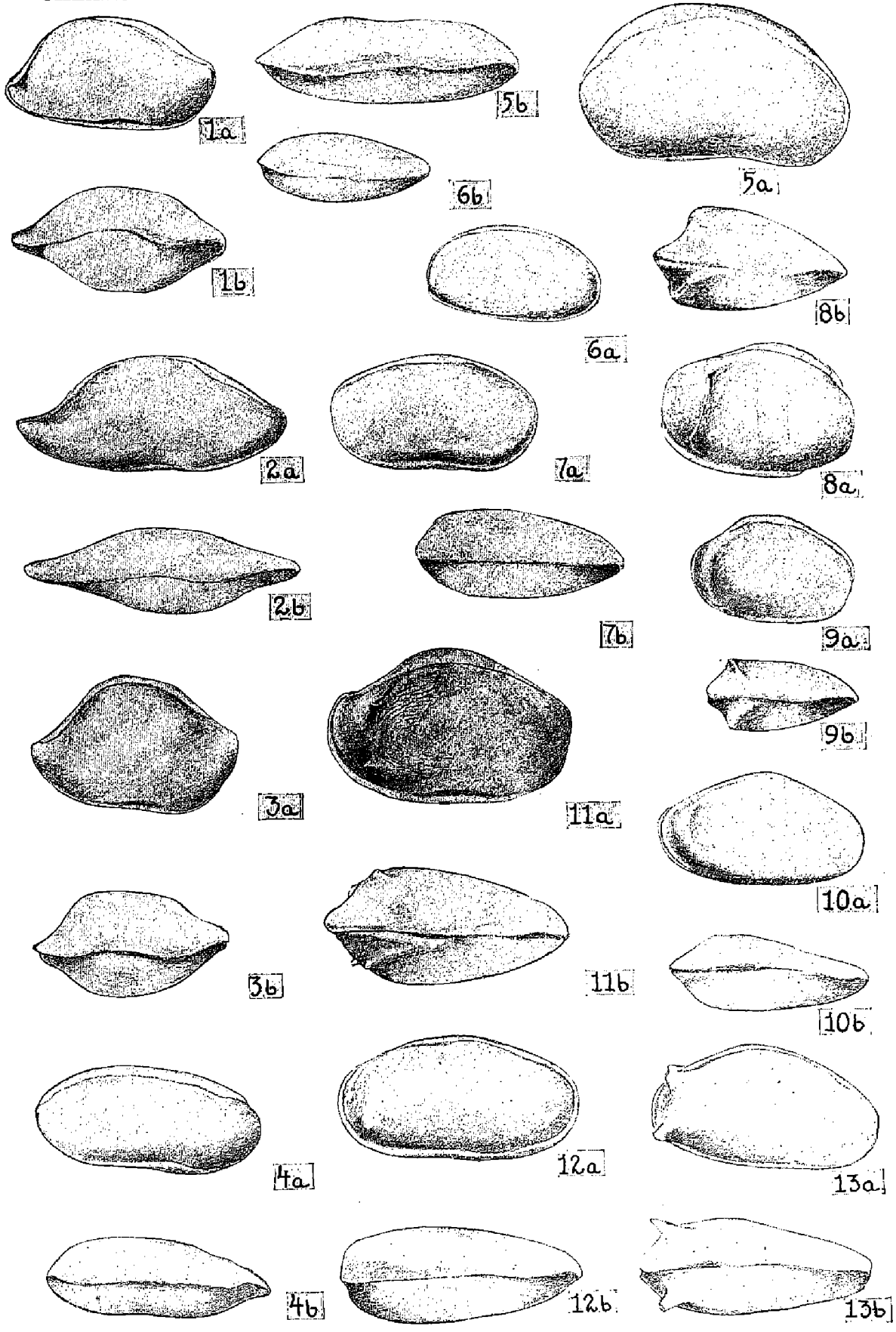

15

EXPLANATION OF PLATE V


1a
2
3
1b
6a
5a
6b
4a
5b
8a
4b
7a
8b
7b
4c
11a
10a
9a
10b
11b
12b
9b
12a

EXPLANATION OF PLATE VI


1a
5b
6b
5a
1b
8b
6a
2a
7a
8a
2b
7b
9a
9b
3a
11a
10a
3b
11b
10b
4a
12a
13a
4b
12b
13b

EXPLANATION OF PLATE VII

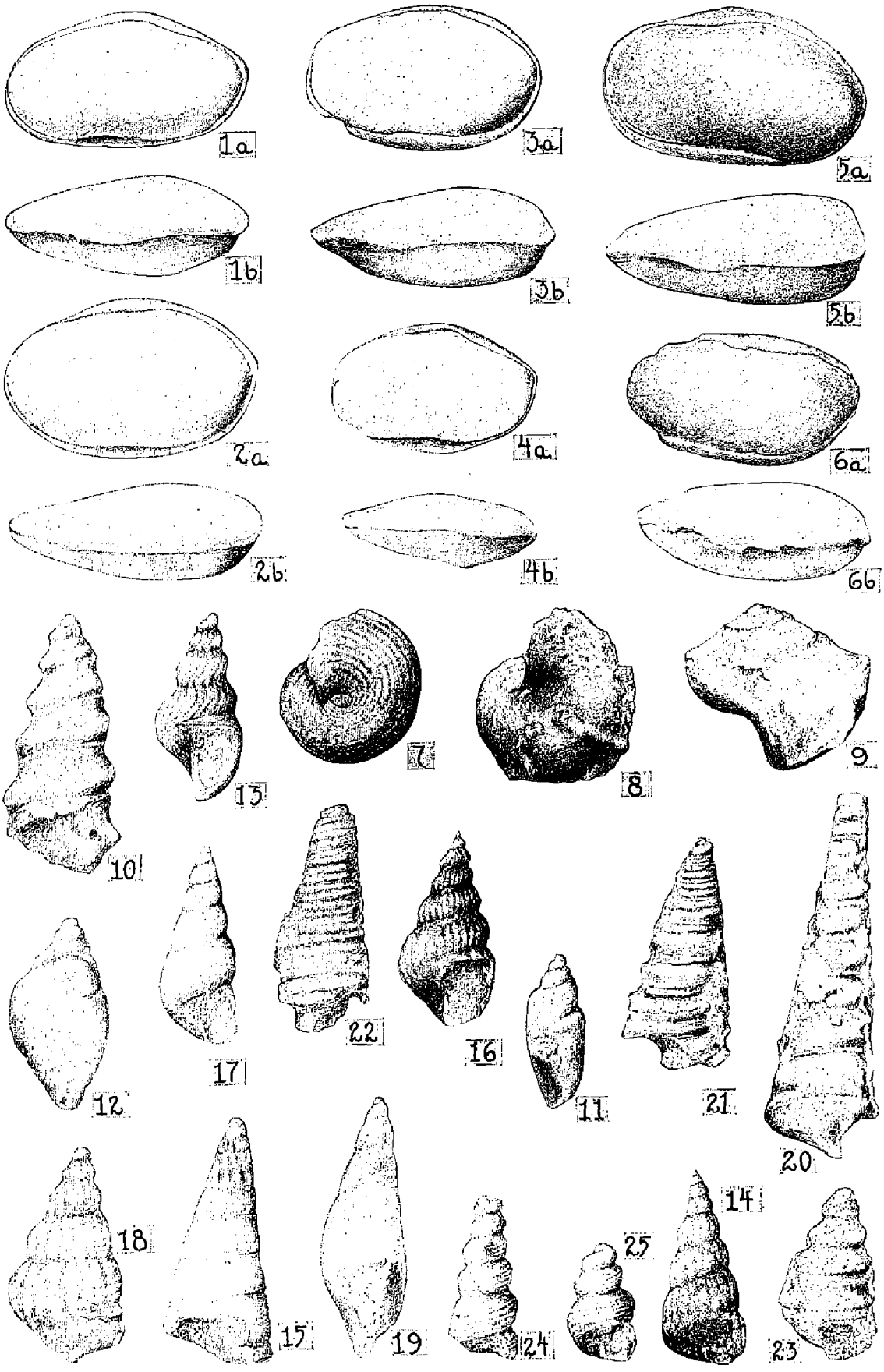

1a
3a
5a
1b
3b
5b
2a
4a
6a
2b
4b
6b
10
13
7
8
9
22
16
17
12
11
21
20
18
15
19
24
25
14
23

CHART OF DISTRIBUTION

SPECIES	Wetumka				Wewoka								Holdenville					
Locality	5	39	57	58	37	38	53	12	42	51	47	23	29	54	43	46	49	44
Foraminifera																		
Hyperamminoides glabra	R		R		C	R	R	R		A								
Ammovertella inversa	R	C	C	A	R	R	C	R	C	C	C		A		R	C	C	R
Ammonema protea					C		C		A	C								
Trepeilopsis spirans		R	R	R					R									
Rectocornuspira lituiformis					?	A	C											
Rectocornuspira calcarina		C	A				A	C	A		R	R	C			A		C
Rectocornuspira holdenvillana													C					
Apterrinella grahamensis	C																	
Endothyra rothrocki																	R	
Endothyra ovata													R				R	
Endothyra rotaliformis			C															
Endothyra ameradaensis									C		C							
Endothyranella powersi	A		A	A		C	A			C		R	R					
Orobias ciscoensis														C				
Bradyina holdenvillensis									R		R		A					
Globivalvulina bulloides				?							R							
Globivalvulina gaptankensis														C				
Tetrataxis plicata														C				
Tetrataxis lata	A		C								C	C						
Tetrataxis corona pauperata														A				
Polytaxis laheei																	A	
Nodosinella ? fittsi		C				A	A								C			
Nodosinella ? ardmorensis	C									C								
Nodosinella ? arenata															C			
Nodosinella ? delicatula																C		
Monogenerina gt andis																	R	
Tuberitina bulbacea																	A	
Ammobaculites stenomeca																C		R
Bigenerina ciscoensis																C		
Deckerella laheei							R			R			C	C				
Climacammina lucilleae													R	C				
Fusulinella meeki		R	A	C														
Fusulinella meeki robusta													A				R	
Fusulinella haworthi								R		C	C		R	A			R	
Fusulinella inconspicua						C												
Annelida																		
Spirorbis anthracosia																	C	
Bryozoa																		
Fenestella sasakwaensis																	A	
Polypora submarginata		C	A		C													
Polypora hexagona					C													
Polypora hirsuta															R			R
Thamniscus tenuiramus												C	R		C		A	
Pinnatopora oculata			R								C		C		R		A	
Pinnatopora bellula			A			R									?			
Pinnatopora pustulosa													C					
Septopora blanda		R		R	A													
Septopora ? elliptica					A						R						C	
Rhombopora pilula	C				A			R					A		C			
Rhombopora constans								R							C		A	
Rhabdomeson magnum								C		R	C		A					C
Rhabdomeson procerum													C					
Rhabdomeson bellum minus													A					
Rhabdomeson filum			C	C			R						R				C	
Streblotrypa multipora		R	A	A	A													
Rhombocladia delicata													C				A	
Prismopora lobata			C	A	A													
Gastropoda																		
Euphemites carbonarius					C	C	C				C							
Bucanopsis meekiana						R							C					
Pleurotomaria carbonaria	R				R		R						C					R
Phanerotrema grayvillensis	R				R	C	C				A							
Murchisonia terebra											R		R					
Macrochilina danvillensis									R									
Bulimorpha minuta					R		C						C				R	R
Loxonema zygopleuroides					R				R				C					
Zygopleura rugosa			C								C	C	C					R
Zygopleura trimera													C					
Zygopleura parva													C					
Zygopleura obsoleta													R					
Hemizyga nodosa			R			C	R					C	C					R
Meekospira peracuta choctawensis						A	R	R			C		R					
Orthonema carbonarium													R					
Orthonema nebrascense													C					
Orthonema quadricarinatum													C					
Orthonema strigatum													C					
Aclisina stevensana			R		R	C	C		R	C	C	C	A					A
Aclisina stevensana gibbosa													C					
Ostracoda																		
Paraparchites latidorsatus			C	R	A													R
Paraparchites cuneatus					R	R									R			
Hollinella ulrichi			C			A	C			R			R					
Hollinella digitata																		C
Hollinella bassleri			?			R	R			R	C				C	A		A
Hollinella limbata					C					R			R					
Cornigella minuta		R														R		R
Jonesina gregaria					R													
Jonesina texana									R									
Jonesina ampla			R	R									C			R		C
Jonesina acuneata			C	C														
Kirkbyina laevis					R													
Ulrichia montosa				R					R									
Amphissites roundyi					C				R	C								
Amphissites dattonensis				C	R				R				C					
Amphissites geneae																		R
Amphissites wewokanus									C									
Amphissites girtyi		C	C	R	R	C	R		C				R					R
Amphissites centronotus	R			A					R								R	
Amphissites simplicissimus		C		A					C				C					
Glyptopleurina ? minuta		R	A	C	C				R	R			C			A		C
Bairdia auricula		R	C	R	A	C			R									
Bairdia oklahomaensis												A	A				C	A
Bairdia beedei														C			?	
Bairdia altifrons					R								C					
Bairdia pompilioides																	C	
Bairdit grahamensis													R					
Bairdia menardensis ?							R										R	
Bairdia crassa																	C	
Bairdia peracuta													R					
Bairdia haworthi		C	A	C	R		C		C	R	C	R	A		R			C
Bairdia nitida																		C
Bairdianella elegans				R									R				R	
Bythocypris sasakwaensis																	C	
Bythocypris rotunda			C							C								
Bythocypris pediformis		R	C	C	C	A	C		C	A	C		R		A	C		R
Healdia nucleolata			A	C	A													
Healdia ciscoensis							C		R				C		A			
Healdia longa					R								?			?		
Healdia bythocyproidea		R		A	A													
Healdia elegans	C	R	R	R			C			C								
Healdia formosa							R		R	C								
Cytherella wewokana											A							
Cytherella intermedia					R				R							C		C
Cavellina pulchella																C		A
Cavellina subpulchella				R	A		R		C		?					A		
Cavellina lata																A		
Cavellina reversa			R															
Locality	5	39	57	58	37	38	53	12	42	51	47	23	29	54	43	46	49	44