
PART III.

CHARACTERISTIC FOSSILS

OF THE

SILURIAN FORMATIONS

.. OF ..

EAST CENTRAL KENTUCKY.

CHIEFLY FROM THE WACO LIMESTONE HORIZON.

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The species here described include only a few of the more characteristic forms which, on account of their wide distribution in the field under investigation, will serve to distinguish the more important horizons. A fuller account of the fauna must await a future time.

Characteristic Fossils of the Silurian Formations of East Central Kentucky.

CHIEFLY FROM THE WACO LIMESTONE HORIZON.

MEEKOPORA BASSLERI, N. SP.

Plate 6, figs. 1A, 1B.

Maximum size of zoarium unknown, but the largest fragments indicate a length of at least 150 millimeters. Zoarium forming thin, flat, branching expansions. The thickness of the zoarium varies between half a millimeter and fully two and a half millimeters. The width of by far the greater number of lobes or branches varies between 10 and 15 millimeters, occasionally reaching 22 millimeters at the points of branching. Zoarium bifoliate, celluliferous on both sides, with rather broad noncelluliferous margins. Apertures circular, elliptical, or, more commonly, oblique and more nearly V-shaped, with the peristome much elevated on the posterior or postero-lateral sides, where the elevation forms a regular lunarium, pointed distally. Apertures arranged more or less regularly in quincuncial order, about 9 or 10 in a width of 5 millimeters, measuring along one of the oblique rows, and 8 in the same distance measuring longitudinally. Maculae occur at intervals of about 5 millimeters; they are rather inconspicuous to the unassisted eye, but under a hand lens they appear as well-marked solid spots, 1 to 2 millimeters in diameter, from which the apertures radiate. In one of the specimens figured the branches vary considerably in width. In smaller fragments the branches retain approximately the same width for lengths of 30 millimeters. The larger specimen figured merely happens to be one in which branching occurs at shorter intervals than usual. Zooecia tubular. Apertures oblique; opening directed chiefly distally or toward the median part of the frond; occasionally two or three of the apertures along the posterior border of the maculae are directed obliquely backward. Occasionally the peristome rises around the aperture on all sides, forming a

small rounded elevation with a tiny apical opening. Ovicells not recognized.

Locality and position: The specimens figured were found north of Estill springs, north of Irvine, Kentucky; they occur also east of Panola; half a mile east of Waco; a quarter of a mile south of Indian Fields; a mile southeast of Indian Fields, where the road from Kiddville joins the road from Indian Fields to Clay City; at Tipton Ferry, and at numerous other localities. It is the most characteristic fossil of the Waco limestone horizon, and I take great pleasure in naming it after Mr. Ray S. Bassler, as a slight acknowledgement of the many favors received from his hand. In my studies of the Ordovician areas of Ohio, Indiana and Kentucky, I have received so much assistance from Mr. Bassler and Mr. John M. Nickles that I cheerfully give all credit for the more valuable results to these gentlemen.

FAVOSITES GOTHLANDICA, LAMARCK.

Plate 2, figs. 1A, 1B.

Corallum in broad, flat discoid expansions, relatively thin considering their width. Specimens often attaining a width of 30, and occasionally of 50 centimeters. Thickness varying from 20 to 50 millimeters. Base with a concentrically wrinkled epitheca, often absent in weathered specimens. Corallites prismatic, subequal in the same specimen; usually from 4 to 5, occasionally 6 millimeters in width. Tabulæ flat or slightly convex or concave, frequently with marginal crenulations or depressions, about 12 in number, distinctly developed. Tabulæ numerous, varying from 10 to 12 in a length of 5 millimeters. In vertical sections the tabulæ often appear confused and broken, and at times even present an appearance suggesting a coarse vesicular structure, but the actual presence of such a structure could not be definitely determined, and it probably does not occur. The presence of septal spines could not be determined in the specimens at hand. Pores surrounded by a slightly raised rim, difficult to detect in most specimens, either because very rare or because they are not well exposed; occasionally seen in vertical rows.

This variety of *Favosites Gothlandica* (frequently called

Favosites favosa) is remarkable for the thinness of the corallum, considering its width.

Locality and position: Along the road north of Estill Springs, north of Irvine; directly east of Panola, along the road south of the railroad; along the road directly north of Vienna; southeast of the home of J. T. Elkins, 5½ miles south of Indian Fields, along the road to Vienna; along the small stream a quarter of a mile south of Indian Fields; along the road immediately north of Tipton Ferry, 2 miles southwest of Clay City, Kentucky. In the Waco limestone layers, of Silurian age, Figure 1A represents a specimen from Irvine, Kentucky; figure 1B represents the closely arranged tabulæ, but without showing the broken and vesiculose appearance of some specimens.

FAVOSITES HISINGERI-APLATA, N. V.

Plate 2, fig. 2, and Plate 4, fig. 5.

Corallum flat, usually in fragments 50 to 100 millimeters wide and 10 to 15 millimeters thick; occasionally 200 to 300 millimeters wide and 45 millimeters thick. Corallites small, varying from .75 to 1 millimeter in width, usually slightly less than one millimeter; polygonal. Tabulæ at varying distances apart, from 9 to 16 in a length of 5 millimeters, occasionally as few as 5 in this length. Septal spines numerous, sometimes reaching half way to the center of the corallites, but frequently not so well preserved and therefore shorter; pointed and curved upward at the end; arranged in 12 vertical rows. Pores small and apparently few in number. Lower surface of the corallum with an epitheca which is concentrically wrinkled and striated, and radiately marked by narrow grooves distinctly delimiting the corallites. The corallites at the base of the corallum first grow parallel to the epitheca, and then rise vertically toward the surface.

This is probably the same variety as that identified by C. Rominger as *Favosites venusta*, in his work on Fossil Corals, Geological Survey of Michigan, volume 3, 1876, plate 5, figure 3, from Drummond Island, Michigan. *Favosites venusta* is described by Hall as having corallites varying from one twenty-eighth to one twenty-fourth of an inch in diameter, and 12 as-

ending spiniform rays. In our specimens the septal spines either are not well preserved, or are characteristically much shorter and therefore do not appear as long spines strongly curved up at the ends. Moreover, *Favosites venusta* is described as being hemispheric or spheroidal, while our specimens are rather flat and discoidal.

Specimens similar to ours but with slightly wider corallites are figured by William J. Davis in his Kentucky Fossil Corals, plate 8, figures 7, 10.

For the flat variety here described the name *Favosites hisingeri-aplata* is here proposed.

Locality and position: Along the road north of Estill Springs, north of Irvine; south of the railroad, a short distance east of Panola station; a mile southeast of Indian Fields, along a road crossing the railroad, a short distance before joining the road from Indian Fields to Clay City; two miles southwest of Clay City, along the road immediately north of Tipton Ferry. The specimen figured, figure 2 on Plate 2, was obtained at Irvine. The enlargement, figure 5 on plate 4, under a lens, shows traces of the spinules. In the Waco limestone layers of Silurian age.

FAVOSITES DECLINATA, N. SP.

Plate 2, figs. 4A, 4B, and Plate 4, fig. 4.

Corallum small, attaining a width of 70 millimeters and a thickness of 20 millimeters, but most specimens do not exceed a width of 40 millimeters. Lower surface with an epitheca which is strongly wrinkled and striated concentrically, and also marked radially by narrow grooves which limit the boundaries of the corallites where in contact with the epitheca. Corallites, where in contact with the epitheca, practically horizontal; thence rising obliquely toward the upper surface of the corallum; apertures polygonal, more or less oblique. Where the apertures are strongly oblique, the vertical diameter may be as little as .7 millimeter, while the lateral diameter is 2 millimeters, but usually the obliquity is much less and the differences between the diameters less striking. Near the central part of the upper surface of the corallum the corallites are approximately vertical and the obliquity of the apertures is less

evident. Tabulæ present; rather distant, about 4 to 5 in a length of 5 millimeters. In vertical sections the oblique growth of the corallites from the epitheca to the upper surface of the corallum is distinctly shown; the tabulæ usually occupy a position intermediate between the horizontal and one at right angles to the direction of the corallites; tabulæ often convexly curved. Inner walls with numerous granules which in some specimens are very well preserved and in others are less distinct. In some very well preserved specimens the granules are distinctly arranged in transverse and in longitudinal lines, the transverse lines being parallel to the tabulæ. In other specimens only the longitudinal lines, or only the transverse arrangement, is readily distinguished, while in some specimens the arrangement is rather irregular. The number of longitudinal rows varies between 18 and 24. Granules occur also upon the upper side of the tabulæ in some specimens. Corallites subequal, averaging 2 millimeters or a little less in width at the apertures; rarely longitudinally wrinkled, never with distinct longitudinal ridges, as in species of *Alveolites*.

Locality and position: Along the road north of Estill Springs, north of Irvine; east of Panola, along the road south of the railroad; half a mile east of Waco, where the road to Cobb Ferry turns off from the pike to Irvine; two miles southwest of Clay City, along the road immediately north of Tipton Ferry. In the Waco limestone layers, of Silurian age. Figures 4A and 4B on plate 2 represent specimens from Irvine, Kentucky. An enlargement is shown in figure 4, plate 4.

SYRINGOLITES HURONENSIS, HINDE.

Plate 2, fig. 3, and Plate 4, fig. 2.

Corallum flat, or gently convex, attaining a width of 120 millimeters and a thickness of about 15 millimeters. Lower surface with an epitheca wrinkled and striated concentrically, and marked by flat radiating lines and also by narrow but distinct radiating grooves limiting the boundaries of the basal parts of the corallites. The corallites are horizontal where in contact with the epitheca and then rise vertically toward the upper surface of the corallum. Corallites polygonal, 2.5 millimeters in width. Tabulæ about 10 to 13 in a length of 5 millimeters,

sloping downward toward the center; upper surface of the tabulæ covered by numerous granules irregularly arranged in 12 radiating sets indistinctly defined from each other. In no case are the granules arranged in distinct radiating rows as in the figures given by Nicholson in his *Tabulate Corals*. This granulated surface may be traced as far as the center of the corallites in well-preserved specimens. Vertical sections, however, show that the tabulæ have a funnel-shaped form, ending at the center in a narrow tube, the tubes of different funnels uniting so as to form a continuous central tube. This tube is crossed by horizontal plates which appear to be more numerous than the tabulæ. It is probably due to these horizontal plates within the tubes of the invaginating funnels that the apertures of the tubes are not readily detected on the upper side of the tabulæ of well-preserved specimens. The lower side of these invaginating funnels usually is well exposed on the lower side of strongly weathered coralla. The tubular basal part often remains on the upper side of strongly weathered specimens as a small, central, sharply elevated tubular wall or ring. The diameter of the continuous funnel varies from .75 to 1 millimeter. In some specimens granules are seen on the inner walls of these tubes, and granules appear also on the inner walls of the corallites, irregularly arranged.

Judging from the description of *Syringolites huronensis* given by Lawrence M. Lambe, in his *Revision of Canadian Palæozoic Corals*, part 1, page 45, our specimens are identical with the type specimens from Manitouaning, Grand Manitoulin Island, in Lake Huron. He states that the septa consist of small spiniform bodies present in large numbers and apparently without definite order on the inner walls of the corallites, and that spines similar to these in size and shape are equally abundant on the upper surface of the tabulæ and extend into the tube. If instead of spines the word granules be substituted the description would fit our specimens very well.

Syringolites huronensis finds a near relative in *Roemeria kunthiana*, Lindstroem, from the Silurian of Gotland, Sweden, from which it differs chiefly in the greater regularity of the funnels, which never are absent in the American species, and in the radiate arrangement of the septal granules along the flat bottom of the calyces.

Locality and position: Two miles southwest of Clay City, along the road immediately north of Tipton Ferry; a mile southeast of Indian Fields, east of the home of Brownlow Bruner, where the road from Kiddville joins the road from Indian Fields to Clay City; half a mile east of Waco, where the road to Cobb Ferry starts off from the pike to Irvine; along the road north of Estill Springs, north of Irvine. In the Waco limestone layers, of Silurian age. Figure 3 on plate 2 represents a specimen from Tipton Ferry. Figure 2 on plate 4 is an enlargement of the same. The radial grouping of the septal granules is shown indistinctly.

HELIOLITES SPONGIOSA. N. SP.

Plate 3, fig. 3; Plate 4, fig. 6; and Plate 5, fig. 5.

Corallum apparently in the form of a flat discoidal mass, of which only a part is preserved in the specimen described. Corallites vertical in this specimen, but the lower, epithecal part of the corallum is not present. Corallites averaging about 1.5 mm. in diameter, and about 2 mm. apart. The spaces between the corallites are occupied by numerous polygonal tubules, parallel to the corallites. As seen on the upper surface of the corallum, the tubules are very irregular in size and arrangement, producing a sort of spongiöse appearance, which is regarded as the distinguishing characteristic of this species. Some of the tubules are fully half a millimeter in diameter at the surface, while others are scarcely a third or even a fourth as wide, and have, therefore, scarcely a ninth of the cross-sectional area. The horizontal tabulæ in the corallites are rather regular in disposition, and number about 15 in a length of 5 mm., while the tabulæ in the tubules number about 22 to 25 in the same distance. As in all other species, however, there is a considerable variation in the distance between the tabulæ. The edges of the calyces are not raised above the general surface of the corallum; and both large and small apertures of tubules are in contact with these edges, the calyces not being surrounded by a narrow radiate border. No septa were detected in the corallites, nor could the presence of septal spines be determined by an examination of the exposed parts of the corallite tubes, although the possibility of their appearing in cross-sections of the corallum is not altogether excluded.

Distinguished from other species of *Heliolites*, as far as known, by the spongiose appearance of the upper surface of the corallum, the absence of septa within the corallites, and, apparently, also by the absence of a distinct exsert marginal rim where the corallites reach the surface.

Locality and position: Found along the road north of Estill Springs, north of Irvine, Kentucky, in the Waco limestone layers, of Silurian age. The enlargement on plate 4 in figure 6 shows distinctly the irregular size and arrangement of the interstitial tubules.

HELIOLITES SP.

Plate 3, fig. 4.

Corallum in form of a discoidal mass, with a concentrically wrinkled epitheca beneath. Corallites scarcely one millimeter in diameter, from one to nearly two millimeters apart. The spaces between the corallites occupied by polygonal tubules, about six or six and a half in a width of two millimeters. Tubules approximately of equal size. Corallites apparently with short septal spines along the inner walls, extending toward the center along the horizontal tabulæ, but not sufficiently preserved for accurate study. The surface of the specimen is weathered; in this condition it shows no evidence of the margins of the corallites having been raised slightly above the general surface of the corallum, nor of a central elevation in the corallites (due to the convergence of upward directed septal spinules) as in the case of *Heliolites interstincta*. Probably a distinct species, characterized by its discoid growth, small corallites, and relatively large tubules.

Locality and position: Found along the road north of Estill Springs, north of Irvine, Kentucky, in the Waco limestone layers, of Silurian age.

HELIOLITES SUBTUBULATA(?), MCCOY.

Plate 3, figs. 5A, 5B.

Corallum flat, 60 or more millimeters wide and 10 millimeters thick in the specimens at hand; probably attaining a much larger size. Lower surface with a concentrically wrinkled

epitheca. Corallites circular, averaging .75 millimeters in diameter, and usually from 1.5 to 2 millimeters distant from each other. The interstitial tubules are polygonal; at the surface of the corallum about 8 or 9, sometimes 10, apertures are seen in a width of 2 millimeters. Horizontal tabulæ in the corallites number about 6 to 8 in a length of 2 millimeters; 9 to 11 occur in the interstitial tubules in a length of 2 millimeters. The margins of the calices rise slightly above the general surface of the corallum. Septal ridges or spinules, if present, not distinctly recognized. In the figure of *Heliolites subtubulata*, published by C. Rominger, in volume 3, of the Geological Survey of Michigan, in 1876 (plate 1, figure 4), the tubules are arranged in parallel rows, best shown by the figure of the specimen from Drummond Island, Michigan. In our specimens, represented by figure 5B, the arrangement is much less regular, although in some specimens the tubules are arranged in approximately parallel lines for short distances. It is not known whether the parallel arrangement of the tubules is constant in the Drummond Island specimens.

Usually identified with *Heliolites subtubulata*, McCoy, from the Wenlock limestone of England, but differing from the type specimens in the smaller size of the corallites, the greater distance between them, and the absence of any unusual thickness in the case of their walls. Provisionally, our specimens may be known as *Heliolites subtubulata-distans*.

In a second group of specimens presenting about the same features as those just described, the coralla increase in height rather than in width, traces of an epithelial structure being shown at different levels on the steep sides. In the specimen figured here, figure 5A, the corallum attains a width of 20 millimeters and a height of 17 millimeters. The tubules are arranged in a rather irregular manner, about 8 or 9 occupy a width of 2 millimeters. Septal spinules short, not distinctly recognized. Provisionally these specimens may be known as *Heliolites subtubulata-nucella*.

Locality and position: The larger, flat and relatively thin specimens (*Heliolites subtubulata-distans*) were found half a mile east of Waco, and along the road north of Estill Springs, near Irvine, Kentucky. The small and relatively thick specimens (*Heliolites subtubulata-nucella*) were found north of

Estill Springs. All occur in the Waco limestone layers, in the Silurian.

LYELLIA EMINULA, N. SP.

Plate 3, fig. 6; Plate 4, fig. 3.

Corallum with upper surface flat or moderately convex; in the type specimen, expanding from a narrower base so as to reach a width of 40 and a height of at least 25 millimeters. Corallites varying in width from 1.2 to 1.5 millimeters, and from .75 to almost 2 millimeters apart. The edges of the corallites are raised slightly above the general surface of the corallum. Septa twelve in number, consisting of carinæ bearing stout spines, which in the specimens examined appear to be short but conspicuous. Interstitial spaces filled with vesicular structure consisting of convex plates resting on each other in such a manner as to form somewhat lenticular cavities varying in width from 1 to 2, occasionally 3, millimeters. The type is represented by figure 6 on Plate 3, and figure 3 on Plate 4. The surface of another specimen, not the type, resembles that of *Heliolites*, the intercalicular surface being marked by numerous small pits having polygonal outlines, at first sight suggesting the presence of intercalicular tubules as in *Heliolites*. The pits reappear on layers at different levels; they are separated by raised and fairly sharp borders. About four and a half to five occur in a width of 2 millimeters. A similar structure is revealed by a lens in *Lyellia americana*, figure 1, plate 2, of C. Rominger's Fossil Corals, published in the third volume of the Geological Survey of Michigan, in 1876. The appearance is that of a bryozoan incrusting the surface, but leaving the apertures of the corallites free.

These forms may be regarded as small varieties of *Lyellia americana*, with corallites of smaller diameter, with shorter septal spines, and smaller vesicular cavities in the interstitial spaces. The edges of the calices do not bear a circle of twelve rounded tubercles, and no rounded tubercles are observed on the intercalicular surfaces. It will be noticed that these statements involve chiefly negations of characteristics seen in well-pre-

served specimens of *Lyellia americana*, or the development of certain of these characteristics on a smaller scale.

Locality and position: Found along the road north of Estill Springs, north of Irvine, Kentucky, in the Waco limestone layers, of Silurian age.

Flat specimens occur, having a width of 65 millimeters, and a height of less than 10 millimeters, with a concentrically wrinkled epitheca. The corallites are often 3, and even 4, millimeters apart. The septal ridges or spinules are much less prominent; the vesicular cavities are smaller, and the intercellular pits on the intercalicular surface are always well preserved. This may be a distinct species. It is well represented by figure 1 on plate 4, and by figure 4 on plate 5, both of which are enlargements. It occurs in the Waco limestones, half a mile east of Waco, where the road to Cobb Ferry leaves the Irvine pike.

ZAPHRENTIS INTERTEXTA, N. SP.

Plate 7, figs. 1A, 1B.

Corallum simple, conical, curved. In the specimen showing the interior of the calyx, the distance from the base of the corallum to that part of the exterior of the corallum which is on a level with the twisted center is about 55 millimeters when measured along the convex side, and scarcely 30 millimeters when measured along the concave side; the width of the corallum at this level is 43 millimeters measured transversely, and 37 millimeters measured from front to rear parallel to the septal fossette. In a second specimen, not showing the interior of the calyx, the length from the base of the corallum to the edge of the calyx is 80 millimeters measured along the convex side, and 43 millimeters measured along the concave side of the corallum; the width of the top of the corallum is 35 millimeters measured transversely, and 50 millimeters from front to rear, but the corallum has been compressed laterally. Its original dimensions were probably about 45 millimeters measured transversely, and scarcely 40 millimeters measured from front to rear. Epitheca complete, with longitudinal septal furrows moderately distinct. Septa numbering about 90, alternately long and short; of these the longer septa extend toward the center, uniting, twisting and crossing each other, so as to form a broad, convex, irregularly reticulated mass at the bottom of the calyx, re-

sembling the pseudo-columella of *Streptelasma rusticum-canadensis*. Judging from a comparison of the two specimens here described, the depth of the calyx is about 21 millimeters, in specimens of this size. A distinct septal fossette is present on the convex side of the corallum, extending up the neighboring part of the pseudo-columella. Along that part of the pseudo-columella bordering on the septal fossette, the edges of the primary septa are much less conspicuous.

The species is believed to be closely related to *Zaphrentis Stokesi*, from the Silurian of Drummond Island, in Lake Huron. Compared with the typical forms, our specimens are much less elongated, and widen more rapidly from the base. The number of septa is conspicuously smaller. Moreover, in our specimens, the primary septa not only curve on approaching the center, but they cross each other in an irregular manner. The edges of the septa on the pseudo-columella are much coarser, but this may not be a constant character. Compared with *Zaphrentis umbonata*, Rominger, from the Silurian of Michigan, our specimen has a broader and less prominently elevated pseudo-columella; moreover, this pseudo-columella is not laterally compressed. The larger size, the greater number of septa, and the distinct septal fossette serve to distinguish it from *Streptelasma spongaria*, Rominger, from the Silurian of Point Detour, Michigan. Our specimen may be only an extreme phase of some species. In the present stage of information, it appears sufficiently different to receive a distinct name.

Locality and position: Along the road north of Estill Springs, north of Irvine, Kentucky; two miles southwest of Clay City, along the road immediately north of Tipton Ferry. In the Waco limestone layers, of Silurian age.

ZAPHRENTIS INTERTEXTA, VARIETIES OR YOUNG.

Plate 7, figs. 5A, 5B, 5C, 5D, 5E.

Associated with the type specimens of *Zaphrentis intertexta* are comparatively numerous smaller specimens having the same general exterior form and appearance, but the twisting and crossing of the primary septa at the center of the calyx is less conspicuous, there is no very distinct convex elevation forming a pseudo-columella, and the edges of the septa are thinner. The

septal fossette is always distinctly developed. Specimens of this type frequently attain a width of 35 millimeters. They are regarded as being merely younger states of *Zaphrentis intertexta*. They occur not uncommonly along the road north of Estill Springs, north of Irvine; east of Panola station, along the road south of the railroad; half a mile east of Waco, where the road to Cobb Ferry turns off from the pike to Irvine. In addition to these specimens there are others whose affinities are not so readily determined. Figures 5A and 5B illustrate specimens in which there is no distinct evidence of the interlacing of the inner ends of the septa into a pseudo-columella. On the contrary, the median posterior and anterior septa apparently join so as to form a single continuous septum across the calyx, from front to rear, nearly straight in figure 5A, but distinctly bent into an open sigmoidal curve in the second specimen, of which a lateral view is presented in figure 5B. This median septum is approached, but not crossed, by the other septa, on each side. Where the median septum is straight, in passing across, the middle of the calyx, the other septa are nearly straight. Where the median septum is strongly bent, the inner ends of the other septa are more distinctly flexuous on approaching the center of the calyx. A somewhat similar condition is represented by figure 5D, in which, however, there is no continuous median septum from front to rear, and the number of primary septa does not exceed 36.

Figure 5C illustrates one of the smaller specimens from Irvine, weathered so as to show the whole of the uppermost tabula extending entirely across the corallum. This tabula is nearly flat, bending downward at the margin, and descending much more strongly into the septal fossette. The middle of the fossette is marked by the edge of one of the primary septa. The inner edges of the other septa are moderately flexuous and show faint evidences of interlacing. The number of primary septa is about 35.

Taken by themselves, the specimens represented by figures 5A and 5B, and those represented by 5C, 5D, and 5E apparently form at least two distinct species, but apparently they are connected by numerous intermediate forms. For the first set, provisionally, the name *Zaphrentis intertexta-irvinensis* is suggested, and for the second, *Zaphrentis intertexta-juvenis*. The latter

may be identical with *Zaphrentis bilateralis*, Hall, and not at all closely related to *Zaphrentis intertexta*, but this can not be determined until enough specimens have been collected at all stages of growth, to be able to identify the young of *intertexta* with confidence.

ZAPHRENTIS CHARAXATA, N. SP.

Plate 7, figs. 4A, 4B, 4C, 4D, 4E.

Corallum small, simple, curved. Length from 15 to 20 millimeters; maximum width about 15 to 18 millimeters; depth of calyx about 6 to 7 millimeters; the greater part of the calyx usually is worn away in the specimens at hand but the base of the calyx with the edges of the septa and the septal fossette frequently are well exposed. Number of primary septa usually between 28 and 33; intermediate between these is an approximately equal number of secondary septa. Primary septa usually strongly thickened on approaching the walls of the calyx, and coalescing there so as to produce the effect of thick-walled coralla. Secondary septa also thickened along the walls of the calyx, but usually seen only along the upper part of the calyx and not extending, more than a short distance toward the center. In some specimens the space between the primary and secondary septa is so small that the secondary septa can not be recognized readily; this contributes to the thickened appearance of the walls of the coralla. In a few exceptionally well-preserved specimens the sides of the primary septa were marked by transverse and rather coarse striations. These striations apparently are better developed near the walls of the calyx than near the edges of the septa. Exterior of the corallum marked by rather faint longitudinal grooves which on slightly weathered specimens appear as zig-zag lines dividing the surface into small polygonal facets arranged in more or less, quincuncial order. These facets, polygonal or more irregular in outline, are well shown by strongly weathered surfaces and their development probably has some indirect connection with the transverse striations on the septa. No denticulations were seen along the inner edges of the septa. Median septal fossette well developed on the convexly curved side of the corallum. Two of the primary septa bordering on the fossette, one on each side, unite

at the inner end of the fossette so as to form a curve like the rounded end of a horse shoe, against which the other primary septa, coming from all directions, terminate. In most specimens only a single primary septum and the corresponding secondary septa are seen along the farther end of the septal fossette, but in one specimen two primary and three secondary septa were found in this position. The inner ends of the septa on approaching the septal fossette may partially coalesce so as to form a rather irregular but comparatively smooth area. In other cases the edges of the septa may be distinguished as far as the borders of the septal fossette. In a few cases they form a small nodulose area, bordering the inner end of the fossette, suggestive of the nodulose irregularities at the center of the calyx of young specimens of *Streptelasma*. The distinguishing features of this species, in the area where found, are its small size, distinct median septal fossette, thick walls, and the faceted appearance of the epitheca even in little worn specimens, becoming very distinct in more weathered specimens. Compared with *Streptelasma patula*, described by Rominger from the Silurian of Drummond Island and Point Detour, in Lake Huron, our specimens are more curved, have a more pronounced septal fossette, and smaller primary septa, leaving room for a wider calicular cavity.

Locality and position: All of the specimens figured are from the locality along the road north of Estill Springs, north of Irvine, Kentucky; specimens occur also a short distance east of Panola, along the road south of the railroad. Found in the Waco limestone layers, of Silurian age.

LINDSTROEMIA LINGULIFERA, N. SP.

Plate 5, figs. 2A, 2B, 2C, 2D, 2E, 2F.

Corallum small, simple, curved. Height usually not over 15 millimeters, but sometimes reaching 17 millimeters. Exterior marked by fine longitudinal grooves corresponding in number to the septa within; also with numerous fine, transverse, concentric striæ. Primary septa varying in number from 27 to 33, uniting at the center of the calyx into a vertical, laterally compressed, linguliform columella, or, at least, forming a conspicuous ridge toward which the other septa converge. A median

septal fossette is found on the posterior side of the calyx; in most specimens this fossette is comparatively shallow and indistinct, but usually the primary septum occupying this fossette does not extend quite as far toward the interior of the calyx as the other primary septa. Secondary septa present, but not conspicuous on account of a thick deposit of sclerenchym on the inner walls of the corallum, between the bases of the septa, thus producing the appearance of a thick-walled corallum. This sclerenchym also partly fills in the base of the visceral chamber. Tabulæ few.

This species may be distinguished from *Lindstroemia gainesi*, W. J. Davis, from the Clinton, 12 miles east of Louisville, Kentucky, by the less conspicuous secondary septa, caused by the much thicker deposit of sclerenchym on the inner walls of the corallum. *Lindstroemia wisconsinensis*, Whitfield, from the Racine limestone (Silurian) of Wisconsin, is a much larger species. The type species, *Lindstroemia dalmani*, occurring in the Silurian of Gotland, Sweden, is of intermediate size. The genus is chiefly Silurian, but *Lindstroemia subduplicata* occurs in the Caradoc of Ayrshire, England, near the top of the Ordovician; it apparently is closely related to the Kentuckian forms. The genus appears to have had its origin in very early Ordovician times. At any rate, a rugose coral with a laterally compressed linguliform columella, labelled as coming from the Birdseye and Black river limestone at the Petite Chaudiere rapids, at Ottawa, Canada, occurs in the Museum of the Canadian Geological Survey. This specimen, equal in size to the Kentucky Silurian specimens, here described, is conical, moderately curved, has 30 primary septa, an equal number of secondary septa, a rather indistinct septal fovea, and no readily perceptible deposit of sclerenchym. For this species, here associated with *Petraia profundum*, the name *Lindstroemia whiteavesi* is proposed.

Locality and position: Figures 2A, 2B are from specimens found a short distance east of Panola, along the road south of the railroad. Figures 2C, 2D, 2E, 2F are from specimens found along the road north of Estill Springs north of Irvine. This species occurs also half a mile east of Waco, where the road to Cobb Ferry turns off from the pike to Irvine. In the Waco limestones, of Silurian age.

POLYOROPHE RADICULA, N. SP.

Plate 5, figs. 3A-3E.

Corallum resembling in form the specimens identified from Louisville, Kentucky, as *Cyathophyllum radicula* by W. J. Davis (Kentucky Fossil Corals, plate 86, figures 2, 3, 4, 5, published in 1885), but structurally distinct both from that species and from typical forms of *Cyathophyllum radicula* as described by C. Rominger from the Silurian of Drummond Island, Michigan.

Corallum simple, attaining a width of 10 to 12 millimeters and a length of 30 millimeters, usually less. Transversely wrinkled and constricted owing to calicinal rejuvenation; the edges indicating former positions of the calyx frequently are distinctly visible as narrow encircling rings edged on the upper side by the septal denticles, producing an appearance a little like the milled edge of a coin. Growth often only moderately curved or nearly straight, but frequently strongly and irregularly curved or bent. Surface of the epitheca marked by longitudinal lines corresponding to the septa in number. In some specimens minute granules occur along these septal striæ, usually in the form of a single row of rather distant granules along each septal line. In other specimens these granules can not be distinguished. In addition to the coarser markings, fine transverse striæ often are present.

Septa, about 60 to 70 in number, very narrow, extending but a short distance from the walls of the calyx, represented chiefly by vertical series of rather prominent denticles. The broken walls of the corallum occasionally appear rather thick, almost a millimeter in some cases, suggesting the presence of a thick deposit of sclerenchym, on the inner walls of the corallum, beyond which the denticles project. In other specimens these walls do not exceed one-third of a millimeter in thickness. There appears to be no evidence of the presence of dissepiments. Tabulæ rather distant, extending across the entire width of the corallum. Their direction varies from directly transverse to oblique, depending upon the direction of the calicular aperture at the time of their formation. Tabulæ comparatively flat in the specimens at hand, covered on the upper side with more or less distinctly radiating lines of coarse granules

which evidently are continuations of the vertical rows of septal denticulations on the inner walls of the corallum. These granules are present over the entire upper surface of the tabulæ, but their arrangement in rows may be better detected in the more peripheral part as a rule. The lower side of the tabulæ appears to be smooth.

While possessing the generic characteristics of the type species, *Polyorophe glabra*, Lindstroem, from the Silurian of Gotland, Sweden, our specimens present a widely different external appearance. They are much smaller, cylindrical rather than conical, and do not possess the lateral, radiceform outgrowths of the epitheca; moreover, the Kentuckian specimens never show evidences of branching nor are united into colonies. *Aphyllostylus gracillus*, Whiteaves, from the Silurian of Manitoba, possesses the septal denticles along the inner walls of the corallum, but not the more or less radiately arranged granules on the upper sides of the tabulæ.

Locality and position: The specimens represented by figures 3A, 3B and 3E are from along the road north of Estill Springs, north of Irvine, Kentucky; those used for figures 3C and 3D are from half a mile east of Waco, where the road to Cobb Ferry turns off from the pike to Irvine; specimens occur also a mile southwest of Indian Fields, where the road from Kiddville joins the road from Indian Fields to Clay City. In the Waco limestone layers, of Silurian age. Figures 3A and 3B are enlargements; owing to the angle at which the views were taken, the specimen represented by these figures appears to be conical, but this is the effect of fore-shortening.

CYATHOPHYLLUM DENSISEPTATUM, N. SP.

Plate 6. figs. 2A-2F.

Corallum simple, of moderate size, curved, attaining a length of 75 millimeters measured along the convex side, and a width of 30 millimeters at the top of the corallum. Epitheca very thin, usually removed by weathering; marked by low, flat longitudinal and rather inconspicuous rugæ corresponding in number to the septa within, also by numerous fine transverse striations, and coarser growth lines and wrinkles. Calyx rather shallow, specimens 28 millimeters wide having calices with a depth of 8 or 9

millimeters. Septa about 90 in full grown specimens, only the primary septa reaching the center where the ends are more or less twisted and slightly raised above the immediately surrounding part of the bottom of the calyx. An inconspicuous septal fossette occurs on the convex side of the corallum, occupied usually by one primary and two secondary septa. Dissepiments small and numerous, curving upward and outward between the septa and appearing in longitudinal sections as a dense vesiculose tissue. In cross-sections the septa vary between slightly convex and V-shaped on the side facing the exterior of the corallum.

Locality and position: All specimens here figured, except that represented by figure 2E, are from along the road north of Estill Springs, north of Irvine, Kentucky; figure 2E represents a specimen from east of Panola, along the road south of the railroad; specimens occur also half a mile east of Waco, where the road to Cobb Ferry turns off from the pike to Irvine; two miles southwest of Clay City, along the road immediately north of Tipton Ferry; a mile southeast of Indian Fields, where the road from Kiddville enters the road from Indian Fields to Clay City, south of the railroad; a quarter of a mile south of Indian Fields, where the road crosses a small stream. In the Waco limestones, of Silurian age.

CYATHOPHYLLUM SEDENTARIUM, N. SP.

Plate 6, figs. 3A, 3B, 3C.

Corallum more or less flattened transversely, in extreme cases one of the horizontal diameters may equal fully twice that at right angles to it. The plane along which this flattening is most developed appears to be approximately lateral or diagonal to the plane of the septal fossette, but this can not be determined satisfactorily from the specimens at hand. This flattening appears to be connected with the method of support. In young specimens radiciform extensions of the epitheca appear to develop on the inclined side of the corallum, attaching the latter to some support. With increasing age this side of the corallum often developed to such an extent as to form a comparatively long and flat area of attachment bordered by the radiciform wrinkles of the epitheca. The growth wrinkles and striations

of the epitheca curve downward toward the distal end of the basal attachment. In addition to these specimens, considered more characteristic of the species, there are others which have ordinary pointed bases or narrow areas of attachment, with a few radiciform epithecal appendages farther up. In still other specimens no radiciform appendages were seen. Corallum marked by very irregular transverse wrinkles and growth lines, the result of calicular rejuvenation. Epitheca thin, strongly marked by transverse wrinkles and striæ and indistinctly marked by longitudinal low lines corresponding in number to the septa. Septa about 100, alternately larger and smaller, only the former reaching the center of the calyx, where the inner ends are slightly twisted. In some specimens no septal fossette could be detected, in others a very indistinct one appeared to extend obliquely toward the rear of the calyx. Calyx rather shallow; about 10 millimeters in depth. In most specimens the margin of the calyx slopes obliquely toward what is here called the front of the corallum. Dissepiments small and numerous, curved upward and outward in longitudinal sections, and slightly curved, strongly convex or even V-shaped in transverse sections. Along a very thin zone, in immediate contact with the epitheca, these small dissepiments are replaced by much larger ones, the concave surfaces of which are longitudinally lined with low septal ridges, while the septa frequently are more or less obsolete. In consequence, the moderately weathered coralla, from which only the epitheca has been removed, frequently resemble the weathered surfaces of species of *Blothrophyllum*. The extension of the septa to the center of the corallum, and the absence of large, strongly tabulæ in this part of the specimens is sufficient evidence that our specimens are not genuine specimens of *Blothrophyllum*. Tabulæ in our specimens are comparatively inconspicuous.

Locality and position: All specimens here figured came from along the road north of Estill Springs, north of Irvine, Kentucky; specimens occur also east of Panola, along the road south of the railroad; half a mile east of Waco, where the road to Cobb Ferry turns off from the pike to Irvine. In the Waco limestone layers, of Silurian age.

CHONOPHYLLUM SOLITARIUM, N. SP.

Plate 7, fig. 2.

Corallum simple, short and wide. Judging from the fragment at hand, the original dimensions of the type specimen were: Width, at least 60 millimeters; height, about 25 millimeters; the rim surrounding the central depression rises about 10 millimeters above the margin of the calyx. From this rim the calicular surface slopes at first moderately and then more gradually downward toward the margin of the calyx. From the same rim the surface slopes rapidly downward into the central depression. The diameter of the central depression is about 9 or 10 millimeters. Distinct vertical septa are seen only along the walls of the central depression and over the surrounding rim as far as a distance of about 8 millimeters from the center of the corallum. Between these septa dissepiments occur. About 60 septa may be recognized, but all are not well exposed; they alternate in size. On the descending calicular slopes these septa are continued as linear flat septal ridges separated by narrow, shallow grooves, of which about 100 may be counted at the margin of the corallum. That part of the corallum lying exterior to the central depression and its rim consists of a succession of calicinal plates resting upon intermediate vesicular tissue. No true septa may be noticed in this peripheral portion, the septa being represented by the septal ridges on the calicinal plates. The base rapidly expanding and probably covered by an epitheca. Calicinal surface strongly oblique to a line through the axial part of the corallum, but this may not be a specific characteristic. Nothing is known of the presence or absence of tabulæ in the central part of the corallum.

Compared with *Chonophyllum Canadense* from the Silurian of Anticostia, our specimen fails to show the abrupt elevation of the rim surrounding central depression. Compared with *Chonophyllum nymphale* from the Silurian of the Baie des Chaleurs, our specimen has more numerous and narrower septal ridges, the base of the central depression is not convexly elevated, and the peripheral part of the calicular expansion is not convexly curved as far as the margin of the corallum, but on the contrary shows a slight concave curvature as in the corresponding parts of the mammiliform calicinal expansions of certain species of

Arachnophyllum. From *Vesicularia major* from the Silurian of Point Detour and Drummond Island, Michigan, our specimen is distinguished by the narrower and relatively deeper central depression and the distinct elevation of the calicular surface on approaching the rim of this depression.

Locality and position: Along the road north of Estill Springs, north of Irvine, Kentucky. In the Waco limestone layers, of Silurian age.

ARACHNOPHYLLUM (STROMBODES) GRANULOSUM, N. SP.

Plate 3, fig. 1.

Corallum compound, explanate, thin; only a part of the corallum is preserved in the specimen figured, and this shows a maximum width of 70 millimeters and a thickness of scarcely 3 millimeters. The lower surface is not exposed. Polyparia opening above in shallow calices meeting along polygonal outlines rising but slightly above the middle parts of the calyx. A very narrow, filiform line forms a border between the calices; this line is interrupted at intervals by minute pits or pores, situated most frequently at the ends of the grooves between the septal ridges. Calices about 7 to 10 millimeters wide along their longer diameters, and from 6 to 7 millimeters wide transverse to this direction. Very shallow depressions, from which the septal ridges radiate, occur in an excentric position, so that the calices have the appearance of opening obliquely upon the surface. It is not known to what extent this oblique position of the slight depression is characteristic of the species. Septal ridges average about 14 or 15 in number. These begin at the margins of the shallow depressions and radiate toward the margins of the calices; those toward the nearest or rear border widen rapidly and are more triangular in outline; those toward the farther or anterior border are more nearly linear; those on the sides curve toward the anterior border. These septal ridges are quite flat or only gently convex in a transverse direction, and are separated by narrow and rather shallow, but very distinct grooves. The surfaces of these septal ridges, are marked by very minute granules. Somewhat coarser granules, very irregularly arranged, occupy the excentric depressed area. In some calices the margins of the depressed areas are slightly, or even distinctly

raised, producing the effect of a sharp circular border. In some cases the weathering away of one of the calicular layers leaves the depressed area of this layer distinctly above the general level of the next lower calicular surface. In vertical sections the corallites are seen to consist of successive calicinal floors supported by a rather coarse vesicular tissue, the cavities of which are rather wide but very shallow. Horizontal tabulæ, closely arranged, appear to cross the region corresponding to the central, depressed part of less excentric calices, but this part is not well exposed in the specimen at hand. Among the species so far described, this coral appears most nearly related to *Strombodes alpenensis*, Rominger.

Locality and position: Half a mile east of Waco, Kentucky, where the road to Cobb Ferry turns off from the Irvine pike. In the Waco limestone layers, of Silurian age.

ARACHNOPHYLLUM (STROMBODES) MAMILLARE-DISTANS. N. V.

Plate 3, figs. 2A, 2B, 2C.

Corallum discoid, flat, with mamiform cones representing the centers of the calices. Basal surface covered by a concentrically wrinkled epitheca, and with a small central point of attachment; in some specimens the epitheca shows also traces of radiating striæ which in width resemble the septal ridges on the upper surface of the corallum. In the largest specimen here figured, the original width of the fragment must have been at least 200 millimeters; the thickness between the mamiform cones was less than 15 millimeters, the centers of the mamiform cones rising in some cases fully 20 millimeters above the epithecal layer. At the top of each mamiform cone there is a well defined pit or crater, from 3 to 3.5 millimeters, occasionally 4 millimeters in diameter. Within this pit, about 18 radiating septa extend from the margin to a small central elevation or projection. Near the margin of the pit, the terminations of about the same number of short, additional septa may be seen. From these septa narrow rugæ pass over the margins of the pits and continue as approximately equal sized linear bands in a radiate direction from the pits across the areas between the cones. The different calicular areas are not separated by raised lines, obtuse elevations, changes of slope, or any other definite

structure. The number of radiating linear bands: varies from 13 to 17 in a width of 10 millimeters. Their surfaces are marked by very minute granules. Horizontal sections show that the radiating septa do not extend beyond the margin of the pits. Vertical sections show the presence of a vesicular structure consisting of nearly horizontal lamellæ resting upon each other at irregular intervals; this structure is characteristic of by far the greater part of the corallum, being absent only in the central areas of the calices among the septa. Between the septa there are indications of dissepiments. The corallum is formed by a succession of numerous thin and closely applied calicinal layers, which show the radiating linear bands even on the inferior surface.

In the bed of a little stream a quarter of a mile south of Indian Fields a specimen was found 45 millimeters thick and 230 millimeters wide.

This variety differs from typical forms of *Arachnophyllum mamillare* in the smaller diameters of the calicinal pits and the greater distance between the mamiform cones.

Locality and position: Along the road south of the railroad, a short distance east of Panola station; also a quarter of a mile east of the home of Brownlow Bruner, north of the creek, along a road a mile southeast of Indian Fields, crossing the railroad and joining the road from Indian Fields to Clay City; also a quarter of a mile south of Indian Fields. At all localities, from the Waco limestone layers, of Silurian age. Figures 2A and 2C represent specimens from Panola; figure 2B represents a specimen from the Brownlow Bruner locality.

A small variety of *Arachnophyllum mamillare*, which may be known as *Arachnophyllum mamillare-wilmingtonensis*, occurs at Wilmington, and at other localities in the Dayton limestone of Ohio. This is the earliest representative of the species. The central pits of the mamiform cones have a diameter of 1.5 millimeters; the distance between the centers of the cones usually varies between 6 and 8, occasionally 10, millimeters. The septal rugæ radiating from the mamiform cones across the intercalicular spaces number about 8 or 9 in a width of 3 millimeters. This species was described as *Lyellia striata*, by U. P. James, in his *Paleontologist*, page 10, in 1878. It was formerly identified also as *Strombodes pygmaeus*, Rominger, in the *Bulletin of Denison University*, volume 3, page 120, in 1888.

CYSTIPHYLLUM SPINULOSUM, N. SP.

Plate 5, figs. 1A-1K.

Corallum simple; moderately curved or nearly straight. Length of specimens found so far less than 50 millimeters. Exterior of corallum covered by an epitheca which is marked by longitudinal grooves, dividing the surface into low, narrow linear ridges as in species having conspicuous septa; septa, however, obsolete. Of these longitudinal ridges, about six occur in a width of 5 millimeters. Exterior also with fine transverse, radiating striæ. Epitheca frequently absent, owing to weathering. In that case the vesicular structure is well exposed. Blister-like cavities, large and conspicuous, frequently 5 millimeters long and of equal or even greater width. The plates forming this vesiculose structure are convex above but concave as seen on the side of weathered surfaces of the coralla, since they curve upward and outward. The concave surface of these plates is marked by low longitudinal striations which correspond in frequency to the septal striæ on the exterior of the corallum. Calyx only partially exposed in the larger specimens at hand, apparently of moderate depth; formed by the convex sides of the uppermost layer of plates. In most specimens the convex side of these plates as exposed in the calyx is covered with coarse granules interspersed with smaller granules; these may take the place of the obsolete septa; in a few specimens they are arranged in approximately radiate lines; in others this arrangement can not be readily detected. While the usual appearance of these markings on the upper side of the plates is that of coarse granules, on well-preserved specimens they frequently are detected as short spines fully a millimeter in length. These spines have been seen in so many specimens that it is evident either that the coarse granules of weathered specimens represent the bases of the weathered spines, or that both spines and coarse granules occur in this species.

This species may be distinguished by the coarsely vesicular structure, the septal striations on the lower side of the plates, and the coarse granules and short spines on the upper side.

Locality and position: All the specimens figured except that represented by figure 1C, were found along the road north of Estill Springs, north of Irvine, Kentucky; figure 1C represents

a specimen found half a mile east of Waco, where the road to Cobb Ferry turns off from the pike to Irvine; specimens occur also east of Panola, along the road south of the railroad. In the Waco limestone layers, of Silurian age.

CALOSTYLIS SPONGIOSA, N. SP.

Plate 7, figs. 3A-3G, and Plate 8, figs. 1A-1B.

Corallum sponge-like in appearance but provided with a distinct although very thin epitheca which usually is absent along the upper part of the corallum, and often even from almost the entire corallum, possibly due to removal by weathering. Coralla simple, attached at the base, forming irregular cylindrical or moderately conical growths. Septa numerous, the upper edges within the calyx irregularly toothed or crenulated; not readily distinguishable near the center of the calyx, where they form a spongy mass, but not a distinct columella. Septa perforated by numerous small openings or pores, and therefore cribiform. The sides of adjacent septa are attached to each other by numerous short, thin, irregular, rod-like bodies, called synapticula.

In the specimen represented by figure 3A, there are about 45 primary septa which may be traced down the walls of the calyx, but are replaced at the bottom of the calyx by a spongy structure not showing definite arrangement. Along the outer part of the corallum, secondary septa alternate with these primary ones. In figure 3B, there are 35 primary septa, with an equal number of secondary septa along the exterior of the specimen. In specimens having the diameter shown by figures 3C, 3D, 3E and 3G, the number of primary and secondary septa is about 90. In some specimens the septa are sharply defined and are distinctly perforated. In other specimens the structure is more confused and the term spongy septa appears to be more descriptive. Possibly this spongy appearance is due largely to the secondary septa. In the central part of the corallum the sclerites and synapticula form a confused sponge-like structure. Epitheca very thin; longitudinal septal rugæ not distinct in most specimens; transverse concentric striæ and wrinkles present.

The species here described assumes numerous forms. Some

of them, beginning with a narrow pointed base, expand rapidly into curved turbinate coralla as in species of *Zaphrentis* and *Cyathophyllum*. In some cases the growth is more sub-cylindrical. In other specimens the coralla are attached by rather broad bases to some other body, producing broad coralla of moderate height. The illustrations here presented show some of these variations.

Our specimens are closely related to the type species, *Calostylis denticulata*, Kjerulf, from the Silurian of Gotland, Sweden, from which it differs chiefly in the more numerous septa, in the distinctly smaller septal pores, and in the absence of branching, even in case of the largest coralla. Species of *Calostylis* have been described also from the Silurian of England. The exact affinities of this genus are still in dispute. Zittel placed it among the perforated madreporoid *Hexacoralla*, while Koken and Neumayr considered it an aberrant type of the rugose *Quadricoralla*.

Locality and position: The specimens here figured are all from along the road north of Estill Springs, north of Irvine, Kentucky; specimens occur also east of Panola, along the road south of the railroad; and half a mile east of Waco, where the road to Cobb Ferry starts off from the pike to Irvine; two miles southwest of Clay City, along the road immediately north of Tipton Ferry; one mile southeast of Indian Fields, south of the railroad, facing the creek, where the road from Kiddville joins the road from Indian Fields to Clay City. In the Waco limestone layers, of Silurian age.

The enlargements on plate 8 show traces of the synapticula and of the porous structure.

PENTAMERUS OBLONGUS.

Plate 1, fig. 2.

In New York this species is not known outside of the Clinton fauna. In Ohio its first appearance is in the Dayton limestone, but here it is very rare. It occurs abundantly in the Springfield and Cedarville limestones.

The specimen here figured is from the Dayton limestone, about two miles west of Peebles, along the railroad. The specimen is symmetrical, but was inclined so as to show the details

better in a photograph. The largest fragment found at this locality indicates a specimen originally about 100 millimeters long; the trilobation of the valves is distinct, the outline of the shell more nearly resembling the form found in the Springfield and Cedarville limestones of Ohio than those predominating in the Clinton of New York. The specimen here figured is an interior cast showing the length of the median septum of the pedicle valve. In addition to the more distinct lobes, there are indistinct narrow folds, much less distinct than those of *Pentamerus oblongus-bisinuatus* from the Silurian of Wisconsin.

Locality and position: Two miles west of Peebles, in Adams county, Ohio. In the Dayton limestone, overlying the ferruginous layers of the Clinton. This horizon has not been traced into Kentucky as yet, but it probably corresponds approximately to the Oldham limestone forming the upper part of the Indian Fields formation, directly beneath the Alger clay.

STRICKLANDINIA NORWOODI, N. SP.

Plate 1, figs. 1A-1D.

The generic position of this shell is uncertain since the structure of the interior is only very imperfectly known, but the exterior form and the nearly obsolete bilaterally diverging plications resemble those of *Stricklandinia davidsoni* as figured by Billings.

Shells rather large, elongate-oval, with a hinge-line varying apparently between moderately curved and nearly straight. As far as may be determined from the specimens at hand, the hinge area of both valves is imperfectly exposed, if at all, the umbonal regions of the pedicle valves being more convex, and the beak more incurved. Both valves, moderately convex, the convexity of the pedicle valve a little greater. It is estimated that the total thickness of a shell 38 millimeters in width is about 15 millimeters. Pedicle valve with a shallow median depression, beginning at the beak, where it is narrow, and extending forward and widening toward the middle of the shell. In some specimens this median impression disappears anteriorly, in others it becomes broader though remaining shallow. The brachial valve is marked by a low median elevation, narrow at the beak, becoming broader anteriorly. As far as the middle of the shell,

this median impression often is bordered on each side by a very shallow depression, giving greater distinctness to the elevation. Toward the anterior margin of the shell, however, both the elevation and the bordering depressions are likely to become indistinct. Both valves comparatively smooth, but showing traces of nearly obsolete broad radiating plications. The latter are sometimes crossed by additional plications having a distinctly bisymmetrical arrangement, apparently curving from the median part of the shell somewhat forward and more strongly toward the lateral part of the shell, so as to cross the nearly obsolete radiating plications. In the specimen represented by figure 1D the radiating plications are readily seen when the valve is held at the proper angle. In specimens represented by figures 1A and 1C the bilaterally divergent crossing plications are seen.

In one of the pedicle valves, broken off at the beak, is seen a cross-section of a V-shaped structure supported by a vertical plate resting on the inner side of the valve. This is interpreted as a spondylium resting on a median septum. In a cast of the interior of this valve this septum appears to have extended to a point 8 millimeters anterior to the hinge-line. The spondylium appears to have been folded so as to form a V-shaped groove and to have extended forward and away from the umbonal part of the shell. The spondylium was short, probably 8 millimeters or less in length.

The cast of the interior of a brachial valve shows two short grooves extending from the beak forward for a distance of 5 millimeters, slightly diverging, their anterior ends about a millimeter and a half apart. On the exterior side of each groove the cast is slightly raised, forming a short narrow ridge. Immediately anterior to these nearly parallel grooves the posterior ends of two narrow muscular scars apparently are found. This structure of the brachial valve apparently agrees best with that shown by *Stricklandinia castellana* from the Silurian of Iowa, as figured by Hall and Clarke, in the eighth volume of the Paleontology of New York, plate 73, figure 7.

Locality and position: All of the specimens figured were found about five and a half miles south of Indian Fields, along the road to Vienna, a short distance south of the culvert southeast of the home of J. T. Elkins. Similar specimens are abundant three miles south of Indian Fields, east of Long Branch; a

mile west of Indian Fields, west of Howard Creek, along the railroad; three miles southwest of Clay City, along Plum creek; along the road north of Estill Springs, north of Irvine; along the railroad between Brassfield and Panola, and elsewhere. The last named locality shows good exposures at the proper horizon, although the best specimens found so far came from the J. T. Elkins locality. The species occurs widely distributed at the top of the Oldham limestone layers. The Oldham limestones are typically exposed along the railroad following the north side of the valley of Oldham creek, between Brassfield and Panola, and here the species may be found readily. It is the most characteristic and most widely distributed shell of the Oldham limestones studied so far. I take great pleasure in naming it after the present head of the Geological Survey of Kentucky, Prof. C. J. Norwood, to whom I am under obligation for encouragement and assistance.

Figures 1A, 1C and 1D represent pedicle valves; figure 1B represents a brachial valve; figure 1D was taken from the shell; the other figures were taken from the natural casts of the interior.

WHITFIELDDELLA SUBQUADRATA, FOERSTE.

Plate 1, figs. 3A-3F.

Shells abundant in the form of casts of the interior showing the muscular scars and the impressions of the teeth and other structures along the hinge-line. It is closely related to *Whitfieldella cylindrica*, and may be regarded merely as a variety of the latter. Compared with typical forms of *Whitfieldella cylindrica*, however, it is a much more robust shell, less elongate, broader at the beak, with no median depression along the pedicle valve and with no sinuate flexure of the shell on approaching the anterior outline. The name *subquadrata* was suggested by shells having the outline represented by figure 3B of which 3A is a cardinal view, with the pedicle valve on the lower side. Subsequently shells having a more oval outline were found to be not rare so that the name originally suggested has lost its value as a descriptive designation of the species.

Interior casts of the pedicle valve strongly marked by a strongly elevated triangular cast of the deep diductor muscular

scar, on each side of which are a series of parallel transverse rugæ, occupying the area in other shells often showing ovarian markings. The cast of the brachial valve shows the presence of a deeply concave hinge plate anterior to which is a short median septum.

Locality and position: All of the specimens figured were obtained about four miles west of Berea, along the lower part of Rocky Branch. The species, however, is widely distributed along the eastern side of the Cincinnati geanticline, from Spencer, Kentucky, to Stamford, and again along the lower part of Fishing creek and along the Cumberland river, at the mouths of Forbush and Little Cub creeks, within twenty miles toward the west of Somerset, Kentucky. It is the most characteristic shell of the limestone layers immediately overlying the Brassfield limestone and forming the base of the Indian Fields formation, just beneath the clays of the Plum creek horizon.

WHITFIELDDELLA QUADRANGULARIS, FOERSTE.

Plate 1, figs. 4A, 4B, 4C.

This shell may be regarded as a variety of *Whitfieldella crassirostra*, from the Silurian of New York, but the shell is somewhat broader at the hinge-line and the anterior margin is not strongly sinuate, the median depression of the pedicle valve being rather slight. This depression, as a rule, is seen only along the anterior half of the pedicle valve. A very faint, scarcely distinguishable median depression sometimes occurs along the corresponding parts of the brachial valve. It is a much less robust shell than *Whitfieldella subquadrata*, to which it is evidently closely related.

Locality and position: All of the specimens figured were obtained northeast of Duncansville, east of Sprows bridge, up a ravine on the north side of the road, 38 feet above the base of the Clinton, in Adams county, Ohio. Similar specimens were found in the western part of the county, south of Winchester. It should occur in the northern part of Kentucky, but has not been discovered as yet.

CHONETES VETUSTA, N. SP.

Largest ventral or pedicel valve about 15 millimeters wide and 6 millimeters long, gently convex; surface marked by about

60 or 70 radiating striæ; hinge line with rather long and divergent fimbriate spines, the longest about 1.5 millimeters in length. None of the specimens show all of the spines, but their number is probably about 2 or 3 on each side of the beak.

Apparently a distinct species, differing from *Chonetes cornutu*, Hall, and *Chonetes undulata*, Hall, in the greater number of radiating striæ. *Chonetes tenuistriata*, Hall, is about of the same size, but has nearly 100 striæ. *Chonetes novascotica*, Hall, is a larger shell, with more than 100 striæ, with 4 or 5 rather short cardinal spines on each side of the beak, and, often, with a flattened or slightly concave space down the middle of the valve. *Chonetes novascotica-waldronensis* usually is a smaller shell, with 2 or 3 rather long cardinal spines, and with the median striation characteristically prominent.

Locality and position: In the shaly limestone, at the top of the Alger clay, of Silurian age, up the hill, north of the home of Alfred Huffman, less than a mile west of Valley, about 8 miles west of Vanceburg, Kentucky.

ISOCHILINA PANOLENSIS, N. SP.

A large species of Ostracod is characteristic of the Waco limestone in East-Central Kentucky. It is most closely related to *Isochilina grandis-latimarginata*, Jones, from the Silurian of Lake Winnepegosis and the Saskatchewan river of Canada. There is, however, scarcely a perceptible trace of an ocular tubercle or of a sulcus. The dorsal margin is straight, and the dorsal angles are definite, although very obtuse. There is no slight emargination of the anterior and posterior margins just before reaching the dorsal line, as in *Isochilina grandis-latimarginata*, but in other respects the outline is closely similar, although, in some specimens, the greatest convexity of the posterior margin is slightly nearer the ventral border.

Our specimens are smaller than *Isochilina grandis-latimarginata*; the usual length is 8 millimeters, but some specimens 10 millimeters long are found. The ventral border of the left valve is deflected strongly downward along the entire length of the valve, making an angle of about 80 or 85 degrees with the general plane of the valve. In one specimen the width of this deflected border is fully .75 millimeters, but this width dimin-

ishes gradually toward the anterior and posterior margins. Held at a favorable angle, a slight elevation of the margin of the upper surface of the valve may be seen just before reaching the deflected border. The valves are convex, the convexity being distinctly greater at a point about two-fifths of the length of the shell from the anterior margin. From this area the shell slopes rather evenly to the anterior and posterior margins, or is faintly concave just before reaching the slightly elevated, very narrow rim. There is no flat marginal rim distinctly defined from the general convexity of the main body of the valve, as in *Isochilina grandis-latimarginata*.

Length of hinge-line of left valve, 5.3 millimeters; greatest length across middle of valve, 7.8 mm.; greatest vertical diameter across middle of valve, 5mm. Some specimens attain a length of 10 millimeters. Surface smooth. Most of the valves found are left valves. One of the right valves differs in form, having a more oblique ventral margin. Its dimensions are: Length of hinge-line, 4.1 millimeters; greatest length of shell, 7.5 mm.; width across posterior third of valve, 5.4 mm.; width across anterior third, 4.6 mm.

Locality and position: Rather abundant at Panola, east of the station, south of the railroad; found also north of Irvine, east of the road passing Estill Springs, a short distance before reaching White Oak creek. Characteristic of the Waco limestone horizon.

BEYRICHIA LATA-TRIPLICATA, NOV. VAR.

In the Paleontology of New York, volume 2, page 301, published in 1852, Prof. James Hall published descriptions of a species of *Bollia* and of a species of *Beyrichia* under the same name *Beyrichia lata*, erroneously regarding these distinct species as opposite valves of the same species. Of these species the *Beyrichia* is described first, but on plate A66 the *Bollia* is figured first. In the catalogue of types and figured specimens in the American Museum of Natural History, at New York, Whitfield and Hovey have referred all of the types to *Bollia lata*, Hall. We prefer to apply the name *Bollia lata* to the species represented by figure 10b; and to use also the name *Beyrichia lata*, Hall, restricting this designation to the species

illustrated by figures 10c, d, e, of plate A66. With this interpretation, *Beyrichia lata*, Hall, differs from *Beyrichia æquilatera*, Hall, chiefly in the much narrower marginal border, elevated so as to form a narrow, distinctly defined rim. *Beyrichia lata* seems to be a distinctly larger species than *Beyrichia æquilatera*. Prof. Rupert T. Jones, in Part III of the Contributions to Canadian Micro-Paleontology, published in 1891, described one specimen as having a length of 1.5 mm. The figure of *Beyrichia lata*, in figure 10a, on plate A66, of the Paleontology of New York, however, is fully 2.75 mm. long.

In the upper part of the Alger clay in Lewis county, Kentucky, southwest of Vanceburg, at Valley opposite the home of W. A. McEldowney, a species of *Beyrichia* occurs in thin plates of argillaceous rock interbedded with the clays. The same species of *Beyrichia* occurs also up the hill, back of the home of Alfred Huffman, and at other localities at the same horizon, along the road to the W. H. Lawrence store. This species of *Beyrichia* varies in length from 2.5 to 3 millimeters. In the best preserved specimen, a right valve, the length is 2.5 mm.; height, 1.8 mm. This species is closely related to *Beyrichia lata*, Hall, but differs in having a distinctly shorter hinge-line, about 1.9 or 2 millimeters in a valve 2.5 millimeters long. The anterior and posterior dorsal angles, instead of being approximately rectangular, are very obtuse, owing to the convex outline of the anterior and posterior margins. The narrow marginal rim is distinct, and is separated from the body of the valve by a narrow groove. The body is trilobate. Of these lobes, the central is the narrowest; the anterior lobe is only slightly larger, but the posterior lobe is considerably larger. All of these lobes rise to approximately the same elevation, and are separated by deep grooves. The middle lobe narrows ventrally and approaches to within a short distance of the groove within the marginal rim, being separated from this groove only by the very narrow ridge connecting the anterior and posterior lobes. If the New York specimens have been figured correctly, our specimens form a distinct variety, distinguished by the greater curvature of the anterior and posterior outlines of the valves, resulting in a shorter hinge line.

Locality and position: Near top of Alger clay, at various localities in Lewis county, Kentucky, from Valley westward as far as the Lawrence store.