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Carroll Lane Fenton

Mildred Adams Fenton

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## SOME BLACK RIVER BRACHIOPODS FROM THE MISSISSIPPI VALLEY.

CARROLL LANE FENTON AND MILDRED ADAMS FENTON

This study originated in the attempt to identify a number of *Rhynchotremas* and *Zygospiras* from the Plattin and Decorah formations of Ste. Genevieve county, Mo. Comparisons were made with sets from several other localities in the Mississippi valley, and thus considerable additional material was examined, involving not only Black River horizons, but the Kimmswick and Maquoketa as well. The results of the study may be summarized in three conclusions:

1. It has become customary to apply the terms *Rhynchotrema inequivalve* and *Zygospira recurvirostris* indiscriminately, to specimens from numerous horizons and localities.
2. *Rhynchotrema inequivalve* was not recognizably described and illustrated by Castelnau, and later authors have used the name without redescribing the original types.
3. Among the forms of the genera *Rhynchotrema* and *Zygospira* commonly referred to the two species here named there are several heretofore undescribed species and varieties.

In the following pages are descriptions and illustrations of such of these forms as have come into the hands of the authors.

### *RHYNCHOTREMA KENTUCKIENSE* sp. nov.

Plate I, figs. 4-5; 18-22

Shell of medium or smaller than medium size, wider than long, and with postero-lateral margins curved and without noticeable flattening. Dimensions of three specimens, the first of which is the holotype: length, 12.6 mm., 12.8 mm., and 10.1 mm.; width, 14.9 mm., 15.7 mm., and 10.5 mm.; thickness, 11.2 mm., 10.4 mm., and 5.7 mm.; width of sinus, 7.7 mm., 8.5 mm., and 5.1 mm.

Pedicle valve convex in the umbonal region; flattened on the lateral slopes. In young specimens the slopes reach the margins without an increase in convexity; in adults such as the holotype the convexity is very abrupt, being accomplished by numerous

strong, lamellose, concentric growth-lines. Beak acutely angular, produced 1 to 2 mm. beyond that of the opposite valve, and but slightly recurved; delthyrium large, triangular, and partly occupied by the beak of the brachial valve. Mesial sinus originates 3 to 5 mm. anterior to the beak, and is occupied by two to four strong, simple plications, the average number being three.

Brachial valve more convex than the pedicle in adults; approximately equal in young. Postero-lateral slopes regularly curved without vertical flattening; antero-lateral slopes of adult specimens abruptly convex, with numerous growth-lines. Mesial fold broad and flattened in young specimens; in adults such as the holotype it is high and rounded. In all specimens examined the fold bears four plications, regardless of aberrations on the sinus. The surface of both valves is marked by fourteen to eighteen strong, simple, angular plications which are separated by narrow, angular furrows. Near the anterior margin, in adult specimens, there are abundant strong, lamellose, concentric growth-lines, which cause a pronounced anterior flattening.

This species is probably the one which Nettleroth figures as *R. inaequivalva* (Cast.). It is associated with *R. mercerense* of this paper, but differs from that species in form and proportion, particularly in that the young *R. kentuckiense* never attains the cuneiform shape, the postero-lateral flattening, and the high blade-like plications that characterize *R. mercerense*.

Formation and Localities: Black river, Danville, Burgis, Paris, and Curdsville, Kentucky.

Holotype, No. 27,445; paratypes, No. 27,446, Walker Museum.

*RHYNCHOTREMA KENTUCKIENSE VARIANS*, var. nov.

Plate I, figs. 1-5

Shell smaller than medium, longer than wide, subovate to subtriangular in outline, with postero-lateral margins slightly flattened vertically. Dimensions of two specimens, the first of which is the holotype: Length, 10.1 mm., and 11.2 mm.; width, 11.7 mm. and 12.1 mm.; thickness, 7.8 mm. and 8 mm.; width of sinus, 6 mm. and 6.6 mm.

Pedicle valve shallow, convex in the unbonal region, but flattened on the slopes; beak prominent, slightly incurved and produced 1 to 1.5 mm. beyond that of the opposite valve. Mesial sinus originates about 3 mm. anterior to the beak, and bears

three simple, angular plications, which are finer and more crowded than those of the slopes. Postero-lateral slopes with a slight vertical flattening and obscuring of the plications.

Brachial valve more convex than the pedicle; beak abruptly incurved into the delthyrium; postero-lateral slopes flattened to correspond to those of the opposite valve. Mesial fold high and sharply defined, bearing four strong, crowded, angular plications. Total number of plications on each valve ranges from thirteen to sixteen, the commonest being fourteen. Anterior portions of both valves marked by numerous lamellose growth-lines.

The variety seems to be an intermediate between *R. kentuckiense* and *R. mercerense* of this paper. Its affinity to the former is shown in the rounded postero-lateral margin, the tendency toward subovate shape, particularly in the young, the high proportion of width to length in young (very near that of *R. kentuckiense*), and in the lamellose growth-lines. The relationship to the latter is found in the postero-lateral flattening, the crowding of plications on fold and sinus, and in the great height and angularity of the plications.

Formation and Localities: Kimmswick Limestone, near Batchtown, Ill., and Sulphur Springs, Mo.

Holotype, No. 27,451, Walker Museum.

#### *RHYNCHOTREMA MERCERENSE* sp. nov.

Plate II, figs. 17-21.

Shell of less than medium size; in the young specimens, longer than wide and acutely subtriangular; in the adults, wider than long, gibbous, and broadly subtriangular. Postero-lateral margins straight and vertically flattened in young specimens; slightly curved and convex in adults. Dimensions of cotypes: Length, 9.9 mm. and 12.9 mm.; width 8.7 mm. and 13.1 mm.; thickness 6.2 mm. and 10.6 mm.; width of sinus 5.1 mm. and 8.3 mm.

Pedicle valve moderately convex in the umbonal region; lateral slopes flattened. Beak sharp, slightly incurved, and projected beyond that of the brachial valve. Mesial sinus originates 4 to 5 mm. anterior to the beak; in the young it forms a narrow, shallow depression which curves gently to the anterior margin; in the adults the curve is more abrupt. In the adult cotype the depth of the sinus at the anterior margin is 4.6 mm.

Brachial valve more convex than the pedicle, with the postero-

lateral slopes flattened vertically, meeting a similar flattened space on the opposite valve, the whole forming a very pronounced vertical area in which the plications are either greatly reduced or are lacking. In the young specimens this area is very much more pronounced than in the adults, in which there is a tendency to develop a convexity of the lateral slopes and a curvature of the postero-lateral margin. Mesial fold, which begins at the beak as a slight depression, becomes elevated at about 4 mm. from the beak; in the young it is low and flat; in the mature, very prominent and rounded. Surface of both valves marked by eleven to seventeen strong, acutely angular plications, those near the fold and sinus being extremely high and sharp. The three (in one case, four) plications of the sinus, and four of the fold are finer than those of the slopes. Anterior slopes of both valves much more abrupt in the young than in the adults.

The resemblances and differences between this species and *R. kentuckiense*, with which it appears to be associated, are discussed in connection with that species. They are, as may be seen by a comparison of the figures showing the young of both, more pronounced among the young than among the adults.

Formations and Localities: Black River, Mercer County, Ky.; Curdsville (?), Curdsville, Kentucky.

Cotypes, No. 27,449, Walker Museum.

#### *RHYNCHOTREMA MINNESOTENSE* (SARD.)

Plate I, figs. 15-17.

1891. *Rhynchonella Minnesotensis* Sardeson, Bull. Minn. Acad. Nat. Sci., 3, p. 333, pl. 4, figs. 21-23.
1893. *Rhynchotrema inequalvis* Winchell and Schuchert (part). Geol. Minn., 3, pt. 1, p. 459, pl. 34, figs. 9-11; 15-23.

Shell small, broadly subovate, wider than long; postero-lateral margin curved, without flattened area. Dimensions of two mature specimens and one young: Length, 10.8 mm., 10 mm., and 7.3 mm.; width 12.6 mm., 11.4 mm., and 7.9 mm.; thickness 8.6 mm., 7.9 mm., and 3.3 mm.; width of sinus 7.1 mm., 5.7 mm., and --- mm.

Pedicle valve uniformly convex in the young; moderately so in the adults, with a considerable flattening anterior to the umbo. Beak sharp, slightly incurved, produced beyond that of the opposite valve; sinus originates 4 to 5 mm. from the beak and con-

tinues to the anterior margin as a broad, shallow depression occupied by four to eight strong, angular plications.

Brachial valve more convex than the pedicle, depressed in the umbonal region and abruptly downcurved in the anterior. Mesial fold originates 5 to 6 mm. anterior to the beak; it is a broad, low elevation bearing one more plication than does the sinus. Surface of both valves marked by fifteen to twenty-five simple, subangular plications, with no growth lines in the specimens examined.

This species was described by Sardeson from the upper Platteville ("Trenton") of Minnesota; Winchell and Schuchert fail to distinguish it from "*Rhynchotrema inequivalvis*" and probably refer to it forms that do not properly belong there. The collections in Walker Museum contain sets from the Platteville at Minneapolis and at Ellsworth, Wisconsin, the latter having been identified by Mr. Sardeson, and a single pedicle valve from the Decorah Shale at Ste. Genevieve, Missouri. The Ellsworth specimens, from which are selected the plesiotypes, are narrower, with fewer and coarser plications than the two Minneapolis specimens and the one from Ste. Genevieve. From *R. wisconsinense* of this paper they may be distinguished by their greater size, more numerous plications, and lack of lamellose growth lines.

Plesiotypes, No. 27,443, Walker Museum.

#### *RHYNCHOTREMA WISCONSINENSE* sp. nov.

Plate I, figs. 6-8.

Shell small, subovate, wider than long, with the postero-lateral margins curved and slopes without vertical flattening. Dimensions of two specimens, the first of which is the holotype: Length, 11 mm., and 9.6 mm.; width, 12.7 mm., and 11.6 mm.; thickness, 8.6 mm., and 7.8 mm.; width of sinus, 5.8 mm., and 5.8 mm.

Pedicle valve moderately convex, with the slopes flattened. Beak sharp, prominent, slightly incurved, with the delthyrium partly occupied by the brachial beak. Mesial sinus originates 3 to 4 mm. from the beak, extending as a broad, flat-bottomed trough to the margin; it is marked by three (rarely four) strong, angular plications.

Brachial valve more convex than the pedicle; umbo slightly depressed; beak abruptly incurved. Slopes curve abruptly to the anterior margin; less so to the postero-lateral. Mesial fold high, flattened, sharply defined, its plications numbering one more than those of the sinus. Surface of both valves marked by twenty

to twenty-two strong, simple, subangular plications, separated by deep, narrow furrows. Entire surface, to within 3 or 4 mm. of the beak, marked by heavy, concentric, lamellose growth lines, which are particularly abundant near the anterior margin. The species is distinguished by these lines, its pronouncedly curved postero-lateral margin, sharply projecting pedicle beak, and its sharply angular plications.

Formation and Locality: Black River (Platteville), Ellsworth, Wisconsin.

Holotype, No. 27,444, Walker Museum.

*RHYNCHOTREMA CUNEIFORME* sp. nov.

Plate I, figs. 12-14.

Shell small, longer than wide, subtriangular. Postero-lateral margins nearly straight, meeting in a very acute angle at the beak; postero-lateral slopes flattened, but with the plications present. Dimensions of the holotype: Length, 10.6 mm.; width, 10 mm.; thickness, 8 mm.; width of sinus, 5.6 mm.

Pedicle valve moderately convex in the umbonal region; slightly flattened anteriorly, with an abrupt convexity near the anterior margin. The broad, shallow sinus begins about 5 mm. from the beak, and is occupied by three to four strong plications. Beak long, sharp, slightly incurved.

Brachial valve deeper and more convex than the pedicle; flattened along the postero-lateral margins, and abruptly convex anteriorly. Beak short and abruptly incurved into the delthyrium; mesial fold originates anterior to the middle of the shell and bears four or five strong plications. Surface of both valves marked by thirteen to fifteen strong, subangular plications, which are reduced in size along the postero-lateral area. Specimens from the Decorah shale are larger and more coarsely plicated than those from the Plattin.

Formations and localities: Plattin, Ste. Genevieve Co.; Decorah Shale, near Ste. Genevieve, Missouri.

Holotype, No. 25,639, Walker Museum.

*RHYNCHOTREMA DECORAHENSE* sp. nov.

Plate I, figs. 9-11.

Shell small, broadly subtriangular; as wide as, or wider than, long. Postero-lateral slopes without vertical flattening. Dimen-

sions of three specimens, the third of which is the holotype: Length, 8 mm., 8.3 mm., and 9 mm.; width, 9.8 mm., 8.8 mm., and 11.2 mm.; thickness, 5.1 mm., 4.8 mm., and 5.4 mm.; width of sinus, 5.2 mm., 4.9 mm., and 5.6 mm.

Pedicle valve convex in the umbo but flattened on the slopes; beak sharp, incurved, and produced beyond that of the opposite valve. Mesial sinus broad, sharply defined, with three strong, simple, angular plications. Brachial valve more convex than the pedicle, due to its shortness, but as shallow as, or shallower than, the pedicle. Umbo slightly flattened; beak sunk into the delthyrium. Mesial fold broad, sharply defined but flattened, and bearing in all specimens examined four strong, simple, angular plications. Surface of both valves marked by fifteen to twenty plications, the average being sixteen or seventeen. Growth lines present in but one specimen, that a deformed one.

While this species seems to be characteristic of the Decorah shale in Iowa, it has not been collected in Ste. Genevieve county. Surprisingly enough, however, it occurs in its typical form in the lower portions of the Maquoketa stage in the neighborhood of Clermont, Iowa, sets being in the collections of both Walker Museum and the University of Iowa.

Holotype, No. 25,632; Paratypes, No. 25,611, Walker Museum.

*RHYNCHOTREMA MISSOURIENSE* sp. nov.

Plate I, figs. 22-26.

Shell small, subovate to subtriangular, as wide as or wider than long; postero-lateral slopes with slight vertical flattening. Dimensions of three specimens, the second and third of which are the cotypes: Length, 11.5 mm., 10 mm., and 9.3 mm.; width, 13.3 mm., 10.2 mm., and 9.7 mm.; thickness, 9.5 mm., 8.3 mm., and 6 mm.; width of sinus, 5.7 mm., 5.8 mm., and 5.1 mm.

Pedicle valve convex on the umbo; flattened on the lateral slopes, and abruptly convex to the margins. Beak acutely angular, incurved, and produced 1 to 1.6 mm. beyond that of the opposite valve. Mesial sinus broad, shallow, flat-bottomed, containing, in all specimens examined, three plications; it originates 4 to 5 mm. anterior to the beak, and curves with increasing abruptness toward the opposite valve.

Brachial valve more convex than the pedicle; beak short and sharply incurved into the delthyrium; region anterior to the umbo slightly flattened; antero-lateral slopes abruptly convex. Mesial fold



arises about midway of the valve; is broad and flattened, bearing four plications. Postero-lateral slopes with slight vertical flattening. Surface of both valves marked by fourteen to eighteen strong, simple, subangular or rounded plications; growth lines lacking in all specimens examined.

This species resembles, in general form, both *R. minnesotense* and *R. wisconsinense*. From the former it differs in its lesser width and greater thickness, fewer plications, and lesser elevation of the fold. From the latter it may be distinguished by its lesser width, greater thickness, fewer and less angular plications, and complete lack of lamellose growth-lines. Its nearest relative seems to be *R. cuneiforme* of this paper, from which it is distinguished by shape, pronounced curvature of the pedicle beak, and more rounded plications.

Formations and Localities: Decorah, — 2½ miles west of Ste. Genevieve, Missouri; Platteville, — Minneapolis, Minnesota; (?) Platin, — Ste. Genevieve County, Missouri.

Cotypes, No. 27,443, Walker Museum.

#### *RHYNCHOTREMA UNIPLICATUM* sp. nov.

Plate II, figs. 10-13; cf. figs. 14-16.

Shell small, subtriangular in outline, wider than long; postero-lateral margins straight, meeting at the beak in an acute angle; anterior margin almost straight. Dimensions of the cotypes: Length, 11.8 mm., and 10 mm.; width, 12 mm., and 10.4 mm.; thickness, 7.7 mm., and 5.8 mm.; width of sinus, 6.7 mm., and 5.2 mm.

Pedicle valve slightly convex in the umbonal region; lateral slopes flattened. Mesial sinus sharply defined; originates about 3 mm. from the beak, and contains one strong plication. Brachial valve more convex than the pedicle. Mesial fold, originating about 3 mm. anterior to the beak, is low but well defined, and bears two strong, rounded plications. Beak sharply incurved, projecting into the delthyrium of the produced pedicle beak. Surface of each valve marked by eleven to fourteen strong, subangular or rounded plications, and by heavy, rounded growth-lines, so very coarse as to give a nodose appearance to the plications.

This species differs from *R. kentuckiense varians* of this paper, with which it is associated, in its lesser number of plications on the fold and sinus, and in the heavy growth lines which are not

lamellose. From *R. dentatum* (Hall), which also possesses a single plication in the sinus, *R. uniplicatum* differs in proportions, as well as in smaller size and less gibbous character. Moreover, in *dentatum* the plications of the fold and sinus are quite as angular as those of the slopes, while in *uniplicatum* they are distinctly broader and more rounded. As compared with Foerste's and Miller's figures of *R. dentatum arnheimense* (*R. arnheimense*), that species is larger, narrower, and characterized by a more curved anterior margin than the one here considered.

Formation and Locality: Kimmswick Limestone, — near Sulphur Springs, Mo., and Batchtown, Ill.

Cotypes, No. 27,450, Walker Museum.

### *ZYGOSPIRA VARIABILIS* sp. nov.

Plate II, Figs. 7-9.

Shell small, elliptical; wider than long in adults but longer than wide in young. Dimensions of three typical specimens: Length, 5.2 mm., 6.5 mm., and 7.5 mm.; width, 5.6 mm., 6.9 mm., and 7.7 mm.; thickness, 2.9 mm., 3.8 mm., and 4.6 mm.

Pedicle valve pronouncedly convex in the umbo, moderately so on the slopes, and depressed or concave near the cardinal extremities. Beak prominent, sharp, incurved, and produced from 0.3 to 0.9 mm. beyond that of the brachial valve. At the crest of the low, rounded mesial fold runs a slight longitudinal depression, manifested as a deepened and very broad furrow between two of the plications. Brachial valve less convex than the pedicle; greatest convexity in the umbo; slopes flattened. Near the beak originates the broad, shallow, undefined mesial sinus, which may or may not be marked by a broadened median plication to correspond to the median furrow of the fold. Width of sinus in a specimen 6.7 mm. broad is approximately 4 mm. Surface of both valves marked by eighteen to twenty-two simple, rounded or sub-angular plications.

What relation this species may hold to *Z. tantilla* Bradley<sup>1</sup> cannot be determined. Bradley does not figure his species, nor does his description afford anything determinative; it might apply to the New York *Z. recurvirostris*. Therefore, since *Z. tantilla* is neither recognizably figured nor defined, it should be abandoned.

*Z. variabilis* differs from the typical *Z. recurvirostris* (Hall and

<sup>1</sup> Bull. Mus. Comp. Zool., 64, p. 525.

Hall & Clarke types) by its greater size, and particularly its greater width, its lesser thickness, and more angular proportions. The plications also are considerably coarser than in the New York form.

Formations and Localities: Plattin, — South Beckett Hill, Ste. Genevieve County, Kentucky; Black River, — Frankfort and Paris, Kentucky.

Holotype; No. 25,861, Walker Museum.

*ZYGOSPIRA VARIABILIS FOUNTAINENSIS* var. nov.

Plate II, Figs. 1-3.

In the Decorah shale at Fountain, Minnesota, and in the Maquoketa shales near Clermont, Iowa, there is found a *Zygospira* which is clearly a slight modification of the typical *Z. variabilis* of the Plattin. The proportions are almost identical, the differences being in the plications. These are somewhat more numerous (eighteen to twenty-four to the valve) than in the typical species, and are noticeably finer and rounder. Had it not been for the occurrence of the same form in two formations so widely separated as the Decorah and the Maquoketa, this would have been interpreted as a purely environmental difference.

Cotypes, No. 27,455, Walker Museum.

*ZYGOSPIRA CALHOUNENSIS* sp. nov.

Plate II, Figs. 4-6.

Shell pronouncedly ovoid, longer than wide. Dimensions of three specimens: Length, 5.3 mm., 5.2 mm., and 5.8 mm.; width, 4.7 mm., 4.9 mm., and 4.6 mm.; thickness, 3.6 mm., 3.9 mm., and 4.2 mm.

Pedicle valve convex, except in the vicinity of the rounded cardinal extremities where, in the broader specimens, it is slightly concave. Beak short, pointed, and abruptly incurved; mesial fold indicated by a slight, flattened elevation. Brachial valve less convex than the pedicle; marked by a broad, shallow, mesial sinus which appears 2 or 3 mm. anterior to the beak. Surface of both valves marked by twenty to twenty-two strong, simple, rounded plications, separated by narrow furrows.

This is another species of the *Z. recurvirostris* group, and is more closely related to the typical New York form than are the two preceding ones. It may be distinguished, however, by its

excessive gibbosity and very slight development of fold and sinus. In the young specimens there is a lesser development of these features, coupled with a flattening or concavity near the cardinal extremities, that indicate close relationship to, and perhaps descent from *Z. variabilis*. It seems probable that both *recurvirostris* and *calhounensis* are the descendants of a species very much like *Z. variabilis*.

Cotypes, No. 27,457, Paratypes, No. 27,458, Walker Museum.

PLATE I

*Rhynchotrema kentuckiense varians* var. nov.

1-3. Brachial, pedicle, and lateral views of the holotype.

*Rhynchotrema wisconsinense* sp. nov.

6-8. Brachial, pedicle, and lateral views of the holotype, showing the lamellae.

*Rhynchotrema decorahense* sp. nov.

9-11. Brachial, pedicle, and lateral views of the holotype, the last showing the great depth of the pedicle valve.

*Rhynchotrema cuneiforme* sp. nov.

12-14. Brachial, pedicle, and lateral views of the holotype.

*Rhynchotrema minnesotense* (Sard.)

15-17. Brachial, pedicle, and lateral views of a plesiotype.

*Rhynchotrema kentuckiense* sp. nov.

4. Brachial view of a small paratype, showing the long, pointed beak.

5. Lateral view of another paratype, showing the shallowness of both valves during the earlier stages of development.

18-19. Brachial and pedicle views of the holotype.

20. Lateral view of the holotype; cf. fig. 5.

21-22. Brachial and pedicle views of a paratype.

(All figures enlarged about 1.5 diameters)

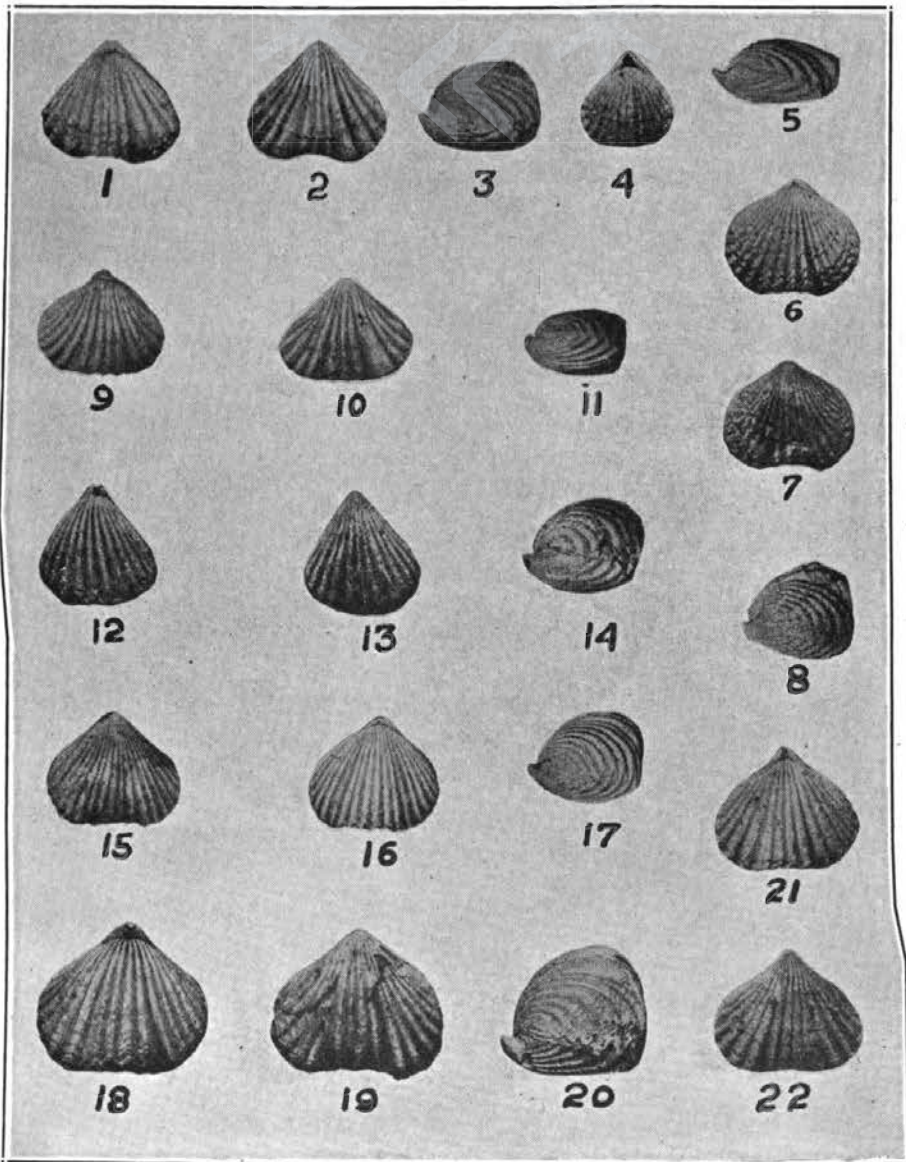








PLATE II

*Zygospira variabilis fountainensis* var. nov.

- 1-3. Brachial, pedicle, and lateral views of a cotype, showing the even, rounded plications and median furrow ( $\times 2.5$ ).

*Zygospira calhounensis* sp. nov.

- 4-6. Brachial, pedicle, and lateral views of a cotype, showing the differences between this species and *Z. variabilis fountainensis* ( $\times 2.5$ ).

*Zygospira variabilis* sp. nov.

- 7-9. Brachial, pedicle, and lateral views of the holotype ( $\times 3$ ).

- 7a. Pedicle view of the holotype; cf fig. 2 ( $\times 1.8$ ).

*Rhynchotrema uniplicatum* sp. nov.

- 10-12. Brachial, pedicle, and lateral views of the oldest cotype. Note the single plication of the sinus and the nodose plications of both valves.

13. Pedicle view of a younger cotype.

*Rhynchotrema dentatum* (Hall)

- 14-16. Brachial, pedicle, and lateral views of a typical Richmond specimen, showing the differences between this species and *R. uniplicatum*.

*Rhynchotrema mercerense* sp. nov.

- 17-19. Brachial, pedicle, and lateral views of the larger of the cotypes.

- 20-21. Brachial and lateral views of the smaller cotype.

*Rhynchotrema missouriense* sp. nov.

- 22-23. Brachial and pedicle views of the larger cotype, showing the coarse, rounded plications.

26. Lateral view of the same specimen.

- 24-25. Brachial and pedicle views of the smaller cotype.

Unless otherwise stated, all figures are enlarged about 1.5 diameters.

