

SOME NEW SPECIES OF *CAMAROTOECHIA* FROM
THE BAINBRIDGE LIMESTONE OF MISSOURI*

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During the years 1923 to 1926, under the direction of the late Stuart Weller, the senior author has studied and described some of the fauna of the Bainbridge limestone of southeastern Missouri. The descriptions written at that time are in a manuscript filed in the libraries of the University of Chicago. A faunal summary and a possible correlation of the limestone have been published in one of the theses abstracts of the University of Chicago.¹ A study of the Bryozoa, and of the micro-fauna was not undertaken in this earlier investigation. During the summer of 1930 the junior author has collected extensively from the Bainbridge formation. In the large amount of additional material that he has secured it becomes evident that some modification of earlier conclusions reached regarding the fauna may be justifiable. Some of those modifications are presented in this paper. In addition, the studies of the junior author are revealing a large micro-fauna in practically all of the Bainbridge.

In the course of the earlier study of the Bainbridge fauna, three new species of *Camarotoechia* were described. Two of them are named *Camarotoechia indianoidea* n. sp. and *Camarotoechia neglectoidea* n. sp., respectively. These names were given in recognition of their striking resemblance to the well-known Silurian species from Indiana and elsewhere. With both of these Bainbridge species in the collections first studied were a number of closely related forms, rather sparsely distributed among the specimens. On account of their relatively rare appearance in the fauna, therefore, it was judged to be more conservative to regard them as but variants of the much more abundant species named above. *Camarotoechia neglectoidea* apparently had but one or

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¹ Ball, J. R., "The Faunas of the Brassfield and Bainbridge Limestones of Southeastern Missouri," The University of Chicago Abstracts of Theses, Science Series, Vol. V, 1926-27, pp. 261-269.

two variants but there appeared to be at least five related to *Camarotoechia indianoidea*. In the evidence afforded by the additional material that Mr. Dunn has collected it becomes quite evident that certain forms, previously regarded as variants, may be considered as distinct species of *Camarotoechia*. They are present in really significant number, and the particular differences that they possess are represented both in individuals that are young and also in mature representatives. It is the conviction of the authors, therefore, that some of the "variants" of the earlier descriptions may be set aside, and that one variant of *C. neglectoidea*, and three of the five variants of *C. indianoidea* may be elevated to specific rank. This reassignment of the forms recently re-studied, leaves at present one variant remaining for *C. neglectoidea*, and two others that now are regarded probably as variants of *C. multiplicata* Ball and Dunn, n. sp., described in this paper. This study, accordingly, increases the number of new species of *Camarotoechia* in the Bainbridge fauna from three to seven, and makes the total number of Brachiopoda now known from the Silurian horizons of this locality fifty-nine.

Descriptions of the new species, including also those of *Camarotoechia indianoidea* and *Camarotoechia neglectoidea*, follow:

Class BRACHIOPODA Dumeril

Order TELOTREMATA Beecher

Family RHYNCHONELLIDAE Gray

Genus CAMAROTOECHIA Hall and Clark

CAMAROTOECHIA INDIANOIDEA Ball, n. sp.

Plate 1, Figs. 1-5

Description.—Shells small, subpentagonal, commonly wider than long, the greatest width about midway between the beak and anterior margin, the postero-lateral margins nearly straight or sometimes slightly concave, diverging at an angle of approximately 95°, the lateral margins nearly straight, the antero-lateral and anterior margins commonly straight but in some instances gently rounded. The dimensions of one individual are: length 11.8 mm.; width 12.5 mm.; thickness 7.6 mm.; greatest width of sinus 10 mm., greatest width of fold 8 mm.

Pedicle valve shallow, its greatest convexity in the umbonal region, the surface sloping abruptly from the umbo to the postero-lateral margins near the beak, with a gently convex curvature toward the lateral and antero-lateral margins becoming slightly flattened or concave near the margins. From beak to anterior margin along the mesial line the

curvature is regularly elliptical, while transversely the curvature is depressed convex. Originating near the base of the umbo, a broadly triangular and shallow mesial sinus, its surface slightly convex transversely, is produced anteriorly in a long and regularly rounded linguiform extension into the opposite valve. It usually bears three, sometimes four, low, broadly rounded plications, faintly discernable across the umbo, but evidently extending from the beak; on each lateral slope are three or four distinct plications with occasionally a few additional ones along the postero-lateral margins, all of them faintly defined posteriorly. Beak small, pointed, and slightly incurved.

Brachial valve thicker than the pedicle, its greatest thickness slightly anterior to the midpoint of the valve, the mesial region flattened transversely in the umbonal vicinity, the flattening continuing anteriorly into the broad mesial fold which originates in about the midpoint of the valve, and in some cases well toward the anterior margin. From the flattened umbonal region the surface descends almost at a right angle into the compressed, slightly concave postero-lateral surfaces. On each lateral slope the surface curves regularly and strongly from the umbonal region toward the antero-lateral margins with a curvature about equal to that in the mesial sinus of the pedicle valve. Along the mesial line from the beak over the umbo the curvature at first is strongly convex, then continues anteriorly in a flattened, gentle, convex line, in some specimens becoming slightly concave near the anterior margin. On the mesial fold commonly are four plications, well defined and subangular at the anterior margin, while on each lateral slope are three or four plications less conspicuous than those on the fold. All the plications extend from the beak but are faintly defined posteriorly. A distinct mesial furrow is well developed in the umbo and extends anteriorly across it. Beak broad, inconspicuous and closely incurved.

Faint concentric markings, sometimes present on both valves, generally are best developed near the anterior margin.

Observations. This species apparently is confined to what has been called the "Merista" bed in the Bainbridge limestone. Along with *Merista tennesseensis*, *Camarotoechia neglectoidea* n. sp., and *Atrypina welleri* n. sp., it is one of the most prevalent brachiopods of that stratum and, like the first two of these named, it is noteworthy for the number of young specimens represented. It is quite similar to *Camarotoechia? indianensis* (Hall) and resembles that species in its variability of form; it differs from it, however, in its relatively more transverse outline, in the fainter development of its plications, and in the persistent occur-

rence of three plications in the pedicle sinus and four on the brachial fold. Individuals in the Bainbridge fauna with three and four plications, respectively, in the sinus and on the fold are so numerous in a collection of over three hundred specimens that they are here regarded as the prevalent and characteristic type of this species.

Location.—South slopes of Greither Hills, overlooking the St. Mary's road, two and one-half miles southeast of Ozora, Missouri.

CAMAROTOECHIA EXTANS, Ball and Dunn, n. sp.

Plate 1, Figs. 11-15

Description. Shells small, subpentagonal, length and width about equal, the greatest width slightly anterior to the midpoint, postero-lateral margins gently rounded, diverging at an angle of about 113° , lateral and antero-lateral margins regularly rounded, anterior margin nearly straight. The dimensions of two individuals, one of them the holotype, are: length 12.6 mm., 13.1 mm.; width 12.5 mm., 13.5 mm.; thickness 10.6 mm. and 7 mm.

Pedicle valve shallow, its greatest convexity in the umbonal region, the surface sloping abruptly from the umbonal region to the postero-lateral margins near the beak and with gentle curvature toward the lateral and antero-lateral margins, and greatly flattened along the lines of the plications bounding the mesial sinus. Along the mesial line from beak to anterior margin the curvature is strongly elliptical, while transversely in the posterior region the surface is depressed convex and deflected downward abruptly at the lateral margins. A shallow mesial sinus, whose width at the anterior margin is about three-fifths the greatest width of the shell, originating at the base of the umbo, nearly flat or slightly convex transversely, is produced anteriorly in a linguulate extension into the opposite valve. In the sinus is a single plication, usually sharply angular, but sometimes faintly defined and extending from the beak: on each lateral slope are three or four low and rounded plications, those next to the sinus larger than the others. These plications also extend from the beak and in some instances there are more than four. Beak erect, small and pointed.

Brachial valve thicker than the pedicle, its greatest thickness in the midpoint of the valve, the surface depressed and flattened at the base of the umbo and on the fold. From the umbonal region the surface descends abruptly, almost at right angles, into a slight concavity on the postero-lateral margins, while along the lateral slopes the curvature from the umbo is strong and regular near the fold, but near the antero-lateral margins the surface is deflected abruptly downward into

the compressed surfaces of the margins. A somewhat narrow mesial fold, originating about the midpoint of the valve, bears two strong, well rounded plications extending from the beak, the mesial furrow separating them distinctly impressed along the umbó. On each lateral slope are from one to three low, simple and rounded plications, less distinct than those on the fold, also extending from the beak, although in some cases nearly obsolete. Beak broadly triangular, inconspicuous, and closely infolded.

Faint concentric markings are sometimes visible on both valves of the shells.

Observations. In average size and in general outline this species resembles *C. indianoidea* n. sp., and formerly was regarded as a somewhat freakish variant of that species. It is more sub-ovate than that species, however, the postero-lateral margins are more rounded, and it has but one and two plications, respectively, in the sinus and on the fold. It also resembles *C. bipartita* Ball and Dunn, n. sp., (Plate I, figs. 6-10) but in that species the plications in the sinus and on the fold are accompanied by fainter, secondary plications that are lacking in *C. extans*.

Locality. South slopes of Greither Hills, two and one-half miles southeast of Ozora, Missouri.

CAMAROTOECHIA BIPARTITA Ball and Dunn n. sp.

Plate 1, Figs. 6-10

Description. Shells small, subpentagonal, length and width about equal, the greatest width at the midpoint of the shell, the postero-lateral margins nearly straight, diverging at an angle of about 102° , the lateral and antero-lateral margins gently rounded, anterior margin slightly angular. The dimensions of two individuals are: length along the fold of the brachial valve 14 mm., 11.4 mm.; width 14 mm., and 11.3 mm.; thickness 10 mm., 7.5 mm.; width of sinus at anterior margin 10 mm. and 7.5 mm.

Pedicle valve shallow, its greatest convexity in the umbonal region, the surface sloping abruptly from the umbonal region to the postero-lateral margins near the beak, and with a gentle convexity toward the antero-lateral margins, in some instances with an abrupt deflection downward at the margins. In many instances there is scarcely any curvature along the plications adjacent to the mesial sinus. A broad and shallow mesial sinus, originating in the umbonal region, whose width at the anterior margin is about three-fifths the greatest width of the shell, the bottom slightly convex transversely, is produced anteriorly as a sub-rectangular lingulate extension deeply into the opposite valve.

The sinus usually bears three plications, the mesial plication more prominent than the others, the two secondary plications sometimes but faintly developed, and occasionally one of the two is lacking. On each lateral slope are three or four low rounded plications, the ones adjacent to the sinus much larger and more angular, the others sometimes but faintly developed, or with all but one or two obsolete. All of the plications, including those in the sinus, extend from the beak. Beak small, pointed, and somewhat closely infolded.

Brachial valve thicker than the pedicle, its greatest thickness anterior to the midpoint of the valve, the surface flattened over the umbo and fold. From the umbonal region the surface slopes at first gently, and then abruptly to the slightly compressed postero-lateral margins. From the region of greatest thickness the surface slopes in the same manner laterally, descending with a pronounced deflection at the lateral and antero-lateral margins. A narrowly triangular mesial fold, originating in the umbonal region, bears on its flattened surface four low, rounded plications, which have developed by bifurcation from the two which extend from the beak, the plications separated equally by a prominent mesial furrow, the plications adjacent to the furrow sometimes more prominent than those lying along the margins of the fold. On each lateral slope the plications sometimes are three, all extending from the beak, but occasionally there are less than three, or the lateral slopes are smooth. Beak broadly triangular and inconspicuous.

Observations. This species tends to be slightly more robust than *Camarotoechia indianoidea*, although where the individuals of the two species are of about the same size, there is a striking similarity in general proportions and outline. It differs markedly, however, from *C. indianoidea* in that its plications in the sinus and on the fold are of unequal size, where in that species the plications are of equal development. It resembles also *C. extans* n. sp., in general outline and convexity, but in that species there are but two plications on the fold and only one in the sinus.

Horizon and locality. Bainbridge limestone, south slope of Greither Hills, Missouri.

CAMAROTOECHIA MULTIPLICATA Ball and Dunn n. sp.

Plate 1, Figs. 16-20

Description. Shells small, subovate to subpentagonal, width slightly greater than the length, the greatest width at the midpoint of the shell, the postero-lateral margins slightly concave, diverging at an angle of

about 95° , the lateral and antero-lateral margins regularly rounded, the anterior margin gently rounded. The dimensions of the holotype are length, 16 mm. width, 13.5 mm., thickness, 9.7 mm.

Pedicle valve shallow, its greatest convexity between the umbo and the midpoint of the valve, the surface along the mesial portion of the valve with strong and regular curvature from the umbo, but from the umbo towards the antero-lateral margins the surface descends at first with gentle curvature, and then becomes flattened considerably near the margins. From the umbo the surface slopes abruptly towards the postero-lateral margins near the beak, descending into a slight concavity on the postero-lateral margins. The same slight deflection occurs also at the lateral and antero-lateral margins. A broadly triangular and shallow mesial sinus, originating at about the midpoint of the valve, and occupying about seven-tenths of the greatest width of the shells, is produced anteriorly in a broad, lingulate extension into the opposite valve. It bears four low, rounded plications, all extending from the beak, with occasionally a fifth plication faintly defined. On the lateral slopes are from three to five plications, low and well-rounded, also extending from the beak. Beak, small, pointed and erect.

Brachial valve thicker than the pedicle, its greatest thickness slightly anterior to the midpoint of the valve, the mesial region somewhat flattened in the umbo, the flattening continuing anteriorly into the broad mesial fold. From the umbonal region the surface descends abruptly into the compressed, slightly concave postero-lateral areas; on each lateral slope the surface extends from the umbonal region in a strong, arcuate curvature to the antero-lateral margins. A broadly triangular fold, originating at about the midpoint of the valve continues with a slight convexity to the anterior margin, sometimes slightly deflected upward at the margin. It bears five low, well-rounded plications, the plications laterally on the fold sometimes less well developed than those nearer the center. All of the plications extend from the beak, and a fairly well defined mesial furrow extends from the beak to the anterior margin. On each lateral slope are four or five close-set, low plications, extending from the beak, but not always as distinct as those on the fold. Beak broadly triangular and infolded.

Concentric lines of growth sometimes visible near the anterior margin of both valves.

Observations. This species has the same general form as *Camero-toechia indianoidea* n. sp., but differs from it and from the other species described in this paper in respect to the greater number of plications that it possesses. It, like the *Merista tennesseensis* Hall of the Bainbridge fauna, exhibits some variability of proportions, a robust, some-

what elongated form appearing with those of the more transverse type. Several other individuals in the collections, while possessing a greater number of plications, have not as yet been described as distinct species. It is more probable, however, that they are variants of this species, if such they are, rather than variants of *C. indianoidea*, as originally named in the University of Chicago manuscript.

Horizon and locality. Bainbridge limestone, south slopes of Greither Hills, near Ozora, Missouri.

CAMAROTOECHIA NEGLECTOIDEA Ball n. sp.

Plate 1, Figs. 21-25

Description. Shells small, subpentagonal, wider than long, the greatest width about midway between beak and anterior margin, postero-lateral margins slightly compressed or concave, diverging at an angle of approximately 114° , lateral margins slightly rounded, antero-lateral and anterior margins straight. The dimensions of the holotype are: length 9.3 mm.; width 11.4 mm.; thickness 7.5 mm.; greatest width of sinus 6.6 mm.; greatest width of fold 4 mm.

Pedicle valve shallow, its greatest thickness in the umbonal region, the surface sloping abruptly from the umbo to the cardinal margins near the beak, but becoming greatly flattened over most of the area of the lateral slopes. Along the mesial line from beak to anterior margin the curvature is strongly elliptical, through a narrowly triangular mesial sinus which originates slightly anterior to the umbo, its surface nearly flat or slightly concave transversely, and is produced anteriorly in a long, linguiform extension into the opposite valve, its distal portion nearly at right angles with the general plane of the valves. It generally contains three, sometimes four, low, angular plications extending from the beak; on each lateral slope are from four to six plications, extending from the beak, slightly more prominent than those in the sinus with the exception of those nearest the postero-lateral margins. Beak small, pointed, and erect.

Brachial valve thicker than the pedicle, its greatest thickness near the anterior margin, the surface descending abruptly from the umbonal region to the cardinal margins near the beak and curving strongly and regularly over the lateral slopes along the fold and descending regularly from the fold toward the lateral and antero-lateral margins. The mesial region is flattened transversely across the umbo, the flattening continuing anteriorly along the long, triangular fold which develops at the umbo and which at the anterior margin is greatly elevated above the lateral slopes. From beak to anterior margin along the mesial

line the curvature is strongly elliptical at first over the umbo, and then becomes considerably flattened toward the anterior margin. The mesial fold bears four low, sharply angular plications all extending from the beak, with four or more less angular plications on each lateral slope. In some instances a mesial groove, developed on the umbo becomes on the fold a more pronounced furrow separating the plications than do the others. Beak relatively broad and closely incurved beneath that of the opposite valve.

Observations. This species, along with *C. indianoidea*, n. sp., is abundant in the *Merista* bed of the Bainbridge limestone. Superficially it is suggestive of *C. neglecta* (Hall) of the Niagaran of Lockport, New York, and of the Waldron, Indiana, beds, but it differs from that species in its greater size, its greater proportionate thickness, its strong transverse development and the larger angle of divergence between its postero-lateral margins. It differs from *C. indianoidea* in its transverse proportions, the angularity of its plications, the elevation of its fold and its narrower and deeper pedicle sinus.

Location. South slopes of Greither Hills, two and a half miles south of Ozora, Missouri.

CAMAROTOECHIA DIVERSA Ball and Dunn n. sp.

Plate 1, Figs. 26-30

Description. Shells small, subpentagonal to subpyramidal, width and length about equal, the greatest width near the anterior margin, the postero-lateral margins distinctly compressed, diverging at an angle of about 90° , the antero-lateral margins gently rounded or subangular, the anterior margin nearly straight. The dimensions of two specimens, the first one the holotype, are: length 8.5 mm., 7.5 mm.; width 8.4 mm., 7 mm.; thickness 8 mm. and 6.2 mm.

Pedicle valve shallow, its greatest thickness near the umbonal region, but frequently the plications bounding the mesial sinus are so elevated at the anterior margin as to impart a subrectangular aspect in the lateral view of the valve. From the umbonal region the surface descends gently for a short distance over the lateral slopes and then becomes greatly flattened. From the umbonal region towards the postero-lateral margins the surface descends with but slight curvature at first, and then descends abruptly into a slight concavity on the marginal surfaces. A deep, narrowly triangular mesial sinus, originating at the base of the umbo, is extended anteriorly in a long lingulate projection into the opposite valve. It contains two distinct, subangular plications, both extending from the beak, while on each lateral slope

are three or four plications also extending from the beak, the ones bordering the mesial sinus usually a little more prominent and deflected sharply upwards at the anterior margin. Beak small, pointed and erect.

Brachial valve thicker than the pedicle, its greatest thickness at about the midpoint of the valve, the umbonal region slightly flattened and distinctly outlined in a triangular pattern by the pronounced compression of the antero-lateral margins. From the umbonal region along the lateral slopes the curvature is strongly arcuate, while a narrow, triangular fold is sharply elevated at the anterior margin. The fold bears three angular plications, all extending from the beak, and each lateral slope has two or three lower and angular plications, with incipient additional plications sometimes faintly developed. These plications also extend from the beak. Beak inconspicuous and infolded.

Observations. This species is more triangular in outline and much more compressed along the postero-lateral margins than *Camarotoechia neglectoidea* of which it formerly was regarded as a variant. Its plications are not as numerous as those of *C. neglectoidea*, and it invariably has two plications in the sinus and three on the fold where *C. neglectoidea* has three and four respectively. It resembles *C. neglectoidea*, however, more than it does *C. indianoidea*, and in its distinct and angular plications and with its extreme thickness near the anterior margin it appears more nearly related to the former than it does to the latter. In these respects it also resembles *C. neglectoidea* more closely than it does any of the other species described in this paper. The constancy of its number of plications in the mesial regions of both valves is a feature that appears in the young of the species as well as in the mature individuals. In the young individuals, however, the sinus and fold are not prominently developed.

Locality. South slopes of Greither Hills, two and one-half miles south of Ozora, Missouri.

EXPLANATION OF PLATE^{1,2}

FIGS. 1-5. *CAMAROTOECHIA INDIANOIDEA* Ball, n. sp.

Brachial, pedicle, lateral, cardinal, and anterior views of the holotype.

Holotype W. M. 22302

Paratypes N. U. 1232

FIGS. 6-10. *CAMAROTOECHIA BIPARTITA* Ball and Dunn, n. sp.

Brachial, pedicle, lateral, cardinal, and anterior views of the holotype.

Holotype W. M. 22343

Paratypes W. M. 22344

Paratypes N. U. 1234

FIGS. 11-15. *CAMAROTOECHIA EXTANS* Ball and Dunn, n. sp.

Brachial, pedicle, lateral, cardinal, and anterior views of the holotype.

Holotype W. M. 22306

Paratypes W. M. 22307

Paratypes N. U. 1235

FIGS. 16-20. *CAMAROTOECHIA MULTIPLICATA* Ball and Dunn, n. sp.

Brachial, pedicle, lateral, cardinal, and anterior views of the holotype.

Holotype W. M. 22342

FIGS. 21-25. *CAMAROTOECHIA NEGLECTOIDEA* Ball, n. sp.*

Brachial, pedicle, lateral, cardinal, and anterior views of the holotype.

Holotype W. M. 22310

Paratypes N. U. 1233

FIGS. 26-30. *CAMAROTOECHIA DIVERSA* Ball and Dunn, n. sp.

Brachial, pedicle, lateral, cardinal, and anterior views of the holotype.

Holotype W. M. 22349

Paratypes W. M. 22350

Paratypes N. U. 1236

¹ All the illustrations are slightly reduced in size.

² The authors are indebted greatly to Mr. B. R. Millington, Northwestern University, for his assistance in the work of photography.



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