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No. 6b. — *The Brachiopods of the Lenoir and Athens Formations of Tennessee and Virginia.*

BY PERCY E. RAYMOND.

Order ATREMATA Beecher.

LINGULA NYMPHA Billings.

Plate 1, fig. 1.

Lingula nympha Billings, Pal. foss. Canada, 1865, 1, p. 214, fig. 198. Ami, Ottawa naturalist, 1894, 8, p. 85.

Shell very large, parallel-sided, convex, the anterior and lateral slopes flattened. The pedicle valve extends only very slightly beyond the opposite one, so that the beak is scarcely more pointed. The exterior shows the usual concentric growth lines, and there are also along the median region, from back to front, radial striations which are accentuated on partially exfoliated individuals.

The figured brachial valve is 58 mm. long and 26 mm. wide, with an index of 223. This shell is somewhat broader than specimens from Newfoundland, whose index, according to Billings, is about 270.

Horizon and Locality: — This is a common fossil in the shaly limestone of the Athens in the cutting one mile south of Otes, Tenn. Nearly all the specimens, however, have been obtained from material brought from this cutting to make a fill on the railroad about 1.5 miles north of Bulls Gap, Tenn. Figured specimen no. 8585, M. C. Z. Billings's specimens were from division N, (Normanskill), at Table Head, Newfoundland.

Order PROTREMATA Beecher.

ORTHIS DISPARILIS Conrad.

Orthis disparilis Conrad, Proc. acad. nat. sci. Philadelphia, 1843, 1, p. 333. See Bull. 92, U. S. nat. mus., 1915, 2, p. 898, for further synonymy.

The presence of this species in the Athens is indicated by a pedicle valve 9 mm. long and about 9.5 mm. wide. It has 25 small rounded plications, and a high incurved cardinal area. Another individual, retaining both shells, has a brachial valve 8 mm. long and 10 mm. wide. These specimens have a higher index than usual for this species, but as both are small, it seems better to place them here than as a new species.

Horizon and Locality: — The first specimen mentioned is from the Athens one mile south of Otes, Tenn. The second, from the Lenoir, between Bulls Gap and Whitesburg, Tenn.

HEBERTELLA BURSA, sp. nov.

Plate 1, fig. 7.

Shell of medium size, both valves moderately convex, hinge shorter than the greatest width of the shell. Surface covered with striations which in general effect appear simple, but increase by bifurcation and implantation close to the beak, and more rarely, near the front. On account of the place of introduction of new members, the striations increase in size uniformly from the umbo to the front, where there are 5 in the space of 5 mm.

The holotype is 26 mm. long and 29 mm. wide at the middle. The width at the hinge is 22 mm. and the index 90.

This species somewhat resembles *H. melonica* Willard and *H. borealis* Billings, but is very much less convex than either of those species.

Horizon and Locality: — A single complete but somewhat crushed individual was found in material taken from the railroad cutting 1 mile south of Otes, Tenn. The horizon is Athens. The holotype is no. 8597, M. C. Z.

PLECTORTHIS EXFOLIATA Raymond.

Hebertella exfoliata Raymond, Am. jour. sci., 1905, 20, p. 370.

Plectorthis exfoliata Raymond, Ann. Carnegie mus., 1911, 7, p. 238, pl. 35, figs. 11, 12.

Specimens from the Lenoir seem to agree in all respects with those from the typical Chazy. Both valves are convex, the width at the hinge does not quite equal the greatest width, and all show about 40 simple, thin, sharp plications. An average specimen is 13 mm. long, 15 mm. wide, and 13 mm. wide at the hinge. An unusually large individual is 15 mm. long.

Horizon and Locality: — This is a very common species in the Lenoir at Lenoir City and at Bluff City, Tenn., and one specimen was found 4 miles east of Concord, Tenn.

VALCOUREA VENTRO-CARINATA (Butts).

Strophomena ventro-carinata Butts. Geol. surv. Ala. special rept., 14, 1926, p. 116, pl. 26, figs. 16, 17.

Shell small, known only from the pedicle valve which is almost flat, being slightly convex at the beak, flat or slightly concave at the front.

The greatest width is at the hinge, the cardinal angles being acute but not greatly extended. The surface is covered with slender, granulose, angular striae, which increase both by bifurcation and implantation, the longer striae being much the more elevated and conspicuous.

A pedicle valve is 10 mm. long and 16 mm. wide at the hinge. There are 14 striae in a space of 5 mm. at the front.

This species differs from *Valcourea strophomenoides* Raymond, *V. deflecta* (Conrad) and all other species of the genus in the flatness of the pedicle valve.

Horizon and Locality: — The types of the species were collected from the Little Oak limestone at Pelham, Ala. Two specimens were found by the writer at the top of the Lenoir 1.5 miles east of Bluff City, Tenn.

VALCOUREA STROPHOMENOIDES Raymond.

Plaesiomys strophomenoides Raymond, Am. jour. sci., 1905, **20**, p. 370.

Valcourea strophomenoides Raymond, Ann. Carnegie mus., 1911, **7**, p. 240, pl. 35, figs. 15–19, pl. 36, fig. 1, text fig. 12.

Horizon and Locality: — A rare species in the Lenoir near the Ross and Republic quarry, southeast of Knoxville, Tenn.

PLAESIOMYS PLATYS (Billings).

Orthis platys Billings, Canadian nat. and geol., 1859, **4**, p. 438, figs. 15a–c. See Bull. 92, U. S. nat. mus., 1915, **1**, p. 444, for further references.

Horizon and Locality: — This species is fairly common in the Athens in the cutting one mile south of Otes, Tenn.

RAFINESQUINA CHAMPLAINENSIS Raymond.

Rafinesquina champlainensis Raymond, Bull. Am. Palaeontology, 1902, **3**, no. 14, p. 303, pl. 18, figs. 5, 6. Ann. Carnegie mus., 1911, **7**, p. 233, figs. 6–9.

Specimens of this species from the Lenoir show the typical convexity and often the full size of species as it occurs in the typical Chazy. A pedicle valve is 41 mm. long and 40 mm. wide at the hinge, which is not quite the greatest width.

Horizon and Locality: — A common fossil in the Lenoir six miles

southeast of Knoxville, east of Concord, and between Bulls Gap and Whitesburg, Tenn.

RAFINESQUINA MINNESOTENSIS (Winchell).

Strophomena minnesotensis Winchell, 9th ann. rept. nat. hist survey of Minnesota, 1881, p. 120. See Bassler, Bull. 92, U. S. nat. mus., 1915, 2, p. 1088, for further references to the literature.

Horizon and Locality: — A single complete individual, of typical size and convexity, was found in the Lenoir 6 miles southeast of Knoxville, Tenn. It was 19 mm. long and 24 mm. wide at the hinge. A smaller specimen was obtained from the Lenoir at Lenoir City, Tenn.

RAFINESQUINA ALTERNATA (Emmons).

Strophomena alternata Emmons, Geology of New York, rept. 2nd district, 1842, p. 395, fig. 3. See Bull. 92, U. S. nat. mus., 1915, p. 1084, for further references to literature.

Small specimens, which have the low curvature, proportions and striae of this species were collected from the Lenoir four miles east of Concord, Tenn., six miles southeast of Knoxville, and east of Bluff City, Tenn.

RAFINESQUINA PULCHELLA, sp. nov.

Plate 2, fig. 10.

Shell very small, nearly as long as wide, widest at the hinge, but slightly constricted in front of it, so as to appear somewhat auriculate. Pedicle valve gently convex, highest at the beak, the umbonal region crossed by a narrow fold which gradually dies out at about the mid-length. The surface is covered by very delicate equal striae which increase by implantation. There are about 9 in a space of 2 mm. at the front.

One individual is 7.5 mm. long and 8.0 mm. wide at the hinge. The index varies on the specimens measured from 80 to 94.

This species may possibly be founded on the young of some larger form, but the occurrence of a considerable number of specimens all of the same size suggests that it is really a dwarf. It differs from the young of *Rafinesquina alternata* in having all the striae of the same size, and is much less convex than small specimens of *R. minnesotensis*.

Horizon and Locality: — A rather common fossil in the Lenoir near the L. and N. station at Athens, Tenn. Holotype no. 8624, paratype no. 8625, M. C. Z.

PLECTAMBONITES AMPLUS, sp. nov.

Plate 2, fig. 9; Plate 3, fig. 12.

Shell very large, deeply concavo-convex, with produced cardinal angles. The surface is crossed by alternating radial striae, each pair of the prominent ones having only three or four fainter ones between them. The median striation on the brachial valve is notably larger than the others.

The best specimen is about 18 mm. long and 35 mm. wide, the index being about 50.

This species is of about the same size and convexity as *Plectambonites crassus* Willard, from which it differs chiefly in that the prominent striae are not double.

Horizon and Locality: — A rare species in the Lenoir, six miles southeast of Knoxville, Tenn. The holotype is no. 8617, M. C. Z.

PLECTAMBONITES DELICATULUS Butts.

Plate 3, fig. 11.

Plectambonites delicatula Butts, Geol. surv. Ala., special rept., 14, 1926, p. 116, pl. 26, figs. 20, 21.

Shell of medium size, deeply concavo-convex, cardinal extremities acutely auriculate. A section along the median line would show the pedicle valve to be nearly semi-circular in profile. The surface is marked by rather distant prominent striae, which increase by implantation, and between each pair there are 6 or 7 low and faint striae, in the furrows between which are lines of small elongate depressions.

The brachial valve has a shallow median sinus on the umbonal region.

The plesiotype is 10 mm. long and 17 mm. wide at the hinge. There are 7 or 8 prominent striae in the space of 5 mm. at the front. The index is about 60.

This species differs from most of the other Ordovician *Plectambonites* of its size in its greater convexity. It is most closely allied to *P. pisum* Ruedemann (N. Y. State mus. bull., 49, 1901, p. 19, pl. 1, figs. 8-20) but differs in being larger and proportionally shorter, that species having an index of 80.

Horizon and Locality: — A rather rare fossil in the Lenoir 6 miles southeast of Knoxville, Tenn. Plesiotype no. 8612, M. C. Z. The original specimens were from the Little Oak limestone near Pelham, Ala.

CHRISTIANIA LAMELLOSA Butts.

Plate 3, figs. 18, 19.

Christiania lamellosa Butts, Geol. surv. Ala., special rept. 14, 1926, p. 116, pl. 26, figs. 31-34.

Shell small, subhemispherical, wider than long, the greatest width near the front being considerably more than that at the hinge. The pedicle valve is unsymmetrical in profile, the highest point behind the middle, and the umbo almost vertical. The brachial valve is more evenly concave. Surface covered with somewhat irregularly arranged concentric lines, but apparently without radial ornamentation.

One specimen is 8.5 mm. long, 13 mm. in greatest width, and 8 mm. wide at the hinge. The index is therefore about 66.

This species is most closely allied to *Christiania subquadrata* Hall, which is now believed to have been obtained from the Ottosee of Blount Co., Tenn. (See Bassler, Bull. 92, U. S. Nat. Mus., 1915, 1, p. 221). It agrees with that form in the presence of concentric and absence of radial striae, but differs in being wider than long. *Christiania trentonensis* Ruedemann is not only proportionately longer than *C. lamellosa*, but also has radial striae.

Horizon and Locality: — A rare fossil in the Lenoir near the L. & N. station at Athens, Tenn., and 6 miles southeast of Knoxville, Tenn. Plesiotype is no. 8618 in the M. C. Z.

OXOPLECIA HOLSTONENSIS Willard.

Horizon and Locality: — A single brachial valve was collected in material brought from the cutting through the Athens one mile south of Otes, Tenn.

It is 10 mm. long, 13.5 mm. broad, has 5 plications on the fold, and 10 on either side. All are crossed by closely spaced concentric lamellae of growth.

CAMARELLA LONGIROSTRA Billings.

Camerella longirostra Billings, Can. nat. and geol., 1859, 4, p. 302, 445, fig. 23.

See Bull. 92, U. S. nat. mus., 1915, 1, p. 172, for further references.

Specimens which can be referred to this species are very common in the Lenoir at Bluff City, Tenn. The pedicle valve is proportionately wider than that of individuals from the typical Chazy, but this does not seem a justifiable basis for erection of a new species.

A large brachial valve is 7.5 mm. long and 8.25 mm. wide. A pedicle

valve is 7 mm. long and 6 mm. wide, the index being 116 as compared with an index of 133 to 140 for shells from Valcour Island, N. Y., and an index of 131 to 150 for specimens from the Mingan Islands measured or figured by Billings. There is in fact a wide difference in proportions between Billings' figured type and the specimens found in Tennessee.

CAMARELLA PANDERI Billings.

Camarella panderi Billings, Can. nat. and geol., 1859, 4, p. 302; Geol. of Canada, 1863, p. 143, figs. 78a, b. Hall and Clarke, Pal. N. Y., 1895, 8, pt. 2, p. 220, pl. 62, figs. 19-23. Raymond, Ann. Carnegie mus., 1911, 7, pl. 36, figs. 31, 32.

Horizon and Locality: — A specimen 3.5 mm. long and 3 mm. wide was collected from the Lenoir at Lenoir City, Tenn.

CAMARELLA VARIANS Billings.

Camarella varians Billings, Can. nat. and geol., 1859, 4, p. 445, fig. 24; Geol. Canada, 1863, p. 127, figs. 52a-d; Pal. foss. Canada, 1865, 1, p. 220. Raymond, Ann. Carnegie mus., 1911, 7, p. 250, pl. 36, figs. 19-27, 33-36.

This variable shell was obtained from the Lenoir east of Bluff City, Tenn. One pedicle valve, 9 mm. long, has two plications in the sinus. Another, 8 mm. in length, has only one, and that a short and inconspicuous ridge.

Order TELOTREMATA Beecher.

CAMAROTOECHIA PRISTINA Raymond.

Camarotoechia pristina Raymond, Am. Jour. Sci., 1905, ser. 4, 20, p. 368; Ann. Carnegie mus., 1911, 7, p. 225, pl. 34, figs. 1-10.

This species is recognized by the fact that the median pair of plications on the fold of the dorsal valve are introduced later in life than the outer pair, and hence are usually smaller.

Horizon and Locality: — A single brachial valve, 6 mm. long and 8 mm. broad, was found in the Lenoir at Lenoir City, Tenn. The species is found in the upper part of the Lower Chazy and the lower part of the Upper Chazy in New York.

ZYGOSPIRA ACUTIROSTRA (Hall).

Atrypa acutirostra Hall, Pal. N. Y., 1847, 1, p. 21, pl. 4, bis., fig. 6. See Bull. 92, U. S. nat. mus., 1915, 2, p. 1340, for further references.

Numerous specimens of this small shell were found in the Lenoir one mile east of Bluff City, Tenn. A characteristic individual from that

locality is 3 mm. long, 2.5 mm. in width and has 10 plications. The specimens differ from those found in the typical Chazy chiefly in that the median plication on the pedicle valve is not conspicuously larger than the others.

THE RELATIONSHIPS OF THE BRACHIOPODS OF THE LENOIR, HOLSTON, ATHENS, AND OTTOSEE FORMATIONS.

THE LENOIR.

Twenty-one species of brachiopods have been reported above from the Lenoir, the oldest of the formations under discussion. The fossils have been derived from three somewhat widely separated localities, under the names of which they will be listed.

VICINITY OF KNOXVILLE.

Under this heading are included the species collected southeast of Knoxville, east of Concord, and at Lenoir City, Tenn. This is the typical region for the Lenoir.

Plectorthis exfoliata Raymond, *Valcourea strophomenoides* Raymond, *Rafinesquina champlainensis* Raymond, *R. minnesotensis* (Winchell), *R. alternata* (Emmons), *Plectambonites amplius* Raymond, *P. delicatulus* Butts, *Camarella panderi* Billings, and *Camarotoechia pristina* Raymond.

BLUFF CITY, TENN.

This locality is about one hundred miles northeast of Knoxville, not far from Bristol.

Plectorthis exfoliata Raymond, *Valcourea ventro-carinata* (Butts), *Rafinesquina alternata* (Emmons), *Camarella longirostra* Billings, *C. varians* Billings, and *Zygospira acutirostra* (Hall).

CATAWBA VALLEY, NORTH OF SALEM, VA.

This locality is about 330 miles northeast of Knoxville.

Hebertella vulgaris Raymond, *Plaesiomys platys* (Billings), *Dinorthis pectinella* (Emmons), *Plectambonites negritus* Willard, and *Clitambonites holstoni* (Hall and Clarke).

Three species, not found at any of the above localities, are:

Orthis disparilis Conrad, *Rafinesquina pulchella* Raymond, and *Christiania lamellosa* Butts. The last two have not been found associated with other species typical of the Lenoir.

COMPARISON OF THE LENOIR WITH THE CHAZY.

It will be at once noted that the brachiopods of the Lenoir have a strongly Chazyan aspect. *Plectorthis exfoliata*, *Hebertella vulgaris*, *Plaesiomys platys*, *Valcourea strophomenoides*, *Rafinesquina champlainensis*, *Camarella longirostra*, *C. varians*, *Camarotoechia pristina* and *Zygospira acutirostra*, 9 of the 21 species, were originally described from the Chazy. *Orthis disparilis*, *Valcourea ventro-carinata*, and *Clitambonites holstoni* have near allies in the Chazy, and *Rafinesquina alternata* occurs in that formation.

These species have such long vertical ranges in the typical Chazy, however, that they do not afford evidence for exact correlation. The presence of *Rafinesquina champlainensis*, *Plaesiomys platys*, and *Camarella varians* would in the typical region of the Chazy, generally indicate Middle Chazy, and the impression of the writer at the present time is that the Lenoir is neither youngest nor oldest Chazy. The only element of the fauna which is not Chazyan is seen in the presence of *Plectambonites* and *Christiania*. Neither of these genera has been found in the Chazy, and their absence has been a striking characteristic of that fauna. Their presence in the Southern Appalachians indicates that we have here a mixture of two faunal elements, but both European in origin.

THE HOLSTON.

The Holston has a rather surprisingly large fauna of brachiopods, many of which, however, are at present known only from a single small quarry at Sharon Springs, Bland Co., Va. The fauna will be listed under three headings.

VICINITY OF KNOXVILLE, TENN.

This includes Fountain City, South Knoxville, and Concord.

Palaeoglossa belli (Billings), *Plaesiomys platys* (Billings), *Pionodema minuscula* Willard, *Plectambonites negritus* Willard, *Leptaena palustris* Willard, *Rafinesquina duplicistriata* Willard, *Ptychoglyptus virginienensis* Willard, and *Camarella panderi* Billings.

BLAND COUNTY, VA.

This includes the Hoge farm, near Bland, as well as the McNutt quarry at Sharon Springs, and is about 185 miles northeast of Knoxville.

Lingula lyelli Billings, *Schizambon cuneatus* Willard, *Conotreta declivis* Willard, *Acrosaccus shuleri* Willard, *A. panneus* Willard, *Petrocrania prona* Raymond, *Hebertella melonica* Willard, *H. vulgaris* Raymond, *Dinorthis pectinella* (Emmons), *Nicolella agilera* Willard, *Plectambonites crassus* Willard, *Rafinesquina minnesotensis* (Winchell), *R. champlainensis* Raymond, *R. distans* Raymond, *R. grandistriata* Willard, *Ptychoglyptus virginienensis* Willard, *Oxoplecta holstonensis* Willard, *Clitambonites porcia* (Billings), *Camarella panderi* Billings, and *Parastrophia rotundiformis* Willard.

VARIOUS LOCALITIES.

The following species have been found at various localities in southwestern Virginia, from Blacksburg on the east to Speers Ferry on the west.

Lingula narrawayi Wilson, *Plectorthis holdeni* Willard, *Dinorthis atavoides* Willard, *Plectambonites equestriatus* Willard, *P. pisum* Ruedemann, *P. triseptatus* Willard, *Leptaena prona* Willard, *Strophomena tenuitesta* Willard, *Clitambonites holstoni* (Hall and Clarke), and *Camarotoechia quadriplicata* Willard.

COMPARISON OF THE BRACHIOPODS OF THE HOLSTON WITH THOSE OF THE CHAZY.

The Holston contains some Chazyan species, although they do not dominate the fauna, as in the case of the Lenoir. They are: *Palaeoglossa belli* (Billings), *Lingula lyelli* Billings, *Petrocrania prona* Raymond, *Hebertella vulgaris* Raymond, *Plaesiomys platys* (Billings),

Rafinesquina champlainensis Raymond, *R. distans* Raymond, and *Clitambonites porcia* (Billings). Two more species, *Schizambon cuneatus* Willard and *Clitambonites holstoni* are very similar to Chazyan brachiopods. The Chazyan element in the Holston amounts to about 25% as contrasted with about 50% in the case of the Lenoir. The element unknown to the Chazy is large and contains *Conotreta*, *Acrosaccus*, *Nicolella*, *Pionodema*, *Plectambonites*, *Ptychoglyptus*, *Oxoplectia* and *Parastrophia*. *Acrosaccus*, *Nicolella* and *Ptychoglyptus* are unknown elsewhere in America, but *Conotreta*, *Oxoplectia* and *Parastrophia* are known from post-Chazyan formations.

THE OTTOSEE.

The greater part of the brachiopods collected from the Ottosee were obtained at two localities, neither of which is in the typical region about Knoxville, Tenn. It is known that this formation is very prolific in brachiopods at other localities which I have not visited, and the species described by Dr. Willard probably represent only a small part of the fauna.

LUTTRELL, TENN. ABOUT 20 MILES NORTH OF KNOXVILLE.

Schizambon cuneatus Willard, *Petrocrania prona* Raymond, *P. cicatricula* Willard, *Orthis disparilis* Conrad, *Plectorthis exfoliata* Raymond, *Hebertella melonica* Willard, *H. vulgaris* Raymond, *Glyptorthis bellarugosa* (Conrad), *Plaesiomys platys* (Billings), *Dinorthis pectinella* (Emmons), *D. quadriplicata* Willard, *D. transversa* Willard, *Pionodema globosa* Willard, *Plectambonites curdsvillenses* Foerste, *Rafinesquina minnesotensis* (Winchell), *R. duplicistriata* Willard, *Clitambonites porcia* (Billings), and *Camarotoechia quadriplicata* Willard.

FUGATES HILL, 7 MILES NORTH OF MENDOTA, VA., AND 85 MILES
NORTHEAST OF LUTTRELL.

Orthis disparilis Conrad, *Plectorthis exfoliata* Raymond, *Hebertella melonica* Willard, *Plaesiomys platys* (Billings), *P. brevis* Willard, *Dinorthis interstriata* Willard, *D. quadriplicata* Willard, *D. transversa* Willard, *Pionodema subaequata* (Conrad), *P. globosa* Willard, *Plectambonites curdsvillensis* Foerste, *P. aequistriatus* Willard, *Rafinesquina minnesotensis* (Winchell), *R. champlainensis* Raymond, *R. duplicistriata* Willard, *Strophomena filitexta* (Hall), *S. tennesseensis* Willard, *S. inspeciosa* Willard, and *Oxoplectia holstonensis* Willard.

LIBERTY HILL, TENN.

This locality is only 15 miles north of Luttrell, but it is the most western (geologically not geographically) outcrop of the Ottosee at which the fauna can be definitely recognized.

Glyptorthis bellarugosa (Conrad), *Dalmanella rogata* (Sardeson), *Plaesiomys platys* (Billings), *P. elongata* Willard, *Pionodema globosa* Willard, *Plectambonites aequistriatus* Willard, *Rafinesquina minnesotensis* (Winchell), *Strophomena filitexta* (Hall), *S. tennesseensis* Willard, *S. inspeciosa* Willard, and *Camarella volborthi* Billings.

VARIOUS LOCALITIES.

In addition to the species listed above, Bassler finds that the type of *Christiania subquadrata* Hall was obtained from the Ottosee of Blount Co., Tenn., and I found a single valve of *Christiania* at the same horizon on the Hoge Farm, Bland Co., Va.

CHAZYAN ELEMENT IN THE OTTOSEE.

Petrocrania prona Raymond, *Plectorthis exfoliata* Raymond, *Hebertella vulgaris* Raymond, *Plaesiomys platys* (Billings), *Rafinesquina champlainensis* Raymond, and *Clitambonites porcia* (Billings) are species described originally from the Chazy, *Glyptorthis bellarugosa* (Conrad) is found in the Chazy on Valcour Island, N. Y., *Camarotoechia quadriplicata* is hardly distinguishable from one of variants of *C. plena* (Hall), and *Schizambon cuneatus* Willard is very like *S. duplicimuratus* Hudson. Thus nine of the thirty-one species, or 29% are distinctly Chazyan. The non-Chazyan element is represented by *Dalmanella*, *Dinorthis*, *Pionodema*, *Plectambonites*, *Christiania*, and *Oxoplectia*.

THE ATHENS.

Brachiopods are very seldom found in the Athens, and the five species so far found are all from one locality south of Otes, Tenn. One only, *Lingula nympha* Billings, is of any particular interest. This large and striking *Lingula* has previously been known only from the Normanskill of Newfoundland. *Hebertella bursa* Raymond is the only unique species, *Plaesiomys platys* (Billings) occurs in the Chazy, *Orthis disparilis* (Conrad) is similar to the Chazyan *O. ignicula* Raymond, and *Oxoplectia holstonensis* survived from the Holston and Ottosee.

THE VERTICAL RANGE OF THE SPECIES.

The faunas of the Lenoir, Holston, Ottosee and Athens are rather strongly individualized, but there are some species which seem to connect them. Only one, *Plaesiomys platys*, is found in all four, but *Rafinesquina minnesotensis*, *R. champlainensis*, *Hebertella vulgaris* and *Dinorthis pectinella* are found in all but the Athens. *Clitambonites holstoni* is found in both the Lenoir and the Holston, *Plectorthis exfoliata* connects the Lenoir and Ottosee, and *Orthis disparilis* is in the Lenoir, Ottosee, and Athens. Altogether, 8 of the 21 species of the Lenoir pass on into one or more younger formations.

Thirty-six species are recorded by Willard from the Holston; 6 of these are survivors from the Lenoir, and 12 continue into the Ottosee. The Holston and Ottosee faunas are therefore closely allied.

Willard found 31 species in the Ottosee, 7 of which survived from the Lenoir and 12 from the Holston. Still, there are 16 species, or more than half the fauna, not shared with the other formations in this region.

Two of the 5 brachiopods so far found in the Athens survived from the Lenoir, one is a familiar Chazyan type of *Hebertella*, and one is a *Lingula* which probably drifted in with the pelagic trilobites. The discovery of a *Ptychoglyptus* in the Athens of Alabama is of interest as suggesting a connection of the Athens and Holston.

THE BRACHIOPODS OF THE STONES RIVER IN
CENTRAL TENNESSEE.

The brachiopods of eastern Tennessee and Virginia should be compared with those of the Stones River group in central Tennessee. This group includes the following members, in descending order, viz: Lebanon limestone, Ridley limestone, Pierce limestone, and Murfreesboro limestone.

LEBANON LIMESTONE.

The following species, except for the two marked with an asterisk, whose names are taken from a list by Dr. Ulrich, were collected by the writer at Lebanon, Tennessee.

Petrocrania sp. ind., *Leptobolus* sp. ind., **Orthis tricenaria* Conrad, *Pionodema minuscula* Willard, *Plaesiomys deflecta* (Conrad), *Glyptorthis bellarugosa* (Conrad), *Rafinesquina minnesotensis* (Winchell), **Plectambonites* sp. ind., *Strophomena filitexta* (Hall), *Scenidium*

anthonense Sardeson, *Rhynchotrema minnesotense* (Sardeson), and *Zygospira saffordi* (Winchell and Schuchert).

RIDLEY.

The following species were collected by the writer on Stones River near Murfreesboro, Tennessee.

Orthis disparilis Conrad, *Glyptorthis bellarugosa* (Conrad), *Rafinesquina minnesotensis* (Winchell), *R. alternata* (Emmons), *Camarella volborthi* Billings, and *Protorhyncha ridleyana* (Safford).

PIERCE.

The following brachiopods are listed from the Pierce in Folio 95, U. S. G. S., 1903, by Ulrich.

Pionodema subaequata (Conrad), *P. stonensis* (Safford), *Strophomena filitexta* (Hall) and *Protorhyncha ridleyana* (Safford).

MURFREESBORO.

The following species were collected by the writer from cherts in the Murfreesboro near Stones River about a mile west of Murfreesboro, Tenn.

Rafinesquina cf. *distans* Raymond, *R. sp. ind.*, and *Zygospira saffordi* (Winchell and Schuchert).

COMPARISON OF EASTERN FAUNAS WITH THOSE OF THE STONES RIVER.

The Murfreesboro evidently contains very few brachiopods, in fact, no previous investigator has reported any. The small fauna is of no value in correlation, although one of the *Rafinesquinas* suggests *R. distans*, which occurs in the Holston, and *Zygospira saffordi* is not very different from the *Zygospira acutirostra* of the Lenoir.

The fauna of the Ridley may be rather definitely connected with the Ottosee. All of the species known from the Ridley except *Protorhyncha ridleyana* have been found in the Ottosee, but the most striking bond between the two formations is the presence of *Camarella volborthi* at Liberty Hill, and of *Glyptorthis bellarugosa* at Liberty Hill and Luttrell in the Ottosee. These species do not occur in the other eastern formations and are particularly abundant and characteristic in the Ridley. The occurrence of an *Oxoplectra* closely allied to *O. holstonensis* in the Ridley of Alabama is also significant.

The fauna of the Pierce is of interest chiefly as the first appearance of *Pionodema subaequata* and *Strophomena filitexta* in central Tennessee. These species appear first in the Ottosee in eastern Tennessee.

The fauna of the Lebanon is also more closely allied to that of the Ottosee than to any of the other eastern formations. From other evidence, however, it appears that it is really somewhat younger than the Ottosee and the likeness was acquired through descent. Particular interest attaches to the fact that *Plectambonites* appears in this section first in the Lebanon, and is not common there. In fact the entire Stones River series of brachiopods appears to have been derived from the eastern basin, with the possible exception of *Protorhyncha*, but it in its turn made no contribution to the eastern fauna.

THE BRACHIOPODS OF THE GIRVAN DISTRICT, SCOTLAND.

The Llandeilo is represented in the Girvan district, Ayrshire, by the Stinchar and Balclatchie formations, the former being the older. According to Reed, who has monographed the faunas (Trans. Royal Soc. of Edinburgh, 51, 1917, pt. 4, pp. 795-998, pl. 1-24), sixty named species and varieties of brachiopods are known from the Stinchar limestone, twenty of which pass into the Balclatchie, and there are seventy species in the latter. Reed commented on the fact that these faunas were more nearly like those of the American Middle Ordovician than like those of the Llandeilo of other parts of Great Britain, but did not make comparisons with particular faunas.

Although there are no species common to Virginia, Tennessee, and Scotland, nearly all the genera occur in both regions, and at least two, *Nicolella* and *Ptychoglyptus* are, so far as is known at present, restricted to the Girvan District and the southern Appalachians. Other significant genera, not of wide distribution either in Europe or North America, are: *Conotreta*, *Schizambon*, *Christiania*, *Camarella* and *Oxoplectia*. *Dalmanella*, *Christiania*, *Plectambonites*, *Camarella*, *Parastrophia*, and *Oxoplectia*, with perhaps other genera, were probably introduced from Europe in Chazy times, very likely *via* Newfoundland.

The following table will show, in parallel columns, which of the American species have close allies in the Girvan district. L, H, O, or A after a species in the American list signifies that it is found in the Lenoir, Holston, Ottosee or Athens. In the Scottish list, S signifies Stinchar and B the Balclatchie.

*Virginia — Tennessee.**Girvan District.*

<i>Palaeoglossa belli.</i> H.	<i>Palaeoglossa amabilis.</i> B.
<i>Lingula lyelli.</i> H.	<i>Lingula angustior.</i> B.
<i>L. nympa.</i> A.	<i>Lingulasma? ardmillanensis.</i> B.
<i>Schizambon cuneatus.</i> H. O.	<i>Schizambon scoticus.</i> S.
<i>Conotreta declivis.</i> H.	<i>Conotreta conoidea.</i> S. B.
<i>Petrocrania prona.</i> H. O.	<i>Philhedra playfairi.</i> B.
<i>Orthis disparilis.</i> L. O. A.	<i>Orthis craigensis.</i> S.
<i>Plectorthis exfoliata.</i> L. O.	<i>Plectorthis duftonensis.</i> B.
<i>P. holdeni.</i> H.	<i>P. subplicatella.</i> B.
<i>Hebertella vulgaris.</i> L. H. O.	<i>Hebertella scotica.</i> S. B.
<i>H. melonica.</i> H. O.	<i>H. bellatrix.</i> B.
<i>H. bursa.</i> A.	<i>H. rankini.</i> B.
<i>Glyptorthis bellarugosa.</i> O.	<i>Glyptorthis balclatchiensis.</i> S. B.
<i>Dalmanella rogata.</i> O.	<i>Dalmanella gracilis.</i> S. B.
<i>Pionodema globosa.</i> O.	<i>Pionodema girvanensis.</i> S. B.
<i>Dinorthis transversa.</i> O.	<i>Dinorthis carrickensis.</i> S. B.
<i>Nicolella agilera.</i> H.	<i>Nicolella actoniae.</i> S. B.
<i>Rafinesquina minnesotensis.</i> H. O.	<i>Rafinesquina semiglobosina.</i> S. B.
<i>R. alternata.</i> L.	<i>R. concentrica.</i> B.
<i>Plectambonites delicatulus.</i> L.	<i>Plectambonites llandeiloensis.</i> B.
<i>P. crassus.</i> H.	<i>P. conspicua.</i> B.
<i>Ptychoglyptus virginienensis.</i> H.	<i>Ptychoglyptus subarachnoidea.</i> B.
<i>Christiania umbonata.</i> L. O?	<i>Christiania youngiana.</i> S. B.
<i>Strophomena filitexta.</i> O.	<i>Strophomena deficiens.</i> S. B.
<i>Oxoplectia holstonensis.</i> H. O. A.	<i>Oxoplectia andersoni.</i> S. B.
<i>Camarella longirostra.</i> L.	<i>Camarella balclatchiensis.</i> S. B.
<i>C. varians.</i> L.	<i>C. thompsoni.</i> S.
<i>C. volborthi.</i> O.	<i>C. peachi.</i> S.
<i>Parastrophia rotundiformis.</i> H.	<i>Parastrophia youngi.</i> S. B.
<i>Camarotoechia quadriplicata.</i> H. O.	<i>Rhynchotrema lapworthi.</i> S.

Summarizing the above, 7 of the 21 species in the Lenoir are closely allied to species in the Girvan district, 15 of the 36 species in the Holston, 17 of the 31 in the Ottosee, more than half, and 4 of the 5 in the Athens. A curious feature of the resemblances is, that the allied species for each of the American formations are about equally distributed between the Stinchar and the Balclatchie, and it is not possible to correlate the formations except in a general way.

Thus, 3 of the species allied to Lenoir forms are found in both the Stinchar and Balclatchie, and 6 are in the Balclatchie as against 5 in the Stinchar. Five of the species allied to brachiopods of the Holston are found in both Stinchar and Balclatchie, 12 are found in the Balclatchie, and 8 in the Stinchar. This suggests that the Holston is more nearly akin to the Balclatchie, but when the Ottosee brachiopods are compared, we find 12 allied species in the Balclatchie as against 13 in the Stinchar, and yet the Ottosee rests on the Holston. Nine of the allied species are in this case common to the Stinchar and Balclatchie. The Athens contains too few brachiopods to make comparisons of any value, but as I have shown in a previous paper, (Bull. Mus. Comp. Zool., 67, 1925, pp. 1-180) the trilobites of that formation are very much like those of the Balclatchie.



1928. "The Brachiopods of the Lenoir and Athens Formations of Tennessee and Virginia." *Bulletin of the Museum of Comparative Zoology at Harvard College* 68, 293–309.

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