

# THE DALMANELLAS OF THE CHEMUNG FORMATION, AND A CLOSELY RELATED NEW BRACHIOPOD GENUS THIEMELLA.

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The Dalmanellas have for many years been known to be well represented in the Chemung formation of New York State. In the process of drawing a paleontological boundary across Watkins Glen and Catatonk quadrangles at the base of the Chemung formation *Dalmanella* was discovered to be one of the most distinctive genera of the Chemung fauna.<sup>a</sup> Specimens of this genus are among the first brachiopods to show the coming of the new fauna in the sections of central New York. As the collections were elaborated, it was discovered that the representatives of the genus increased in size on ascending the Chemung; that certain characters distinguish the Dalmanellas of western New York from those of central New York, small and large; and that the published definitions of the species fail to note the distinguishing marks by which the evolution of species is indicated. These observations have led to the belief that a redefinition of the Dalmanellas of the Chemung formation will be helpful to students using fossils as a means of discriminating geological horizons.

The Chemung Dalmanellas (particularly the small specimens) closely resemble *Orthis testudinaria* of the Ordovician. There are also several species in the upper Devonian of Great Britain and continental Europe, which present much similarity to the New York forms.

Without here attempting to show the exact place occupied by the Chemung species in either the geological evolution of the race or in its adjustment to world-wide conditions of environment, the present paper will attempt to define the characters which are definitely connected with range and distribution of the species for this limited portion of Devonian time and for the area of New York and neighboring States.

In reporting species in previous papers on Devonian Paleontology the author has made no attempts to revise the definitions of

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<sup>a</sup> The Devonian Section of Ithaca, N. Y. Jour. Geol., XIV, 1906-7, p. 580 and XV, p. 104.

the species cited. They have been taken with their accepted meanings. This method is sufficiently accurate for practical purposes so long as the chief object in view is to identify the faunal aggregates and to define and locate them stratigraphically and geographically.

This general work has already been accomplished for a limited area and for the faunas ranging through a limited portion of the geological time scale. It is now proposed to take a step in advance and to attempt to discriminate the species of a single genus for the field under investigation on the basis of their geologic range and geographic distribution.

In any specific definition it is, of course, important to take note of characters by which the specimens described are distinguished from other representatives of the genus; but to distinguish species alone by the conspicuousness of their characters tends to emphasize the aberrant and rare. The dominant rather than the rare, the common rather than the aberrant characters must be used in discriminating the characteristics of natural species. But in seeking the dominant characteristics of a species the basis upon which the aggregation of the individuals making up the group is founded must also be natural and not artificial. In some cases the specimens selected by authors as types of their specific definitions are fairly good representatives of the natural species to which they belong, but in numerous cases of paleontologic species it is discovered, after the definitions have become established, that the selected types are actually aberrant forms, rare and not characteristic of any natural aggregation of individuals.

Without positively knowing the cause of aggregation it is possible to distinguish natural from artificial aggregates. Examples of natural aggregates of organic individuals are (*a*) the contents of a single stratum at a single outcrop (that is, a faunule); (*b*) the series of successive faunules in a single section through which range the majority of the same species holding approximately the same proportions of abundance in comparison with other species (that is, a fauna considered geologically); and (*c*) the group of faunules spread over a particular geographic area and extending to the limits within which the particular species occupies the same general place of abundance or rarity in the composite fauna (that is, the fauna geographically considered); all these are natural aggregates. On the other hand, the specimens in a museum labelled Hamilton or Trenton or Cretaceous do not necessarily constitute natural aggregates for purposes of specific description. It is also probable that no set of specimens combined on the basis of exhibiting the same characters is necessarily on that account a natural aggregate of individuals.

Prior to determining what particular part environment or heredity may take in determining the characters of organisms record must be made of the relations borne by the characters to a change of conditions of environment and to a breaking of continuity of the sequence of individuals in the stream of life.

To ascertain these relations it is not sufficient to study living organisms alone. From living organisms we may learn of the results of past adjustments to environment, but not of the steps by which those adjustments were attained. The periods of time open to man's observation are too brief for demonstrating the consequences of current changes of environment upon a mass of living organisms. Nor do living organisms furnish the evidence necessary to disentangle the effects of uniformity of environmental conditions from community of descent. In order to distribute the consequences to their specific causes it is necessary to ascertain under what conditions each chief force acts with uniformity upon the individuals under study.

The three chief forces concerned may be called Heredity, Environment, and Evolution, using these terms to express those preexisting conditions which, being uniform for any genetically related group of organisms, may be assumed to produce uniform morphologic effects. Heredity will then connote the forces operating in direct genetic descent, that is, the control exercised by the ancestry upon the characters of offspring. Environment will connote the forces and the control exercised upon organisms of the same ancestry by particular environmental conditions. Evolution will connote the forces and the control exercised upon a race of organisms of like ancestry under the same environment by continuous reproduction for periods of time of geologic significance.

In the present study the morphologic results of such forces acting upon the representatives of a single genus are employed for the purpose of discovering those forces and their modes of operation.

It is assumed as a working hypothesis that differences in form, among the representatives of a single genus aggregated in a single local faunule, may be traced chiefly to hereditary causes; that differences associated with areal distribution may be assigned chiefly to environmental conditions; and that differences associated with geological succession may be assigned chiefly to evolution.

The reason for thus distributing the hypothetical causes of differences is derived from the following considerations:

*First.* In the local faunule environmental conditions may be assumed to have been approximately uniform for all the individuals represented in the faunule, and the stage of evolutionary progress is also the same for all, hence of the three chief causes of modification we are restricted to the operation of the laws of heredity.

*Second.* In the case of geographic distribution, at the same geological horizon, we are restricted to heredity and environmental influences. Modifications of form, therefore, which are expressed only as between faunules of separate localities are accounted for as occasioned primarily by the differing conditions of environment of the separate localities.

*Third.* Finally, in the case of modifications of form observed in the faunules of successive stratigraphic stages of the same locality, the distinguishing differences, so far as they are other than those of the local faunule and other than those of the geographic provinces, are evolutionary.

It would not be safe to conclude that in producing any one of these three classes of modification only one of the assigned forces has been in operation, but only that in each case the one indicated has been chiefly operative.

The Dalmanellas of the Chemung formation of New York State are closely enough related to each other morphologically to make it probable that they are all of common descent. The question of their relationship to Dalmanellas of earlier geologic periods, or to those of other geographic provinces of the Devonian, can be determined with greater precision after the facts of their relations to each other have been thoroughly established. We may also leave for later consideration the question whether the subgroups into which they are divisible do or do not show indication of intersterility. As a whole they constitute for the time and place a well-defined group of organisms which for the present may be regarded as a genus. The subgroups into which the genus is divided will be called species.

#### THE GENERIC CHARACTERS OF DALMANELLA.

The name *Dalmanella* was proposed by Hall and Clark in 1892<sup>a</sup> for a subdivision of the genus *Orthis* Dalman. This group of *Orthis* had been previously called "group of *Orthis testudinaria* Dalman" by Hall in the year 1890.<sup>b</sup>

The characters of *Orthis testudinaria* perpetuated in the Devonian Dalmanellas are as follows:

*First.* The general form varies in outline from subcircular<sup>c</sup> to subquadrate<sup>d</sup> and wide-hinged forms.<sup>e</sup>

*Second.* The pedicle valve has a small but elevated beak from which a blunt carination of the outer surface extends, broadening and flattening toward the front.

*Third.* The brachial valve has a sulcus along the center which broadens toward the front.

<sup>a</sup> Pal. N. Y., VIII, 1892, p. 205.

<sup>b</sup> Bull. Geol. Soc. of Am., I, pp. 19-205.

<sup>c</sup> Pal. N. Y., VIII, 1892, p. 205, pl. VB, fig. 29.

<sup>d</sup> Figs. 27 and 33.

<sup>e</sup> Fig. 32.

*Fourth.* The hinge is shorter than the greatest width of shell.

*Fifth.* The elevated radiating lines ("striae") are about fourteen at the beak and increase to fifty at the front in the smaller species, and to nearly twice that number in larger species. They are more or less fasciculated. In extreme cases several very fine secondary lines are seen lying on the sides of the dominant primary lines of the group.

*Sixth.* In the interior of the pedicle valve there is a more or less quadrate muscular impression, pointed toward the beak and bilobed anteriorly.

*Seventh.* The hinge teeth are prominent and continue into a ridge about the muscular scar (much as in *Schizophoria*.)

*Eighth.* In the brachial valve the cardinal process is either simple or subdivided in larger shells by three, four, or more longitudinal furrows.

*Ninth.* The crura are proportionately well developed, and show serrations on their bases facing the cardinal margin.

*Tenth.* In size, specimens of this genus vary from less than 10 to over 30 mm. in length, and reach a width in some species of 45 to 50 mm.

*Comments.*—The exterior of the pedicle valve of the Dalmanellas is distinguished from the corresponding valves of *Schizophoria* by the carination of the median line of the shell proceeding from a point between the place of the muscular scars to the front. *Schizophoria* has a broad sulcus from half way down which becomes stronger and wider at the front.

In the interior of the shell of *Schizophoria* the muscular scars are divided by a strong median septum, which is evident at the posterior end of the scars and becomes stronger toward their front ends. It continues forward in a slight septum which in extreme cases nearly reaches the front margin of the shell. A similar septum divides the muscular scars in *Dalmanella carinata*, but it is shallow at the posterior end of the scars, widens and becomes stronger anteriorly, and at near the front extremity of the muscular scars it suddenly divides into two ridges and becomes lost or inconspicuous around the front margin of the scars. Between the prongs of this V-shaped anterior termination of the median septum the upfolding of the shell begins which constitutes the carination along the middle of the exterior of the shell, characteristic of all the larger forms of upper Devonian Dalmanellas. In the smaller forms the carination is present, but the Y-shaped median septum is not strongly developed.

This character is expressed on Plate VIII, fig. 30, of the original illustrations of *Orthis carinata*.<sup>a</sup> Fig. 16 of the same plate is drawn to represent a narrow depressed line of the same kind in a specimen that would otherwise represent a *Schizophoria*. Typical expressions

<sup>a</sup> Pal. N. Y., IV.

of the Chemung *Schizophoria* are represented in figs. 19, 17, and 18 of the same plate, in which a slight septum extends forward. Fig. 29 is drawn to express a depression along the center of the pedicle valve of a *Dalmanella tioga*. I have not seen such a form, and it is possible that the drawing at this point is erroneous. In all specimens hitherto examined by the writer, the V-shaped anterior termination of the median septum separating the muscular scars marks the Dalmanellas, and does not occur on specimens of *Schizophoria*. In some specimens of *Schizophoria* there are seen two grooves continuing anteriorly, the inner edges of the muscular scars lying so close together as to form a thin median ridge,<sup>a</sup> but in these cases the ridge is continuous with the median septum and does not divide into the V-shaped septum. The interpretation is that in such cases the double grooves are vascular markings which would not be likely to affect the exterior of the shell. The V-shaped forking of the median septum at the front end of the muscular scars in the pedicle valves is considered as a generic character separating the Devonian Dalmanellas from *Schizophoria* with which they are often associated. This character can be detected in some specimens in which the external carination is so slight as to be unrecognizable.

A full statement of the authors' interpretation of the characters of *Dalmanella* is given by Hall and Clarke<sup>b</sup> in the work above cited, in which is given the following list of species representative of the genus there established (p. 207):

*Orthis subaquata* Conrad.—Chazy fauna.

*Orthis testudinaria*, *O. emacerata*, *O. meeki*, *O. multisepta*, etc.—Trenton and Hudson faunas.

*Orthis elegantula*.—Niagara.

*Orthis perlegans*, *O. concinna*, *O. plano-conveva*, *O. subcarinata*.—Lower Helderberg.

*Orthis lenticularis* Vanuxem, not Wahlenberg.—Corniferous.

*Orthis lepida* Hall [not Schmur, II. S. W.].—Hamilton.

*Orthis superstes*, new species.—Chemung.

To this list the authors add (p. 324) *Orthis quadrans* Hall from the lower Helderberg, and *Orthis infera* Calvin and *O. leonensis* Hall from the Chemung.

Schuchert<sup>c</sup> adds to the list:

*Orthis nettoana* Rathbun.—Middle Devonian.

In 1905, H. S. Williams<sup>d</sup> called attention to the fact that the species *Orthis carinata* and *O. tioga* of Hall, referred to the group *Schizophoria* by Hall and Clarke,<sup>e</sup> properly belong to the group *Dalmanella*.

<sup>a</sup> As in the Plate XI, fig. 14, of Generic Illustrations of Brachiopods. Eleventh Ann. Rept. of the State Geologist for the year 1891. Albany, 1892.

<sup>b</sup> Pal. N. Y., VIII, Pt. 1, 1892, pp. 205-207.

<sup>c</sup> Synopsis of Am. fossil Brachiopods, U. S. Geol. Surv. Bull. No. 87, 1897.

<sup>d</sup> U. S. Geological Survey, Bull. No. 241, 1905, p. 36.

<sup>e</sup> Pal. N. Y., VIII, 1892, p. 226.

Of the species cited above, the one reported from the Hamilton under the name *Orthis lepida* Hall is either identical with *Orthis lepida* Schmur,<sup>a</sup> which it closely resembles, or else should receive a new name, as it was not described till 1860,<sup>b</sup> after the application of the name had been made by Schmur. As it is reported from the shores of Canandaigua Lake, it may be appropriately called *Dalmanella canandaiguana*.

#### AMERICAN SPECIES OF DALMANELLA.

There are at present known the following species of the group *Dalmanella*, occurring in the rocks of the Devonian of North America as high as the Hamilton formation: *Dalmanella (lepida)* Hall, 1860, not Schmur, 1853.) *canandaiguana* H. S. Williams, 1907, Hamilton formation.

*D. infera* Calvin, 1878, Chemung formation.

*D. leonensis* Hall, 1867, Chemung formation.

*D. superstes* Hall and Clarke, 1892, Chemung formation.

*D. carinata* Hall, 1843, Chemung formation.

*D. tioga* Hall, 1843, Chemung formation.

#### BRITISH AND EUROPEAN CONTINENTAL SPECIES.

The *Dalmanellas* were early recognized in the European Devonian by Sowerby, Phillips, C. Roemer, Verneuil, Schmur, and others, and have been described under various specific names.

Sowerby in 1840 described *Orthis interlineata*.<sup>c</sup> Hall's original of *Orthis tioga*<sup>d</sup> was first identified with Sowerby's species, *Orthis interlineata*, but as was afterwards discovered Sowerby's description is not fully applicable to the New York form and the new name *O. tioga* was applied to it.<sup>e</sup> In 1841 Phillips revised Sowerby's species, restricting the name *O. interlineata* to such forms as were moderately wide (*a*), and assigned a new name, *Orthis arcuata*, to similar broadly elliptical forms from the middle Devonian (*b*), and erected still another species, *Orthis parallela* (*c*), for orbicular forms in which the greatest width is near the front. (See *Thiemella ville-novia* on p. 60.)<sup>f</sup>

<sup>a</sup> Paleontographica, XXX, 1853, p. 218.

<sup>b</sup> N. Y. State Cab. Nat. Hist. 13th Rept., 1860, p. 78.

<sup>c</sup> Geol. Trans. London, 2d ser., V, 1840, pl. LIV, fig. 14, and explanation of plate.

<sup>d</sup> Geol. N. Y., 4th Dist., 1843, p. 268, figs. 3 and 4 on p. 267.

<sup>e</sup> Pal. N. Y., IV, 1867, p. 59, pl. VIII, figs. 20-29.

<sup>f</sup> Phillips's Pal. Foss. Cornwall and Devon, 1841, (*a*) p. 63, pl. xxvi, figs. 106 *a*, *b*, *c*, *d*, *e*, *f*, *g*, *h*; (*b*) p. 64, pl. xxvi, figs. 107, *a*, *b*, *c*; (*c*) p. 64, pl. xxvi, figs. 109 *a*, *b*, *c*, *d*.

Hall, in 1843, recognized Sowerby's species (*Orthis interlineata*) in the New York Devonian, but later, as previously stated, assigned the name *Orthis tioga* to that form.<sup>a</sup>

Davidson, in 1864-69<sup>b</sup>, again revised the British Devonian Dalmanellas and placed Phillips's species *O. parallela* under *O. interlineata* as a synonym. He also recognized Phillips's species *O. arcuata* as the name for the middle Devonian forms; and the upper Devonian forms were included under the name *O. interlineata*.

C. F. Roemer (1844)<sup>c</sup> included the German Devonian Dalmanellas under the specific names *Orthis testudinaria* and *Orthis testudinaria* var. *ventro-plana*.

These forms were later revised by Verneuil and Schnur.

In the year 1845 Verneuil<sup>d</sup> described the species *Orthis opercularis*, which closely resembles Hall's species *Orthis tioga*. Verneuil calls attention also to its close resemblance to *Orthis testudinaria* Dalman, and expresses the opinion that the species is identical with the form described in 1844 by C. F. Roemer under the name *Orthis testudinaria*, var. *ventro-plana*.<sup>e</sup> The Eifelian form described by Roemer<sup>f</sup> under the name *Orthis testudinaria*, was referred by Verneuil to Sowerby's species *Orthis lunata*.<sup>g</sup>

The specimen figured as the type of *Orthis opercularis* is from the Devonian limestone of the Eifel, and the form provisionally referred to the species from Russia is from the region of the Volkof River.

Schnur, in 1853 described this species,<sup>h</sup> but his figures give it finer surface lines than are represented on Verneuil's figures.

In 1850, Verneuil described the species *Orthis dumontiana*,<sup>i</sup> which also closely resembles a species from the New York Chemung, *Orthis tioga* Hall, 1867. The original specimen of *O. dumontiana* was found in the Devonian limestone of Alejé near Sabero, Spain. In this same paper (1850) Verneuil cites in the list of species coming from the Devonian rocks of the mountains of Léon and Asturia two species, *Orthis gervilli* Verneuil (MS.) and *O. eifeliensis* Verneuil (MS.), without descriptions. Schnur, in the paper above cited, refers to and figures the second of these species,<sup>j</sup> and it is clearly a Dalmanella.

<sup>a</sup> Geol. N. Y., 4th Dist., 1843, p. 268.

<sup>b</sup> Brit. Dev. Brachiopoda, III, 1864-69, p. 91, pl. xvii, figs. 18-23, and p. 93, pl. xvii, figs. 13-17.

<sup>c</sup> Rhein. Uebergangsgeb., p. 76, pl. v, figs. a, b, c, d.

<sup>d</sup> Géologie de la Russie, II, Paléontologie (Edw. de Verneuil), 1845, p. 187, pl. viii, figs. 2 a, b.

<sup>e</sup> Rhein. Uebergangsgeb., p. 76, pl. v, figs. 6 c, d.

<sup>f</sup> Idem, p. 76, pl. v, figs. 6 a, b.

<sup>g</sup> Géologie de la Russie, II, Paléontologie, p. 180.

<sup>h</sup> Zusammenstellung u. Beschreibung sämmtlicher im Uebergangsgebirge der Eifel vorkommenden Brachiopoden. Paleontographica, III, 1853, p. 214.

<sup>i</sup> Soc. Geol. de France, Bull., VII, 2d ser., 1850, p. 181, pl. iv, figs. 7 a, b, c.

<sup>j</sup> Schnur, Paleontographica, III, 1853, p. 213, pl. xxxvii, figs. 6 a, b, c.

*Orthis eifelensis* closely resembles Hall's species *Orthis leonensis* (Hall, 1867). It is common in the Eifelian Devonian.

There are several other species from the European Devonian rocks belonging to this same group of Orthids, though less closely resembling species already described from New York than those cited above. The following may be mentioned:

*Orthis lunata* Sowerby 1839.<sup>a</sup> Ludlow and Old Red also cited by Verneuil.<sup>b</sup>

*Orthis canalicula* Schuur.<sup>c</sup>

*Orthis tetragona* Verneuil.<sup>d</sup>

#### REDEFINITION OF THE NEW YORK SPECIES.

In proposing to redefine the Devonian Dalmanellas of the New York upper Devonian, the great similarity of the European forms to ours is not overlooked. It is strongly probable that the European species are, genetically, very closely related to those of the New York Devonian. But for the purpose of discriminating geological horizons it is important to take notice of those characters by which closely related forms express their adaptation to local conditions of environment. In doing this it has been found necessary to break up some of our well-known specific groups, to give restricted definition to the types, and to apply new names to forms generally included with one of the restricted types but differing from it by the characters here emphasized. To do the same for the European forms would require more exhaustive study of the European material than is practicable at once, and when done it will not materially add to the value of our definitions of local forms for students dealing with them in practical study of our American formations, and it is believed that it can be better done after this analysis is accomplished.

#### SUBDIVISION OF THE GENUS INTO SPECIES.

The Dalmanellas of the upper Devonian of the New York geological province may be divided into the following groups, based upon characters which are associated with either the geographic distribution or the geologic range of the species exhibiting them.

To some of these groups specific names have already been applied. Those names have been adopted in their full sense in case the definitions do not confuse forms having different range or distribution. In case the characters selected for specific definition are so confused the author's name is retained for that part of the species which includes the forms first described by him as types of the species; and

<sup>a</sup> Sil Syst. Murch., p. 611, pl. III, fig. 12*d* and pl. v, fig. 15.

<sup>b</sup> Geologie de la Russie, p. 189, pl. XIII, figs. G *a, b, c, d*, Russia and Eifel.

<sup>c</sup> Paleontographica, III, 1853, p. 213.

<sup>d</sup> Geologie de la Russie, p. 214.

those forms which have a different distributional or range value are removed and redescribed under a separate specific name.

The following-named specific groups are sufficiently well restricted in either their geographic distribution or geologic range to serve a useful purpose in the indication of geological horizon:

*Dalmanella leonensis* Hall, 1867. This species appears in the Chemung formation of Chautauqua and Cattaraugus counties, and extends as far eastward as the Genesee Valley. It ranges from the earliest appearance of the typical Chemung fauna upward, but the limit of its upward range is not known to the writer.

*Dalmanella danbyi*, new species, appears in the Danby *Dalmanella* zone at the base of the Chemung formation in Schuyler, Tompkins, Chemung, and Tioga counties of central New York. It is restricted in range to the lowest 150 feet of the Cayuta member of the Chemung, that is, the *Dalmanella danbyi* zone.

*Dalmanella superstes* Hall and Clarke, 1892, associated with *D. danbyi*, is found in the *Dalmanella danbyi* zone at the base of the Chemung in Steuben, Chemung, and Tioga counties.

*Thienella villenoria*, new genus and new species, is associated with *D. leonensis* in Chautauqua County, New York.

*Dalmanella tioga* Hall, 1867, appears in the Cayuta member of the Chemung formation in Schuyler, Tompkins, Chemung, and Tioga counties, central New York. It is common in the lower Cayuta member above the *Dalmanella danbyi* zone but it is not common above the middle of that member.

*Dalmanella elmira*, new species, appears in the Cayuta member of the Chemung formation in Chemung and Tioga counties; is common throughout the Cayuta member above the *Dalmanella danbyi* zone, but is rarely if ever seen in the Wellsburg member.

*Dalmanella carinata* Hall, 1843, appears in the third Tropideleptus zone and the upper part of the Cayuta member of the Chemung formation of Chemung and Tioga counties, central New York.

*Dalmanella allegania*, new species, appears in the lower part of the Chemung formation at Cuba, Allegany County, where it is associated with *Dalmanella leonensis*. The limits of its range are not known.

*Dalmanella virginia*, new species, appears in the Chemung formation of West Virginia; it has not been seen in New York State. The limits of its distribution and range are not known, but it is restricted according to present knowledge to the eastern extension of the Chemung basin.

#### GENERAL CHARACTERS.

Examination of the *Dalmanellas* in their relations of distribution and range has made some general facts clear which may be mentioned before classifying them or going into details in defining their differences.

*Size.*—The collections at present in hand show a geographical difference in expression of size and a definite law of increase in size on continued occupation of the area.

The species *Orthis* (*Dalmanella*) *leonensis* Hall is the common form in western New York, and so far as known there are no Dalmanellas in the western New York Chemung attaining a diameter of 20 mm., and rarely is a specimen seen exceeding 15 mm. in width. Further search may modify this statement.

The collections from central New York east of the Genesee River show another law. The Dalmanellas from the geological sections of Watkins Glen and Catatunk quadrangles exhibit a general increase in size with each successive stage from their first appearance to their final exhibition. The first zone, called the *Dalmanella danbyi* zone, at the base of the Cayuta member, about 150 feet thick, contains only small individuals, the majority of which do not exceed 12 mm. in width and the largest of which probably do not exceed 15 mm. The specimens in the succeeding fossiliferous zones of the Cayuta member are rarely under 20 mm. in width and an occasional specimen reaches a width of 40 mm. In the separate fossiliferous zones of the middle and upper Cayuta the average size differs, but for each zone the variation in size is restricted within narrower limits than the extremes, showing that local conditions of environment exercised some control upon the dimensions. In some zones the average size is about 20 mm., in other zones about 25 mm. In the zones with the smaller average there is evidence of slower growth, while those of larger average give indication of luxuriance of growth. In general, however, the zones near the top of the Cayuta member exhibit larger dimensions than those of the earlier zones of the Cayuta member.

The specimens from the highest zones of the Cayuta member and the later representatives of the genus show the greatest average dimensions, about 30 mm., running up to 40 mm. or over in width.

*Contour forms of shells of Dalmanella.*—A comparative study of the Dalmanellas has demonstrated the importance of designating by some distinct term the form of contour or outline of the shell without regard to size or taxonomic rank assigned to the specimens. This matter of contour seems to be an expression of differential rate of growth of the shells in various directions during growth from embryonic to adult age. A shell in which the growth proceeds at a relatively uniform rate in all directions will assume a circular contour. The shells of *Dalmanella* grow much more rapidly toward the front than toward the cardinal side of the umbones or starting point of growth. In general the contour of a *Dalmanella* is deltoid, and looked at from a point vertical to the hinge line the cardinal margin presents a straight line. The contour rapidly broadens from the end of the straight part of the hinge so that the shell assumes in general

a gently curved cardinal margin. The growth from umbo directly toward the front is commonly nearly twice as rapid as the growth parallel to the hinge. The resulting effect is the production of a shell whose width is less than twice its length.

The important dimensions of the contour are those from beak to front along the median line, which is the length, and the greatest diameter attained in a direction at right angles to the length, which is the width.

Taking these two diameters, we may define the forms of contour to be as follows:

*Form alpha.*—Length and width, nearly equal, greatest width about half way from beak to front.

*Form beta.*—Width greater than length, shell elliptical, greatest width subcentral.

*Form gamma.*—Length and width subequal, but greatest width near front margin.

*Form delta.*—Length and width subequal, but greatest width near hinge line.

For all the above four forms the two valves are slightly convex.

As the growth accelerates in the direction from beak to front, the surface of the brachial valve arches upward making that valve gibbous while the opposite valve remains nearly flat and becomes in some cases concave at the margins. The actual contour around the plane of meeting of the edges of the two valves does not greatly depart from the form already designated, although the decrease in relative rapidity of growth in a lateral direction results in placing the greatest width up above the middle near the hinge line. This mode of growth is seen in species *D. carinata* and *D. virginia*, resulting in two contour forms.

*Form epsilon.*—Actual contour oval with width greater than length, but the brachial valve strongly arched, the pedicle valve flat or slightly convex, giving to the brachial valve an outline approaching the form *delta* and to the pedicle valve an elliptical form like *beta*, but with the greatest width near hinge line. This form is seen in *D. carinata* var. *epsilon*.

*Form zeta.*—Same as epsilon except that the pedicle valve is concave, particularly along the median line from beak to front and with the margin of shell scooping outward as seen in typical *D. carinata*.

These contour forms are not evolutionary but affect specimens at each stage of their history except in the following particulars, viz:

The form *alpha* dominates throughout the Chemung series; form *beta* is rare among the earliest small forms, but as the size increases the form *beta* dominates in the Cayuta member for the zone immediately following the *Dalmanella danbyi* stage. When the second stage of increase of size is attained the form *gamma* becomes domi-

nant, and in the upper part of the Cayuta member this form tends to throw the maximum width up toward the hinge line to make form *delta*. In only the highest zones are forms *epsilon* and *zeta* found.

*Striæ and lines*.—In their definition of the genus *Dalmanella*, Messrs. Hall and Clarke speak of the surface as "covered with fine rounded striæ."<sup>a</sup>

In this, as in other cases of descriptive literature, the term *stria* (pl. *striæ*) is often used in such a way as to indicate that the author refers to linear markings raised above the general surface and does not mean incised narrow grooves. In discussing the surface markings of such shells<sup>b</sup> it is important to distinguish between linear markings raised above the surface and those depressed below the surface.

From its etymology the term *stria* properly means a depressed furrow or channel, but for the elevated linear markings the term *line* is more appropriate. In this paper *line* (and not *stria*) will be used wherever the markings indicated are raised above the surface, and *stria* will be used only where a groove between two lines is meant or where the linear markings are actually incised below the general surface of the shell.

The radiating lines increase in number with growth of each individual by implantation of secondary lines on the sides of the primary lines; the primary line is generally retained as primary in the fascicle of secondary and tertiary lines out to the front of the shell.

Upon the initial entrance of the genus into the province, a primary radiating line occupies a median position at the beak of the brachial valve in the smaller specimens and retains its dominance there to the front. On passing upward in the series as the size increases the effect is most pronounced upon the central part of the shell. The implantation of secondary and then of tertiary lines takes place higher up toward the beak in the later forms, resulting in a fuller fasciculation of the lines at corresponding distances from beak than in the smaller species.

In this acceleration of growth the central line becomes dichotomized early in growth so that in most specimens of *D. tioga*, *D. cluira* and later forms the dominance of a median central line in the brachial valve is lost sight of and a depressed *stria* is dominant from very close to the beak all the way to the front in the middle of the sulcus of the brachial valves. This difference in the arrangement of the lines in the central fascicle of the brachial valve, instead of being

<sup>a</sup> Eleventh Annual Report State Geologist, New York, 1892. Handbook of Brachiopoda, Pt. 1, p. 270.

<sup>b</sup> See Sardeson. The Galena and the Maquoketa Series. Pt. 3. Am. Geol., XIX, 1897, pp. 91-111.

regarded as indication of different race, is regarded as definite indication of the closest relationship between the several successive representatives of the genus. It is an expression of acceleration in growth coordinate with increase of size of individuals, and therefore may be ascribed to some evolutionary force or forces operating upon the race, considered as a continuous series of genetically related individuals, rather than to either heredity or environment.

#### DESCRIPTION OF SPECIES.

DALMANELLA LEONENSIS Hall, 1867.

Plate II, figs. 1, 2, 5, 6, 9, 10, 13, 24.

A small orthoid shell of the type of *Orthis testudinaria* of the Ordovician (ordinarily not over 12 mm. wide); valves subequal in thickness; the beak of the pedicle valve extends slightly beyond the hinge line; the hinge is short; greatest width of shell is at or below the middle line; in the brachial valve the sulcus is not evident at the beak but gradually indents the shells along the median line; toward the front it is broad and shallow. The central part of the pedicle valve is slightly carinated from the beak forward. Neither the sulcus nor the fold is sharply separated off from the low, curved general surface of the shell.

The surface is marked by fine radiating, elevated lines, arising at the beak in 12 to 14 primary lines which are increased by implantation of secondary lines on their sides; the secondary lines are generally in pairs. A little further along in growth these secondary lines increase to nearly the size of the center ones, when a pair of tertiary lines appear on their sides, thus forming a spreading fascicle of lines which are subequal in size at the front. The lines curve backward at the cardinal angles. They increase to 20 or 25 each side of the middle at the front margin of specimens of ordinary size.

One, two, or three concentric lines of growth occasionally appear.

The type specimens used by Hall and specimens found in the same region identified with his figures appear all to have been thin shells, as indicated by the faint expression of their muscular scars and the appearance on molds of the interior in many specimens of lines running over the place of the muscular scars.

In the molds of the interior of brachial valves there is a distinct narrow flat groove (a narrow flattened ridge in the original) separating the muscular scars but inconspicuous beyond the anterior edge of muscular scars. There is a sulcus extending from between the scars forward to the front rim of the shell where it is generally broadened and shallow. The molds of the interior of the pedicle valves are nearly evenly rounded, showing little trace of central carination, but the central part is more abruptly curved than the sides.

The hinge teeth sharply differentiate the muscular scars from the sides of the shell; the muscular scars run up to a blunt point in the pedicle area, and are bilobed anteriorly. A slight, rim-like elevation generally continues from the base of the teeth around and in front of the muscular scars.

In the brachial valves the muscular scars are generally only faintly indicated, though in specimens with thick shell they are distinguishable as four subquadrate scars occupying the deepest portion of the valve (in molds of the interior they show on the highest part of the surface), the posterior edges and the interior edges of the posterior set are most strongly differentiated from the general surface by the median ridge extending forward from the base of the cardinal process.

The crura are small at their bases, and in size inferior to the base of the cardinal process which rises abruptly from the general shell wall, and is pointed strongly backward. The space back of the muscular scars in the brachial valve is about one-tenth of the total length of the shell. It is twice as large in shells of *D. danbyi* of the same size.

In a set of specimens preserving the shell, from locality 517 A7,<sup>a</sup> the lines are beautifully rounded above and separated by flattened spaces (i. e., striae) slightly broader than the lines. This appears to be a character distinguishing this species from *D. danbyi*, in which the lines are subangular.

The following specimens, representing the characteristics of the species as above restricted, are figured on Plate II.

Fig. 13 (1225 B1, specimen No. 21), mold of interior of brachial valve.

Fig. 24 (1225 B1, specimen No. 37), mold of interior of pedicle valve.

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<sup>a</sup> The numbers and letters associated with the specimens cited in this report are locality numbers of specimens listed for the U. S. National Museum. When numbers are given they are serial numbers assigned to the collections of the Devonian made by the author and his party for the U. S. Geological Survey. Example 517=Westville, Chatauga County, New York; 1225=Villanova, Chautauqua County, New York. In the case where the label begins with letters, the letters indicate the quadrangle, the number and letter following indicate the block of the 15-minute quadrangle. As for instance 1th. 3 K, means Ithaca 15'' quadrangle, third block of the one-minute blocks from left to right, and block K of the one-minute blocks from top of quadrangle down lettered alphabetically, or the eleventh in order.

The letters and numbers following these primary marks indicate the section number and the zone of the section according to the system used in gathering and labeling the specimens. The specimens of Dalmanellas have been permanently mounted on tablets. In case several Dalmanellas are mounted on a single tablet serial numbers are assigned the specimens. These are indicated by the specimen numbers.

Figs. 1-2 (1225 B1, specimen No. 67-67a), mold of exteriors of brachial valve.

Figs. 5-6 (1225 B1, specimen No. 97-98), mold of exteriors of pedicle valve.

Fig 9 (517 A7+, specimen No. 24), exterior surface brachial valve.

Fig. 10 (517 A7+, specimen No. 25), exterior surface pedicle valve.

The specimens marked 1225 are from Villenova, Chautauqua County, near the eastern boundary of the town. Specimens marked 517 A7+ are from a loose slab found in Chautauqua Creek, Westville, Chautauqua County, at about 850 feet A. T. The slab is believed to come from near the base of the Chemung formation of that locality.

*Comments.*—The species *Orthis leonensis* as defined and figured by Hall<sup>a</sup> covers three forms, namely, form *alpha* (figs. 3, 7, and 8 of his Plate VIII); form *beta* (figs. 4 and 6) and form *gamma* (fig. 5).

The form *alpha*, represented by Hall's figures 3, 7, and 8, is chosen as the type of the species *Orthis leonensis* as here restricted. No specimen of form *beta* has been seen by the writer in collections from Chautauqua or Cattaraugus counties. A few specimens from a quarry south of Cuba, Allegany County, have this form. As they are there associated in the same rock with typical specimens of *O. leonensis* it is assumed that the two forms were genetically differentiated at the time and the name *Dalmanella allegania* is proposed for individuals of general likeness to *D. leonensis* but having the form *beta* as described beyond.

The specimen represented by Hall's fig. 5 is associated with typical forms of *D. leonensis* in a series of specimens collected in the town of Villenova, Chautauqua County. These specimens present features distinct from those of *D. leonensis*, and for them the name *Thiemella villenovia* is proposed.

DALMANELLA DANBYI, new species.

Plate II, figs. 3, 4, 7, 8, 14, 15, 21, and 25.

In size and general form this species is very similar to form *alpha* of *Orthis leonensis* Hall. It differs from that species in the following characters: The elevated radiating lines tend to preserve the fasciculate character to the front, thus causing the shell to appear as covered by lines of differing size. (In *D. leonensis* the fasciculate character of the lines is conspicuous near the beak but inconspicuous toward the front.) The lines increase by division a little more rapidly than in *D. leonensis*. At the front of specimens of 10 mm. length the number of lines each side of the middle is about 30. In specimens of *D. leonensis* of the same size there are about 20 to 25. From the

<sup>a</sup> Pal. N. Y., IV, 1867, p. 62, pl. VIII.

evidence in hand the radiating lines of *D. danbyi* appear to be slightly angular while in well preserved specimens of *D. leonensis* they are evenly rounded and the spaces between them are flat. The median sulcus on the brachial valve and the median carination on the pedicle valve are more sharply differentiated from the general slope of the surface in *D. danbyi* than in *D. leonensis*.

The cardinal process on the inside of the brachial valve of *D. danbyi* is more elongate, the crura are considerably stronger, and the internal muscular and vascular markings are in general stronger for shells of corresponding size than in *D. leonensis*.

The molds of the interior of brachial valves (the condition in which the specimens are generally found) may be quickly distinguished from *D. Leonensis* by their strong curae. The curae are much larger than the cardinal process; in specimens 10 mm. in length the curae reach anterior from the point of the beak about 2 mm., or are approximately one-fifth of the length of the shell. The cardinal process forms, in the interior molds, a narrow slit of less than half the length of the base of the slits representing the curae. In the ordinary form of *D. danbyi*, as well as in all specimens of *D. leonensis* at present examined, the cardinal process is simple,

In a specimen of the form *beta* (*Dalmanella danbyi*, var. *beta*, new variety), from the *Dalmanella danbyi* zone at West Danby, a faint indication is seen of the trifold slitting of the cardinal process on its outer side. (See Plate II, fig. 18.)

The length of this specimen is only 10 mm., but its breadth is 14 mm. It occurs in the upper part of the *Dalmanella danbyi* zone in association with specimens of the ordinary form *alpha* of *Dalmanella danbyi*. It is only about half the size of specimens of *Dalmanella tioga* of the same form, occurring in the strata of the Cayuta member not far above. In this form of *D. tioga* the trifold character of the cardinal process is distinct in all specimens examined. I have regarded this specimen as possibly a young or undeveloped form of *D. tioga*, but on account of its size and associations it is listed as *D. danbyi*, var. *beta*.

In no specimen of the western form, *Dalmanella leonensis*, has the trifold marking of the end of the cardinal process been seen, though it is not impossible that well-developed specimens may exhibit this character.

As the shell thickens (shown by the obliteration of the impressions of outer striations upon molds of the interior) the interior molds of brachial valves show a gradual increase of distinctness in the outline of the muscular impressions and the grooves for vascular channels over the surface. There is also, coordinate with this development, a contracting of the lateral and front margins forming a more gibbous shell. These facts are well exhibited in a series of

specimens from zone Dr. 7 I, 1 e. Nos. 1 to 26 belonging to the Cornell University Museum, and for the pedicle valves Nos. 27 to 41 of the same station.

The specific name *Orthis (Dalmanella) superstes* was given by Hall and Clarke to these thickened forms with vascular markings.<sup>a</sup> The "broad, low, median sinus" on the pedicle valve running from the middle of the valve to the front, described as a distinctive character of *O. superstes*,<sup>b</sup> is not seen on specimens of *D. danbyi*.

Although the specimens of *D. danbyi* generally occur in the condition of molds, a few have been collected with the shell of the surface preserved.

In size the specimens of *D. danbyi* rarely exceed 12 mm. in width.

The following specimens are selected and figured as types of *Dalmanella danbyi* on Plate II.

Fig. 15 (Ith. 3 K. 1 kk, specimen 1), mold of interior of brachial valve. (Compare with 1225 B 1. 21.)

Fig. 14 (Ith. 3 K. 1 oo., specimen 1), mold of interior of brachial valve. (Compare with 1225 B. 1. 21.)

Fig. 25 (Dr. 7 I, 1 e., specimen 31), mold of interior pedicle valve.

Fig. 7 (Dr. 7 I, 1 e., specimen 46), mold of exterior pedicle valve.

Fig. 3 (Ith. 3 K. 1 oo., specimen 2), mold of exterior brachial valve.

Fig. 8 (Ith. 3 K. 1 oo., specimen 3), mold of exterior pedicle valve.

Fig. 4 (Ith. 3 K. 1 rr.), mold of exterior of brachial valve.

Locality Ith. 3 K. is in West Danby, Tompkins County, and is the typical section of the *Dalmanella danbyi* zone at the base of the Chemung formation.

Dr. 7 I, is a section on the east side of Bald Hill, Caroline, Tompkins County, and also contains the fauna of the *Dalmanella danbyi* zone.

DALMANELLA ALLEGANIA, new species.

Plate II, figs. 17 and 20.

This name is proposed for specimens having the form *beta* and figured by Hall<sup>c</sup> among the types of his species *Orthis leonensis*. The specific character, namely, its broadly oval shape, distinguishes it from the typical *Dalmanella leonensis* of Chautauqua County. The typical specimens measure 8 by 11 mm. and 8.7 by 12.3 mm. The surface markings and the interior markings of both valves are very similar to those of *D. leonensis*. The muscular scars of the pedicle valve are wider than in *D. leonensis*. No specimens of this form have been seen by the writer among the specimens of *D. leonensis* of Chautauqua County.

<sup>a</sup> Pal. N. Y., VIII, Pt. 1, 1892, p. 342.

<sup>b</sup> See p. 53.

<sup>c</sup> Pal. N. Y., IV, p. 167, pl. VIII, fig. 4.

The type specimens are from the quarry south of Cuba, Allegany County, New York, in the Chemung formation near the base; but the exact distance above the base is not ascertained.

ORTHIS (DALMANELLA) SUPERSTES<sup>a</sup> Hall and Clarke, 1892.

Plate II, figs. 26 and 27.

The characters which distinguish this species from *D. danbyi*, the Devonian form of New York which is most closely resembles, are the following: In general form it is subquadrate, inflated, thick-shelled, but with surface markings much as in *D. danbyi*. The exterior of brachial valves is marked by a "shallow sinus from near beak to front which broadens toward the front." In the pedicle valve, according to the original description, "the beak is somewhat inflated and slopes evenly in all directions for nearly one-half of the shell; from this point forward is a broad low median sinus, which is most conspicuously developed in old and gibbous shells." In this character the species differs from both *D. leonensis* and *D. danbyi*.

The interior of the brachial valve has, besides the quadrate muscular markings, two pairs of vascular channels running obliquely from them toward the margins; the first, or posterior pair, starts from the groove between the two scars of the same side and runs out obliquely toward the center of the lateral margin; the second set starts near the middle in front of the anterior scars and runs obliquely toward the antero-lateral corners of the shell.

In the interior of pedicle valves, on each side of the middle of the shell, two faint vascular channels proceed forward from the front edge of the muscular scars and diverge slightly from each other as they proceed; about halfway to the front each suddenly again divides into two smaller channels which diverge at nearly right angles from each other to near the front margin; the central branches nearly touch on the median line; the other two reach the front at about one-third distance from center to the antero-lateral angle of the shell. In Hall and Clarke's figures there is also a central branch between the two lateral channels; this has not been detected in specimens in the U. S. Geological Survey collections.

The above characters constitute the diagnostic marks by which this form is distinguished. The following specimens are selected as representative and are shown on Plate II:

Fig. 27 (El. 3 I, E2 No. 11), mold of interior of brachial valve.

Fig. 26 (Dr. 7 I, E2 No. 37), mold of interior of pedicle valve.

Localities, El. 3 I is directly east of Elmira, at base of hill rising above the northern bridge crossing Newtown Creek.

<sup>a</sup>Pal. N. Y., VIII, Pt. 1, p. 342, pl. Vc, figs. 44-47. Original specimens from the Chemung group near Howard, Steuben County, New York.

Dr. 7 I is on the east side of Bald Hill, Caroline, Tompkins County, New York. Both of these localities are of typical sections of the *Dalmanella danbyi* zone at the base of the Cayuta member of the Chemung formation.

ORTHIS TIOGA Hall.

Among the original figures illustrating Hall's species *Orthis tioga*<sup>a</sup> two distinct forms are recognized. Figs. 26 and 21 on Plate VIII are of form *alpha*; figs. 20, 22, and 29, are form *beta*, as those terms are used above in describing *Dalmanella leonensis*. The form *gamma* is not represented among the figures of this species. Subquadrate specimens in which the hinge line is long and the cardinal angles abrupt is represented in figs. 25 and 23; this is form *delta*. *Orthis carinata* Hall is an extreme of the modification expressed by form *delta*, and has been called forms *epsilon* and *zeta*.<sup>b</sup>

In order to discuss the geological and geographical relationship of these several forms specific names are required to represent them. The form *beta*, first figured by the author, is adopted in his original description as the typical form of *Orthis tioga*. Figs. 20 and 23 on Hall's Plate VIII, are typical of that description. That form was referred to Sowerby's species *O. interlineata* by Hall in 1843, and the statement was made that "the figures of Sowerby correspond better with the fossils than those of Mr. Phillips. The casts, however, fig. 3 above, and 106a of the latter, very closely resemble each other, and there can be no doubt of the identity of the fossils."<sup>c</sup>

More careful study of the New York forms led Hall to refer these broadly elliptical forms (form *beta*) to the species *Orthis tioga*, but with them were associated others of the form which Phillips regarded as specifically different and to which he gave the name *Orthis parallela*, placing it in his group of "orbicular orthides" instead of "elliptical orthides" in which *O. interlineata* was included.

The second form *alpha* is represented among the figures of Hall's species *O. tioga* by figs. 3 and 8.<sup>d</sup> To the small representatives of form *alpha* the names *D. leonensis* and *D. danbyi* are here given. For the large species of form *alpha*, such as Hall included in the species *Orthis tioga*, the name *Dalmanella elmira* is proposed.

<sup>a</sup> Pal. N. Y., IV, 1867, p. 59, pl. VIII, figs. 20-29.

<sup>b</sup> See p. 46.

<sup>c</sup> Geol. N. Y., 4th Dist., 1843, p. 268.

<sup>d</sup> Hall, Pal. N. Y., IV, Brachiopodes, 1867, pl. VIII.

## DALMANELLA TIOGA Hall, sensu stricto.

Plate III, figs. 1, 2, 3, 4, 5, 7, 9, 10, 12.

(=*Orthis tioga* HALL in part.)

In the original description of *Orthis tioga* the form is defined as follows: "Shell transverse, broadly elliptical, about two-thirds as long as wide; length of hinge line a little greater than half the width of the shell; the extremities rounded into a general curved outline."<sup>a</sup>

Hall's figs. 20, 22, 29, and 24 on Plate VIII accompanying the description represent such a form, and they are regarded as types of the species as here restricted. The broadly elliptical form is characteristic, and the specimens are gently convex but neither gibbous nor flat. The median sulcus of the brachial valve is distinct but shallow, and the median ridge of the pedicle valve is also distinct from beak to front, but it is low and not carinated. The radiating surface lines ("striae") are distinctly fasciculated as is shown on our fig. 4, Plate III.

The cardinal process is rather small and narrow, but in well-preserved molds its subdivision into three longitudinal ridges is evident.

In dimensions the species is intermediate between the earlier forms (*D. danbyi*, *superstes*, and *leonensis*) and the common Chemung forms *D. almira*, and *carinata*.

The specimens in the U. S. Geological Survey collection selected to represent this species (see Plate III) measure as follows:

Fig. 7, 12.3 by 19.5 mm.

Fig. 4, 12.9 by 19.7 mm.

Fig. 10, 16 by 25.5 mm.

Fig. 1, 13.6 by 19.7 mm.

Fig. 3, 14.9 by 22 mm.

Fig. 12, 15.4 by 21.5 mm.

Average, 14.1 by 21.3 mm.

Hall's figures on his Plate VIII measure as follows:

Fig. 20, 14.3 by 21.3 mm.

Fig. 29, 18 by 27 mm.

Fig. 22, 20 by 29 mm.

The molds of an interior and an exterior of a large brachial valve of this form from Granville center, Bradford County, Pennsylvania, 1455 B<sup>1, b</sup> show the following dimensions: 25.2 by 40 mm. Plate III, figs. 2 and 5.

All of the forms mentioned above come from the lower part of the Cayuta member of the Chemung formation but above the *Dalmanella danbyi* zone. The species is associated with *D. almira*, but *D. almira*

<sup>a</sup> Pal. N. Y., IV, 1867, p. 59.

<sup>b</sup> U. S. Geological Survey, Bull. 244, p. 104.

is the prevailing form in the upper half of the Cayuta member, and this typical form, *D. tioga*, is rare above the middle.

Specimens from the Survey collections selected to represent this species are figured on Plate III.

Fig. 7 (El. 2K, 1n. No. 11), mold of interior brachial valve.

Fig. 4 (El. 6C, B6, No. 8), mold of exterior pedicle valve.

Fig. 10 (El. 7J, 1c. No. 1), mold of interior brachial valve.

Fig. 1 (El. 7J, 1c. No. 3), mold of exterior brachial valve.

Fig. 3 (El. 7J, 1c. No. 5), mold of exterior pedicle valve (distorted).

Fig. 12 (El. 7J, 1c. No. 2), mold of interior pedicle valve.

The localities represented above are:

El. 2K.—Elmira town, above Delaware, Lackawanna and Western Railroad, on east side of river about a mile north of Big Island.

El. 6C.—Catlin, about one and a half miles south of Pine Valley at base of hill west of Northern Central Railroad track.

El. 7J.—Section from Fitch bridge up ravine southeast side of Hawley Hill, a few miles west of Elmira.

1455, B<sup>1</sup>.—Granville Center, Bradford County, Pennsylvania.

DALMANELLA ELMIRA, new species.

Plate III, figs. 6, 8, 11, 13, 14, 15, 16, 17.

(= *Orthis tioga* HALL (in part), as represented by figs. 21, 26, 27, and 28 on Plate VIII, Pal. N. Y., IV, 1867.)

This species differs from *O. tioga*, as restricted, by its subquadrate form; the length is from four-fifths to five-sixths the width. In the smaller as well as earlier specimens the greatest width is nearly medial, in specimens from the middle and upper Cayuta member the greatest width is in the upper third of the shell.

The typical surface form is low convex for the brachial valve, and nearly flat, but not concave for the pedicle valve. In molds of the pedicle valve the muscular scars are convex on their outer faces. The shell is convex along the line running through the middle from beak to front; it is flat or slightly concave in typical specimens of *D. carinata*.

The typical *D. elmira* is found associated with *D. tioga* in the lower part of the Chemung, but in the middle and upper part of the Cayuta member *D. elmira* becomes the prevailing species.

Type specimens of *Dalmanella elmira* are figured on Plate III as follows:

Fig. 13 (El. 6C, B6, No. 2), mold of interior brachial valve.

Fig. 11 (El. 6C, B6, No. 3), mold of interior brachial valve.

Fig. 15 (El. 6C, B6, No. 5), mold of interior pedicle valve.

Fig. 17 (Wv. 1A, 1h, No. 1), mold of interior of brachial valve.

Fig. 8 (Wv. 1A, 1vv, No. 5), mold of exterior brachial valve.

Fig. 11 (Wv. 1A, 1vv, No. 1), mold of interior brachial valve.

Fig. 6 (Wv. 1A, 1vv, No. 2), mold of exterior of same specimen.

The localities from which these types of the species come are:

El. 6C.—Southeast corner of Catlin, Chemung County,  $1\frac{1}{2}$  miles south of Pine Valley, on side hill above and west of the Northern Central Railroad tracks.

Wv. 1A.—The ravine west of Spencer Lake, in northwest corner of town of Spencer, Tioga County, New York.

The specimens come from the middle portion of the Cayuta member of the Chemung formation above the *Dalmanella danbyi* zone.

DALMANELLA CARINATA Hall.<sup>a</sup>

Plate IV, figs. 1, 2, 4, and 6.

The distinctive specific characters of *Dalmanella carinata* are considered to be its large size (25 to 35 mm. long and larger); its form, oval with the breadth greater than length, the greatest breadth above the middle line of growth; the brachial valve convex, the greatest convexity along the center from beak to front; the pedicle valve flat to concave along the median line; in molds of the interior of the pedicle valve the muscular impression presents a flat to concave surface and elevated pointed beak. In extremely developed specimens the median carination in the pedicle valve is nearly obliterated by the broad incoop of the surface.

The cardinal process is wide and the trifold slitting of its end is conspicuous; the crura are broadly divergent and strong. In molds of the interior of well-developed pedicle valves there is a narrow furrow running from the beak to the side of each muscular scar, representing (in the original shell) an elevated linear ridge, about a millimeter distant from, and nearly parallel to, the inner face of the hinge teeth bounding the muscular scars.

Specimens representing these characters from the U. S. Geological Survey collections are figured on Plate IV.

Fig. 4 (Wv. 1A, 1uuu, No. 1), mold of interior of brachial valve.

Fig. 1 (Wv. 1A, 1www, No. 14), mold of interior of pedicle valve.

Fig. 2 (Wv. 1A, 1www, No. 15), mold of interior of pedicle valve.

The convexity of the brachial valve, the flat to concave form of the pedicle valve, and the elevation and flattening of beak of the pedicle valve produce a form similar to that of *Orthotheses*.

<sup>a</sup> N. Y. Geol. Rept. 4th Dist., 1843, p. 267; also Pal. N. Y., IV, 1867, p. 58, and pl. VIII, figs. 30, 31, and 32. The specimens selected from the Geological Survey collection as representing this species are Wv. 1A, 1uuu, Nos. 1 and 4, 15 and 14.

## DALMANELLA CARINATA var. EPSILON, new variety.

Plate IV, figs. 3, 5, 7, 8, 9.

In the collections of *Dalmanella* from the Chemung in New York the two valves are always separate. This variety *epsilon* is founded on pedicle valves having the earlier half of the shell flattened with sharply pointed small elevated beak, but the margins of the shell are gradually or abruptly turned inward, producing a convex general form with flat or gently hollowed center of the shell, instead of the concave shell of the normal shape of the species.

These forms with convex pedicle valves are believed to be not specifically distinct from, but rather varietal modifications of, *D. carinata* and are adult individuals, the form resulting from an abrupt retardation of radial growth along the perimeter of the shell in later stages of its growth.

In the normal forms there is the same retardation of growth along the perimeter, but it begins early, is continuous and results in bending the margin outward instead of inward, making a concave pedicle valve.

Types of variety *epsilon* are represented on Plate IV by —

Fig. 3 (Ith. 3K, 1vvv, 2), mold of interior of pedicle valve.

Fig. 8 (Ith. 3K, 1vvv, 1), mold of interior of pedicle valve.

Fig. 5 (Wv. 7B, 1j<sup>1</sup>, 15), (Cornell Univ. Mus.), mold of interior of pedicle valve.

Fig. 9 (Wv. 7B, 1j<sup>1</sup>, 1), (Cornell Univ. Mus.), mold of interior of pedicle valve.

Fig. 7 (Wv. 7B, 1j<sup>1</sup>, 5), mold of interior of pedicle valve.

The localities of *D. carinata* and variety *epsilon* are Ith. 3K, 1vvv, West Danby, high up in the section a mile or so south of West Danby, upper part of Cayuta member; Wv. 7B, 1j<sup>1</sup>, section above Swartwood, from the faunule of the third or Swartwood *Tropidoleptus* zone at the top of the Cayuta member of the Chemung formation.

## DALMANELLA VIRGINIA, new species.

Plate IV, figs. 10, 11, 12, 13, and 16.

The brachial valve of the type-specimen is subcircular in outline; dimensions 20.5 mm. long by 24.2 wide; very gibbous (8.3 mm. deep) median sulcus deep, bounded on each side by prominent rounded ridges rising 2 or 3 mm. above the bottom of the sulcus; cardinal process, crura and muscular scars strongly developed; cardinal process sharply cut longitudinally into three parts. These characters are illustrated by type-specimen No. 1 of 1380 B<sup>3</sup> (Plate IV,

fig. 12) from near White Sulphur Springs, West Virginia, from the faunule described in U. S. Geological Survey Bulletin, No. 244 (1905), p. 35. In the list of faunule it is entered as "6 *D. tioga*."

The exterior of the shell is marked by coarse, uneven, radiating lines rapidly bifurcating and fasciculated as shown in fig. 11, Plate IV (type-specimen 14 of 1380 B<sup>3</sup>).

The pedicle valve is irregularly concave, with sharp beak, greatest width near cardinal margin, evenly rounded in front, a median carination extending from beak to front bounded by rounded grooves; short coarse fasciculated radiating lines, those on the carination finer and more even in size than on the sides. These characters are shown on fig. 13, Plate IV, illustrating type-specimens, No. 6 of 1380 B<sup>3</sup>, of which the dimensions are 13.4 mm. long by 20.2 wide, and by specimen No. 10 of the same faunule, fig. 16 of same plate.

The interior of the pedicle valve has strong cardinal teeth, muscular scar sharply defined posteriorly, but its outlines are indistinct posteriorly; the median carination is sharp at the front edge which is indented into a shallow sinus. This is expressed by fig. 10 of Plate IV, representing a mold of the interior, No. 7, of 1380 B<sup>3</sup>.

DALMANELLA VIRGINIA variety BETA, new variety.

Plate IV, figs. 14 and 15.

The casts of the exterior and interior of a small elliptical specimen, from the faunule containing the typical specimens of *Dalmanella virginia*, are believed to represent a young specimen of the same species. Its form is broadly elliptical, dimensions are 6.4 mm. long by 10.3 mm. broad, sides evenly rounded, a well defined sulcus from beak to front, fasciculated radiating lines. In the mold of interior the mark of the cardinal process is a narrow slit; its trifid termination is distinctly evident when magnified. Surface broadly convex.

Type-specimens are figured on Plate IV.

Fig. 14 (1380 B<sup>3</sup> specimen No. 11), exterior mold of brachial valve.

Fig. 15 (1380 B<sup>3</sup> specimen No. 12), exterior mold of same brachial valve.

*Locality*.—Near White Sulphur Springs, West Virginia, faunule described in U. S. Geological Survey Bulletin, No. 244, page 35, under locality No. 1380 B<sup>3</sup>.

THIEMELLA, new genus.

In Hall's description of *Orthis leonensis*<sup>a</sup> a specimen was included (fig. 5) which on the following page was referred to as possibly belonging to C. A. White's species *Orthis thiemci*,<sup>b</sup> coming from the

<sup>a</sup> Pal. N. Y., IV, Pt. 1, p. 62, pl. VIII.

<sup>b</sup> Jour. Boston Soc. N. H., VII, p. 231.

beds 1 and 7 of Burlington, Iowa. And his figure (Plate VIII, fig. 2) was referred with doubt to the same species.<sup>a</sup>

Specimens from Villenova, Chautauqua County, New York, a few miles north of Leon, Chatauqua County, where some of these forms were obtained by Hall, have been studied in connection with *Dalmanella leonensis*. They prove to be generically distinct from *Dalmanella* and for them the name *Thiemella* is proposed, taking the new species, *Thiemella villenovia*, described beyond, as the type of the genus.

The generic characters combine some of the characters of *Schizophoria*, *Rhipidomella*, and *Dalmanella*. In exterior form the adult specimens resemble *Rhipidomella*, as indicated by White, who likens the species to Western forms of *Orthis* (*Rhipidomella*) *vanuxemi*,<sup>b</sup> but the mature brachial valve has a distinct fold and the pedicle valve has a broad sinus at the front. The muscular scars of the pedicle valve are, in outline, very similar to those of *Schizophoria*, and the "forked septum" is less sharp than in the typical larger species of *Dalmanella*. The muscular scars of the brachial valve are heart shaped, not fan shaped as in *Rhipidomella*, and they are less distinct than in either *Rhipidomella* or *Dalmanella*. There are two radiating ridges proceeding from the crura bounding the muscular scar as in *Rhipidomella*. The cardinal process and crurae are described as strong, but both are confined closer to the hinge area than in *Dalmanella*.

The strong rounded septum "extending from the cardinal process nearly half the length of the shell," resembles *Rhipidomella*, though it is less sharply marked than in *Dalmanella*.

The surface lines are finer than *Dalmanella leonensis* after the first third of growth; this may, however, be a specific character of *T. villenovia*.

THIEMELLA VILLENOVIA, new species.

Plate II, figs. 11, 12, 16, 19, 22, and 23.

In the young stage of growth (for the first 5 mm.) this species is undistinguishable exteriorly from specimens of *Dalmanella leonensis* with which it is associated. From that point onward it changes form rapidly, the distinct sulcus of the brachial valve flattens out so as to make an evenly convex surface, and in larger shells there is an elevation of the central part of the brachial valve corresponding with the distinct sinus of the opposite valve (see fig. 11). The pedicle valve in like manner begins with an elevated broadly carinated center but upon reaching the front the surface becomes centrally depressed into

<sup>a</sup> Pal. N. Y., IV, Pt. 1, p. 63.

<sup>b</sup> Jour. Boston Soc. N. H., VII, p. 232.

a broad sinus (see fig. 12). The radiate surface lines after the first stage of growth lose their fasciculated mode of growth and become fine and uniform over the surface, finer than on the surface of *D. leonensis*. The cardinal process and crurae are close up to the hinge line and are not conspicuous on the inner walls of the shell.

In the brachial valve the radiating, slightly elevated ridges bounding the muscular scars are dominant, other markings of the scars are inconspicuous.

In the pedicle valve the muscular scar is bilobed, the central portion of the medial septum low but running forward, as in *Schizophoria*; the diverging part of the septum is inconspicuous.

The form of the pedicle valve is narrower at cardinal than at front end but it is not so wide anteriorly as is the brachial valve. The brachial valve shows a short hinge line and a gradual increase in width to near the front where it abruptly curves into the front margin (see fig. 16). The form of the pedicle valve is nearly flat about the beak, and scoops outward toward the antero-lateral angles as in typical *Dalmanella carinata* (see figs. 12 and 22). In size the species averages about 14 mm. long by 16 mm. wide; larger specimens reach the width of 17 mm.

One of the figures given by Hall in illustration of *Orthis leonensis*<sup>a</sup> representing a brachial valve and another figure of a pedicle valve referred with doubt to *Orthis thiemei* White are both believed to belong to this species.

Type specimens of *Thiemella villenora* were found associated with *D. leonensis* in Dye's quarry in the eastern part of the town of Villenova, Chantauqua County, western New York. They are figured on Plate II.

Fig. 16 (1225 B<sup>1</sup>, specimen No. 31), mold of interior of brachial valve.

Fig. 19 (1225 B<sup>1</sup>, specimen No. 35), mold of interior of brachial valve.

Fig. 22 (1225 B<sup>1</sup>, specimen No. 46), mold of interior of pedicle valve.

Fig. 23 (1225 B<sup>1</sup>, specimen No. 55), mold of interior of pedicle valve.

Fig. 12 (1225 B<sup>1</sup>, specimen No. 103), mold of exterior of pedicle valve.

Fig. 11 (1225 B<sup>1</sup>, specimen No. 104), mold of exterior of brachial valve.

The specimens were collected by G. D. Harris for the U. S. Geological Survey and will be deposited in the National Museum, Washington, D. C.

<sup>a</sup> Pal. N. Y., IV, Pl. 1, pl. VII, fig. 5.

## EXPLANATION OF PLATES.

## PLATE II.

*Dalmanella iconcusis.*

- Figs. 1, 2. Molds of exterior of brachial valves.  
 5, 6. Molds of exterior of pedicle valves.  
 13. Mold of interior of brachial valve.  
 24. Mold of interior of pedicle valve, Chemung formation, Villenova, Chautauqua County, New York.  
 9. Exterior surface of a brachial valve.  
 10. Exterior surface of a pedicle valve, Chemung formation, Westville, Chautauqua County, New York.

(Specimens 9 and 10 were found at side of Chautauqua Creek in a loose slab, believed to have fallen from rocks exposed in the creek.)

*Dalmanella danbyi.*

- Figs. 3, 4. Mold of exterior of a brachial valve.  
 7, 8. Mold of exterior of a pedicle valve.  
 14, 15. Molds of interior of brachial valves.  
 21, 25. Molds of interior of pedicle valves. Danby Dalmanella zone of Cayuta member, Chemung formation. Figs. 4, 8, 14, 15, 21, from West Danby, Tompkins County, New York. Figs. 7, 25, from Eastern slope Bald Mountain, Caroline, New York.

*Dalmanella danbyi* var. *bela.*

- Fig. 18. Mold of interior of a brachial valve. From middle part of Danby Dalmanella zone, West Danby, New York.

*Thiemella villenoria.*

- Fig. 11. Mold of exterior of a brachial valve.  
 12. Mold of exterior of a pedicle valve.  
 16, 19. Molds of interior of brachial valves.  
 22, 23. Molds of interior of pedicle valves, Chemung formation, Villenova, Chautauqua County, New York.

*Dalmanella allegania.*

- Fig. 17. Mold of interior of brachial valve.  
 20. Mold of interior of pedicle valve, Chemung formation, south Cuba, Allegany County, New York.

*Dalmanella superstes.*

- Fig. 26. Mold of interior of a pedicle valve. Danby Dalmanella zone, Chemung formation, eastern slope Bald Mountain, Caroline, Tompkins County, New York.  
 27. Mold of interior of a brachial valve. Chemung formation, east Elmira at base of hill rising above north bridge crossing Newton Creek, Elmira, New York.

## PLATE III.

*Dalmanella tioga.*

Fig. 1. Mold of exterior of a brachial valve.

3. Mold of exterior of a pedicle valve. Chemung formation, lower part of Cayuta member, in section southeast side of Hawley Hill, west of Elmira, New York.
2. Mold of exterior of a large specimen of brachial valve. Chemung formation, Granville Center, Bradford County, Pennsylvania.
4. Mold of exterior of a pedicle valve. Chemung formation, lower part of Cayuta member, Catlin, Chemung County, New York.
5. Mold of interior of a large specimen of brachial valve. Chemung formation, Granville Center, Bradford County, Pennsylvania.
- 7, 10. Molds of interior of brachial valves of normal size. Chemung formation, lower part of Cayuta member, Elmira, New York. (No. 7 from east side river about a mile north of Big Island; No. 10 from Hawley Hill, west of Elmira.)
9. Mold of interior of brachial valve. Chemung formation, lower part of Cayuta member, Catlin, Chemung County, New York.
12. Mold of interior of pedicle valve. Chemung formation, lower part of Cayuta member, Hawley Hill, west of Elmira.

*Dalmanella elmira.*

Figs. 6, 8. Molds of exterior of brachial valves. Chemung formation, Cayuta member, ravine opposite Spencer Lake, Spencer, Tioga County, New York.

- 11, 13. Molds of interior of brachial valves. Chemung formation, lower part of Cayuta member, Catlin, Chemung County, New York.
- 14, 17. Molds of interior brachial valves. Chemung formation, Cayuta member, Spencer Lake Ravine, Spencer, Tioga County, New York.
- 15, 16. Molds of interior of pedicle valves. Chemung formation, lower part Cayuta member, Catlin, Chemung County, New York.

## PLATE IV.

*Dalmanella carinata.*

Figs. 1, 2. Molds of interior of pedicle valves. Chemung formation, near top Cayuta member, Spencer Lake Ravine, Spencer, Tioga County, New York.

- 4, 6. Molds of interior of brachial valves. Chemung formation, near top of Cayuta member, Spencer Lake Ravine, Spencer, Tioga County, New York.

*Dalmanella carinata* var. *epsilon*.

Figs. 3, 5, 7, 8, 9. Molds of interior pedicle valves. Chemung formation, near top of Cayuta member; 3 and 8 from Seely Hill, upper part of West Danby section, West Danby, Tompkins County, New York; 5, 7, 9 from Swartwood *Tropidolopis* zone, top of Swartwood section, Austin Hill, Erin, Chemung County, New York.

*Dalmanella virginia.*

- Fig. 10. Mold of interior of pedicle valve.  
11. Mold of exterior of brachial valve.  
12. Mold of interior of brachial valve.  
13, 16. Molds of exterior pedicle valves.

*Dalmanella virginia* var. *beta*.

Figs. 14 and 15 molds of the exterior and interior of a young specimen of a brachial valve.

All the specimens of *Dalmanella virginia* are from the Chemung formation, White Sulphur Springs, West Virginia.

The specimens figured in this paper all belong to the collections of the U. S. Geological Survey, ultimately to be deposited in the U. S. National Museum, in Washington, except specimens fig. 7, 25, and 26 of Plate 11, and figs. 5, 7, and 9 of Plate IV, which belong to the collections of Cornell University Museum, Ithaca, New York.



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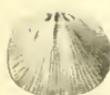
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DALMANELLAS OF THE CHEMUNG FORMATION.

FOR EXPLANATION OF PLATE SEE PAGE 62.





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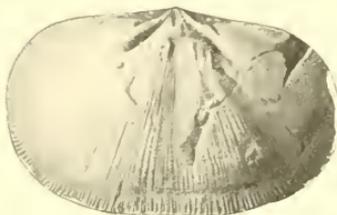
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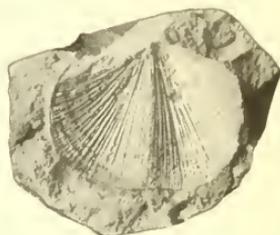
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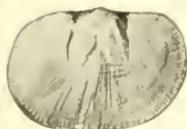
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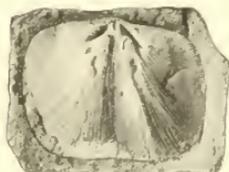
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DALMANELLAS OF THE CHEMUNG FORMATION.

FOR EXPLANATION OF PLATE SEE PAGE 63.





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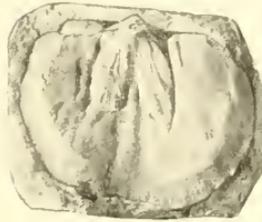
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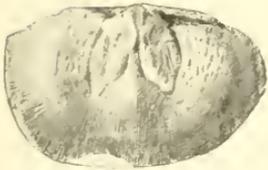
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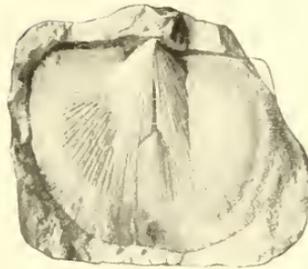
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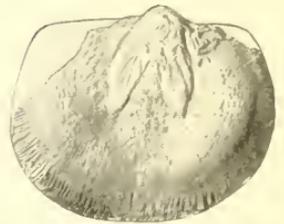
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DALMANELLAS OF THE CHEMUNG FORMATION.

FOR EXPLANATION OF PLATE SEE PAGES 63 AND 64.

