

ART. III.—*A Quantitative Study of Variation in the Fossil Brachiopod Platystrophia lynx*;\* by EDGAR R. CUMINGS and ABRAM V. MAUCK. (With Plates II and III.)

DURING the year 1900-01 the authors made extensive collections of the brachiopod *Platystrophia lynx* from the Upper Ordovician rocks at Vevay, Indiana (Switzerland Co.).

Inasmuch as this species is extremely variable and at the same time exceptionally abundant and well preserved, a quantitative study of the variations presented at once suggested itself. Such an investigation is the more warranted because of the different opinions current as to the taxonomic importance of several of the forms under which *Platystrophia* presents itself.†

The specimens used in this investigation were collected from a zone which at Vevay extends from 240 ft. to 360 ft. above the level of the Ohio River. Part of the material was so collected that the precise layer is known from which a given specimen came; the object being to determine as accurately as possible the factor of range.‡ The majority of the specimens used are from the upper 50 or 60 feet, and the upper 20 feet contains by far the most as well as the best of the material. Examples could not be obtained in sufficient abundance from the base of the *Platystrophia* zone to make a quantitative treatment possible; but we were able to ascertain that in the lower part of its range at Vevay, and in general throughout the Ohio Valley, *Platystrophia* presents less variation than at higher horizons; and that in the lower beds only the small pauciplicate form is present.§

Beside the material collected layer by layer, a large collection was made from the upper beds wherever exposures could be found in the vicinity of Vevay.

The data taken for study are: Ratio of width to length of shell (equals shell index); ratio of depth to breadth of sinus

\* Presented before Section E at the Denver meeting of the American Association for the Advancement of Science, August, 1901.

† For synonymy and bibliography of *Platystrophia* see Davidson, Silurian Brachiopoda, 1871, p. 268; Hall and Clarke, Pal. N. Y., vol. viii, pt. i, pp. 200, 201; Schuchert, Am. Foss. Brachiopoda, Bull. U. S. G. S., No. 87, pp. 308-310.

‡ The Vevay section is published in the Am. Geol., vol. xxviii, Dec., 1901, pp. 361-381. By reference to page 373 of that paper it will be seen that the lowest specimens of *Platystrophia* (associated with *Dekayia ulrichi*) are small and of a type similar to var. *laticosta* or var. *dentata* Meek (*crassa* James). The form *lynx* does not come in till within 30 or 40 feet of the top of the section.

§ Specimens have been examined from these lower zones at Cincinnati, Ohio, Lawrenceburg, Aurora, Rising Sun, Vevay and numerous points on Laughery Creek in Indiana.

(equals sinus index); number of plications on ventral valve; number of plications on dorsal valve; number of plications in sinus; number of plications on fold.\*

The width of the shell is in every case the greatest width, whether this occurs at the hinge line or farther forward. It was obtained by means of adjustable spring calipers. The width of the sinus was obtained by spreading the points of spring dividers between the anterior lateral angles of the sinus. The depth of the sinus was obtained by spreading the points of the dividers from one anterior lateral angle of the sinus to the anterior extremity of the first adjacent furrow in the bottom of the sinus. All measurements were read off on a millimeter scale and are correct to within 0.25<sup>mm</sup>.

The number of shells used varies for the several characters indicated above, on account of imperfect material. Only entire shells were used for measurements; but the number of plications, especially the number in the sinus, may frequently be determined with accuracy on very poorly preserved specimens. The number of shells used in determining any one character is called a *group*.

#### *Group I, Shell Index.*

Width divided by length. Number of shells used, 679. Range of variation from 1.0 to 1.8. Mode† at 1.3, with frequency of 300.4.‡ Variation here is moderate in amount, and in the direction of greater width than length.

#### *Group II, Sinus Index.*

Width of sinus divided by depth of sinus. Number of shells used, 664. Range of variation from 0.9 to 3.0. Mode at 1.7 with a frequency of 112.2. Variation great in amount, and in the direction of a shallow sinus.

#### *Group III, Number of Plications on Ventral Valve.*

Number of shells used, 1173. Range of variation from 10 to 28. Mode at 17 with a frequency of 176.3. Variation large in amount, and in the direction of the greater number of plications.

\* Prof. Shaler has given (Foss. Brach., Ohio Valley, p. 43) a series of measurements of a limited number (20) of specimens of *Platystrophia*. His series includes also forms from Richmond, Indiana, and other American localities. In a forthcoming paper I shall take up the discussion of material from all the provinces both American and European, where *Platystrophia* is known to occur.—E. R. C.

† The term *mode* means the highest point of the curve, i. e., the class with the greatest frequency.

‡ For the purposes of comparison all frequencies were reduced to frequencies per thousand.

FREQUENCIES PER THOUSAND.																							Number of Shells used.		Constant for reduction to 1000*.
Classes	0.9	1.0	1.1	1.2	1.3	1.4	1.5	1.6	1.7	1.8	1.9	2.0	2.1	2.2	2.3	2.4	2.5	2.6	2.7	2.8	2.9	3.0			
Group I	1.47	55.96	266.55	800.43	212.06	98.67	51.54	10.30	2.94																
Group II	4.5	9.03	9.03	33.13	51.20	60.24	70.78	106.92	112.95	103.91	90.36	78.31	73.79	57.22	39.15	31.62	30.12	19.57	12.04	3.01	1.50	1.50			
ABSOLUTE FREQUENCIES.																									

ABSOLUTE FREQUENCIES.

	Group I	Group II	1	38	181	204	144	67	35	7	2	38	26	21	20	13	8	2	1	679	1-4727
			3	6	6	32	34	40	47	71	69	60	52	49						664	1-5060

FREQUENCIES PER THOUSAND.

	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29
Classes																				
Group III	0.85	4.26	5.96	37.51	43.47	107.41	120.20	176.46	152.59	118.49	115.08	50.29	31.54	17.90	8.52	5.11	1.70	1.70	.85	
Group IIIa		2.21	13.30	24.39	55.43	93.12	110.80	119.73	199.55	133.03	104.21	57.64	35.47	17.73	13.30	6.65	4.43	4.43	2.21	2.21

ABSOLUTE FREQUENCIES.

Group III	1	5	7	44	51	126	141	207	179	139	135	59	37	21	10	6	2	1	1173	0.8525
Group IIIa		1	6	11	25	42	50	54	90	60	47	26	16	8	6	3	2	1	451	2.2173

FREQUENCIES PER THOUSAND.

Classes	1	2	3	4	5	6	7	8
Group IV	14.87	26.91	725.19	174.21	39.11	4.24	1.41	
Group V	17.02	23.29	793.85	123.04	37.63	2.68	0.89	

ABSOLUTE FREQUENCIES.

[illegible]

*Group IIIa, Plications on Dorsal Valve.*

Number of shells used, 451. Range of variation from 11 to 29. Mode at 18 with frequency of 199.55. Variation correlated with that of Group III.

*Group IV, Plications in Sinus.*

Number of shells used, 1412. Range of variation from 1 to 7. Mode at 3 with frequency of 729.1. Variation in the direction of the larger number of plications.

*Group V, Plications on Fold.*

Number of shells used, 1116. Range of variation from 2 to 8. Mode at 4, with a frequency of 793.8. Variation precisely correlated with that of Group IV.\*

The complete data are charted on page 11. The method of constructing the curves of fig. 1 is the usual one of laying off the classes along the axis of abscissas and the frequencies along corresponding ordinates.

The lack of correspondence between Groups III and IIIa, which should be exactly correlated, is due to the relatively small number of specimens used in Group IIIa. It forcibly emphasizes the necessity of using as large series of specimens as possible.

All the curves are skewed. None of them show more than one mode. They all rise abruptly and fall off less abruptly. This shows a certain correlation of the different variants.

An attempt was made to determine the relation of the number of plications in the sinus to the number on the entire valve. Hall says: "The prevailing number of lateral plications is seven on each side of the sinus or lobe; and so long as the mesial plications remain three and four, so long the lateral ones are seven. As soon as there is even an appearance of a departure from this number on the mesial lobe and sinus, and where the rudiment of an additional plait is visible, we then find the lateral plaits to be nine or ten."†

Our material does not bear out this statement. To test the point it was assumed that there is a precise correlation between number of plications in the sinus and number of plications on the whole valve. The area of the frequency polygon for any given number of plications in the sinus should then be equal to the sum of the areas of the frequency polygons of a definite number of plications on the valve. For example, the frequency polygon of three to four plications in the sinus has an area equal to that of the sum of the areas of the frequency

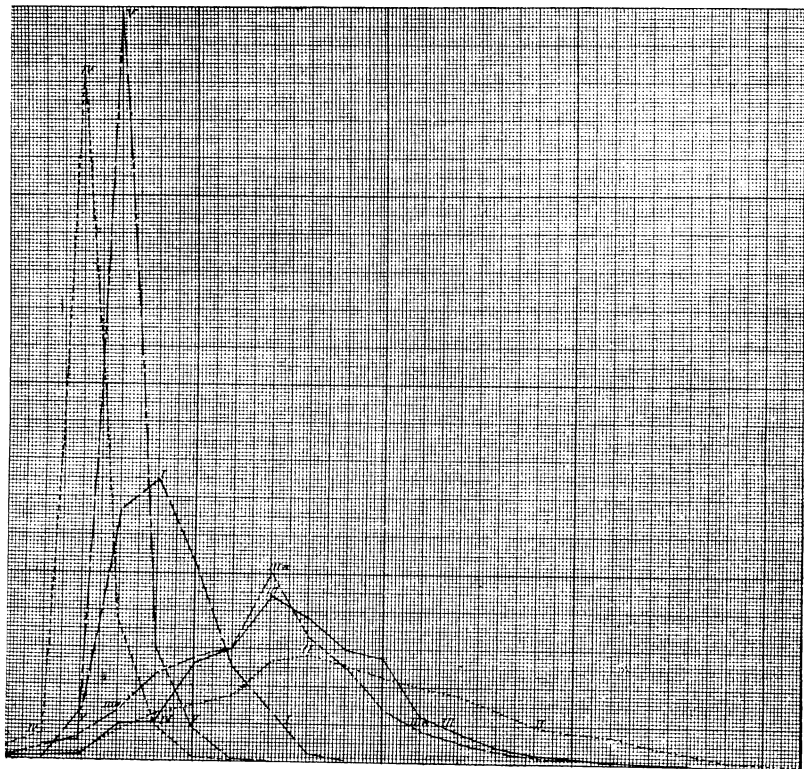
\* While there is necessarily one more plication on the fold than in the sinus, the fact that many specimens, owing to state of preservation, can be used for the determination of one group that are not available for the other, makes the two groups supplement each other.

† Hall, Pal. N. Y., vol. i, 1847, p. 134.

polygons of seventeen, eighteen, nineteen, and twenty plications on the ventral valve. Therefore any shell with four plications in the sinus should have between seventeen and twenty (both numbers inclusive) plications on the valve. It should have no more and no fewer.

An inspection of our material does not show this to be the

IV V



a b IV V I IIIa III II

FIG 1. Curves of Groups I to V. On the axis of ordinates, each small division represents four individuals. On the axis of abscissas, each fifth (as from a to b) represents one class.

case. In a series of 153 specimens with four plications in the sinus, the range is from 16 to 26 plications on the ventral valve. The average is 18.8 plications. The specimens with two plications in the sinus have from 11 to 22 plications on the valve. Those with one plication in the sinus have from 10 to 15 on the valve. The correlation is approximate rather than precise.

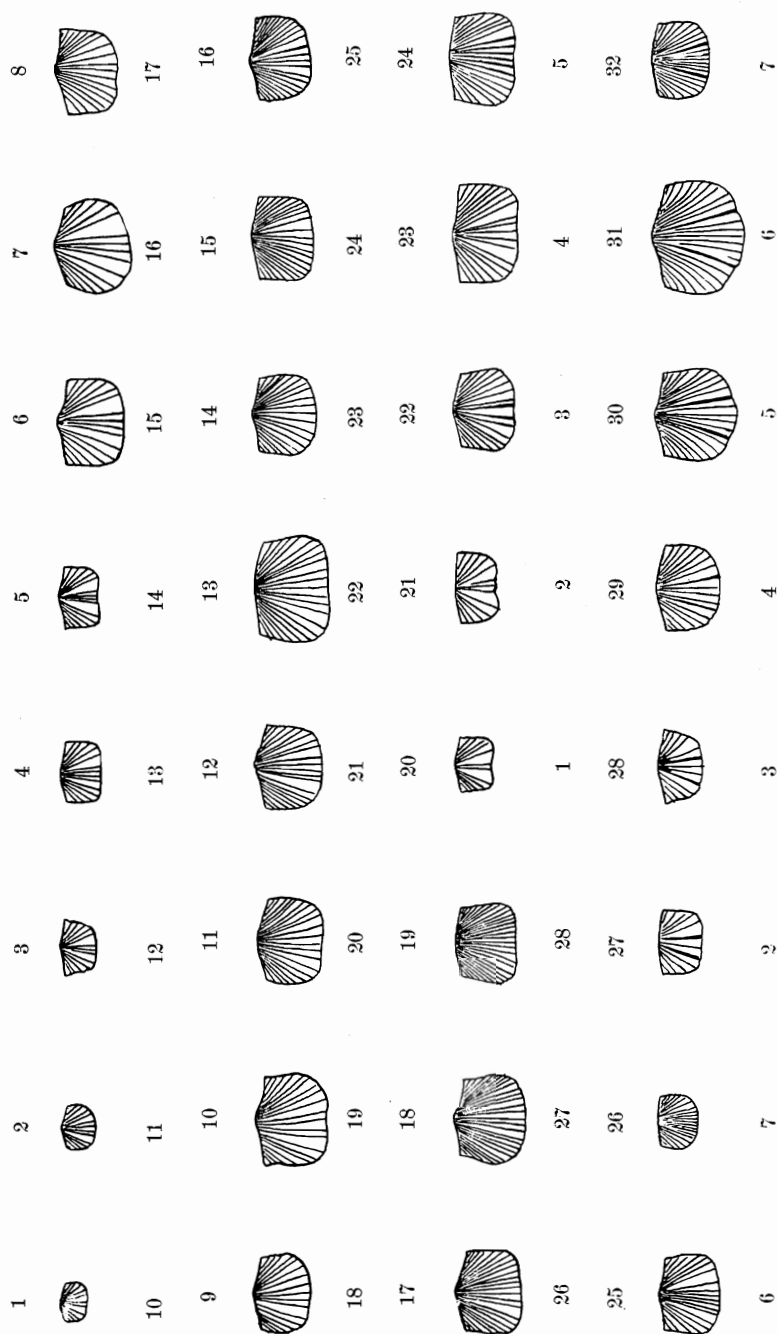
An inspection of Plates II and III shows the small size of the extreme forms, and conversely the large size and robust growth of those forms near the modes. The largest specimens will not be found exactly at the mode in any of the characters for which curves are plotted, but in classes to the right of the mode. That is, while it is true, for example, that by far the majority of specimens have three plications in the sinus, the largest specimens are more likely to be found in classes having more than three plications in the sinus. They will never be found in classes having less than three plications. When, however, the class falls some distance to the right of the mode it will again be found to contain small specimens. Smallness of size is, therefore, an accompaniment of the general extinction that prevails more and more, away from the mode. In the case of the number of plications on the valve, extinction does not become severe till the 20th is reached; and in the classes between 17 and 20 will be found the largest individuals.

In regard to the validity of the several species or varieties into which the *lynæ* group of forms has been divided, namely, *Platystrophia lynæ*, *P. laticosta*, *P. dentata* Meek (= *P. crassa* James), there is absolutely no character or combination of characters that can be relied upon to separate any large collection into distinct species. To a limited extent the above forms differ in range; although the authors have frequently seen all three represented on a single slab of limestone. It is well, however, to distinguish for stratigraphic purposes such varieties as *laticosta*, and *dentata* Meek.\*

The following is a description of the modal form of *Platystrophia lynæ*: shell three-tenths wider than long; greatest width about half-way from the hinge line to the front of the shell; width of sinus seven-tenths greater than its depth; seventeen angular plications on the ventral valve, three of which are in the sinus; eighteen on the dorsal valve, four of which are on the fold.

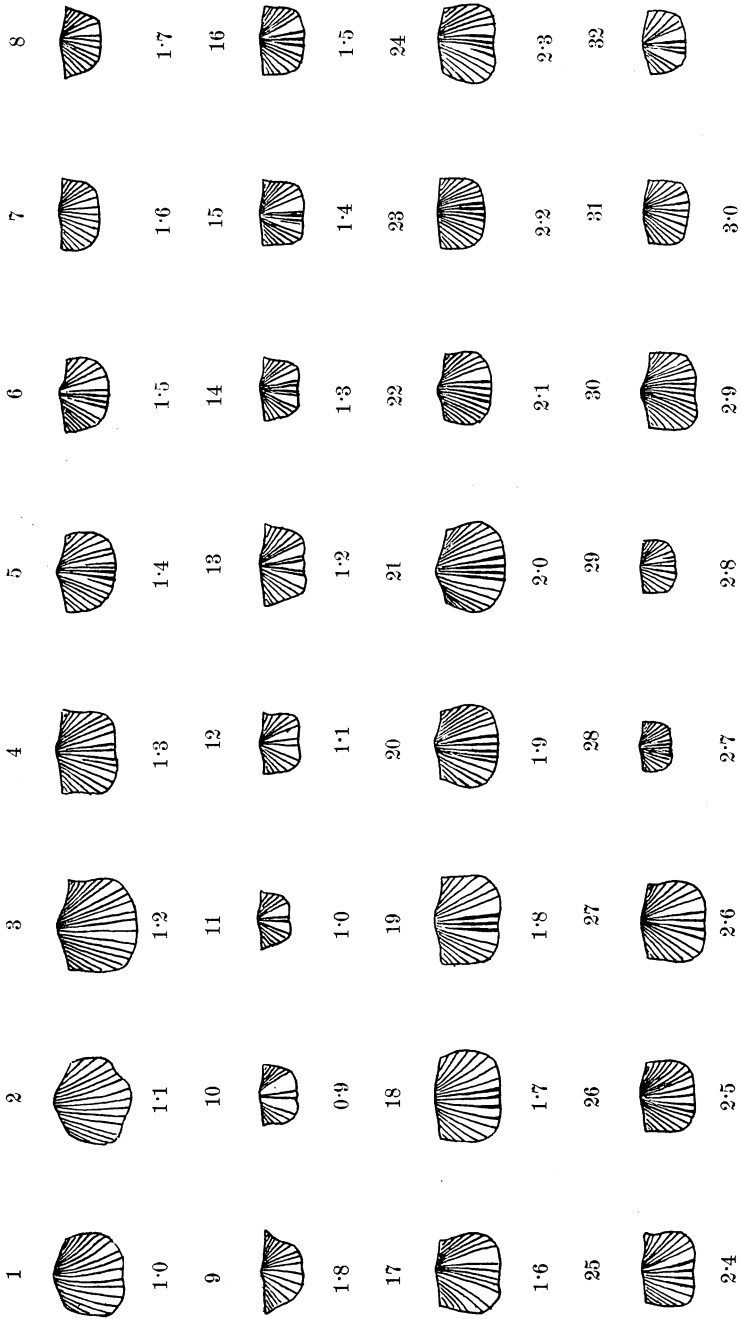
\*As stated in a preceding footnote, the other forms, *acutilirata* Conrad, *biforata* Schl. and other foreign forms of *Platystrophia* are not considered in this paper. The form identified by Miller, and doubtfully by Meek, as *dentata* Pander is the *costata* of the latter author. Pander has figured *dentata* and *costata* (= *chama* Eichwald) side by side on pl. xi of his *Beitrage zur Geog. Russ.* *Dentata* has two plications in the sinus and three on the fold, while *costata* has one in the sinus and two on the fold. The name *chama* Eichwald cannot be retained for this variety, since the *Spirifer costatus* of Sowerby is a true *Spirifer*, and there is no other prior use of the name *costata* among the Orthidæ. See de Verneuil *Geol. de la Russie*, p. 140, and Sowerby, *Tr. Geol. Soc. Lond.*, 2d ser., v, pl. lv, fig. 5-7. On the varieties of *Platystrophia* see especially Meek, *Pal. Ohio*, i, 1873, pp. 112-121; Hall, *Pal. N. Y.*, i, 1847, pp. 133-134; Winchell and Schuchert, *Minn. Geol. Surv.*, iii, 1893, pp. 454-457; Davidson, *British Silurian Brachiopoda*, 1871, p. 268 et seq.; Schuchert, *Bull. 87, U. S. G. S.*, p. 308; Sardeson, *Am. Geol.*, xix, p. 109.

PLATE II.



Figs. 1 to 19 inclusive, plications on ventral valve. Figs. 20 to 26 inclusive, plications in sinus. Figs. 27 to 32 inclusive, plications on fold. Numbers below the figures refer to number of plications in each case.

PLATE III.



Figs. 1 to 9 inclusive, shell index. Figs. 10 to 31 inclusive, sinus index. Numbers below the figures give the value of the index in each case.