

more ancient channel than any of these, however, is found from a to b. This rises on much higher ground at a and though not so well marked as the more recent channel its lower course, as it nears b, has become well emphasized by recent drainage of the adjacent country.

The stream will probably forage its way to all the bounding ridges and denude them—render them bluffs—before cutting its new channel, xy, when it will again leave them to weather themselves into symmetrical shapes, dress in forest verdure and present history as well as future possibilities, which speculation in this age is unable to suggest.

NOTES ON THE ORDOVICIAN ROCKS OF SOUTHERN INDIANA.

BY EDGAR R. CUMINGS.

The present paper dealing with the stratigraphy of the Ordovician of Indiana is preliminary to a more complete report on this interesting series of rocks, which the writer has in preparation. In the latter paper an extended discussion of the faunas of these rocks will be possible. At present the study of the large collections obtained is not sufficiently advanced to admit of any such presentation. It is therefore proposed to give here practically nothing but the notes taken in the field, with such supplementary remarks as may seem necessary.

The work of the Indiana University Geological Survey during the field season of 1900 covered the counties of Dearborn, Switzerland, Ohio and Jefferson. The following sections were measured and from most of them extensive collections were made:

Section in Kentucky opposite the mouth of the Miami River (5.9A):*

	<i>Ft.</i>	<i>In.</i>
51—Covered to top of hill	112	..
50—Fragments of Strophomenoid shells.....	..	7
49—Shale	1	..
48—Limestone. Fragments of Brachiopods.....	..	6
47—Shale	1	..
46—Hard limestone with <i>Rafinesquina</i>	..	5
45—Shale	2	4
44—Limestone. <i>Rafinesquina</i> abundant	..	5
43—Covered, probably shale	17	6

* This section in Kentucky is given because it is the farthest east of any section showing exposures of rock to river level.

	<i>Ft.</i>	<i>In.</i>
42—Shale	2	6
41—Limestone	5	2
40—Shale with thin layers of sandstone.....	8	6
39—Limestone with Bryozoa and <i>Rafinesquina</i>	..	3
38—Mostly shale.....	10	8
37—Crystalline limestone. <i>Rafinesquina</i> and <i>Dalmanella</i>	9	..
36—Shale	2	3
35—Thin layers of bryozoal limestone	1	..
34—Shale	6	9
33—Bryozoal limestone	..	6
32—Shale	7	..
31—Limestone, shale at top. <i>Dalmanella</i> (aa)	..	7
30—Covered	42	..
29—Compact highly crystalline limestone; few fossils.....	..	3
28—Shale	2	9
27—Highly crystalline limestone containing fragments of <i>Asaphus</i> ...	..	7
26—Shale	..	5
25—Compact limestone containing <i>Dalmanella</i>	..	5
24—Covered, probably some limestone.....	16	..
23—Brachiopod limestone (?).....	..	4
22—Covered	8	4
21—Limestone. <i>Rafinesquina</i> and Trilobites.....	..	3
20—Shale	6	4
19—Covered (probably shale).....	16	..
18—Limestone (in place?)	..	6
17—Shale	10	8
16—Limestone. Bryozoa, <i>Plectambonites</i>	..	3
15—Shale	1	..
14—Limestone. <i>Dalmanella</i> , <i>Plectambonites</i>	..	2
13—Shale	..	7
12—Sandstone	..	3
11—Shale	2	9
10—Limestone with <i>Dalmanella</i>	..	3
9—Shale, possibly some sandy layers	5	..
8—Hard compact limestone, very few fossils.....	..	5
7—Shale	6	..
6—Layer of crystalline, crinoidal limestone.....	..	..
5—Partly covered, mostly shale	33	..
4—Sandy layer with <i>Trinucleus concentricus</i>	..	1
3—Shale	5	4
2—Limestone containing <i>Dalmanella</i> (aa*).....	2	3
1—Shale to level of Ohio river.....	6	2
Total section.....	361	..

* a, abundant; aa, very abundant; c, common; r, rare.

In the high hill just south of Aurora the rocks are exposed as follows (½ 1.35 A):

	<i>Ft.</i>	<i>In.</i>
45—A few layers at the top contain <i>Rafinesquina</i> , the remainder covered.....	60	..
44—Limestone with <i>Platystrophia</i> , <i>Hebertella</i> , <i>Rafinesquina</i> , <i>Monticulipora</i> , etc.....	16	..
43—Highly fossiliferous limestone. <i>Platystrophia</i> , <i>Hebertella</i> , etc....	1	6
42—Shale with occasional layers of limestone	4	4
41—Limestone with <i>Zygospira</i> and Gastropoda	3	4
40—Limestone. <i>Rafinesquina</i> (aa)	1	6
39—Shale.	..	8
38—Same as 32.....	..	4
37—Covered	1	8
36—Coarsely crystalline highly fossiliferous limestone.....	..	2
35—Covered	6	10
34—Same as 32.....	..	3
33—Shale.	1	8
32—Coarse-grained fossiliferous limestone, with yellow argillaceous material in streaks	..	8
31—Shale	..	6
30—Limestone. <i>Zygospira</i> and <i>Hebertella</i>	..	6
29—Shale and shaly limestone	1	3
28—Very fine grained compact limestone, no fossils.....	..	3
28—Shale.	1	..
26—Limestone intercalated with shale	1	6
25—Shale.	..	9
24—Sandstone	..	3
23—Covered	2	6
22—Coarse-grained, blue limestone, mottled with brown. Large thick-shelled <i>Rafinesquinas</i>	..	8
21—Shale.	..	8
20—Hard blue crystalline.....	..	8
19—Covered	1	4
18—Limestone (in place?)	..	10
17—Covered, probably limestone	10	8
16—Steel-blue finely crastalline limestone with <i>Rafinesquina</i>	..	5
15—Shale.	..	8
14—Shaly sandstone.....	..	3
13—Coarse crystalline limestone.....	..	8
12—Shale.	..	6
11—Compact limestone, gray mottled with yellow.....	..	6
10—Shale.	..	9
9—Compact fine-grained drab limestone. Few fossils	..	9
8—Shale.	1	..

	<i>Ft.</i>	<i>In.</i>
7—Compact, hard, coarsely crystalline limestone containing <i>Rafinesquina</i> ..	7	7
6—Shale ..	10	10
5—Blue crystalline limestone. <i>Rafinesquina</i> ..	4	4
4—Shale ..	6	6
3—Crystalline limestone with <i>Rafinesquina</i> , <i>Platystrophia</i> , <i>Monticulipora</i> , etc.	6	6
2—Talus with immense number of fossils ..	85	..
1—Covered to the level of the river. <i>Dalmanella</i> abundant in the loose pieces near the bottom ..	180	..
Total section ..	393	..

On the north side of Laughery Creek, opposite Hartford, the following section was measured : (§ 1.36 A.)

	<i>Ft.</i>	<i>In.</i>
34—To top of the hill, loose pieces of limestone containing <i>Platystrophia</i> and <i>Hebertella</i> ..	60	..
33—Thin bedded limestone ..	5	5
32—Covered ..	2	8
31—Same as 29.	3	3
30—Shale ..	4	4
29—Limestone with argillaceous streaks ..	5	5
28—Covered ..	2	8
27—Hard compact limestone.	4	4
26—Covered ..	8	8
25—Coarse-grained crystalline argillaceous limestone ..	4	4
24—Covered ..	6	6
23—Limestone containing Gastropoda and <i>Rafinesquina</i> ..	6	6
22—Covered ..	5	..
21—Same as 18 ..	3	3
20—Covered ..	1	..
19—Same as 18 ..	4	4
18—Limestone coarsely crystalline, light colored ..	3	3
17—Sandstone ..	3	3
16—Same as 14 ..	2	2
15—Same as 14 ..	4	4
14—Drab crystalline limestone ..	3	3
13—Covered ..	6	6
12—Same as 10 ..	5	5
11—Covered ..	6	..
10—Thin-bedded crystalline limestone ..	6	5
9—Covered ..	1	4
8—Coarse crystalline limestone.	6	6
7—Covered ..	6	6

	<i>Ft.</i>	<i>In.</i>
6—Coarse crystalline limestone.....	..	10
5—Covered	10	8
4—Same as 2	..	3
3—Covered	..	2
2—Very hard compact limestone. <i>Rafinesquina</i>	..	9
1—Covered to level of road	150	..
Total section.....	255	..

In the bluff on the north side of Laughery Creek, a little over a mile west of Milton, the following section was measured: ($\frac{1}{2}$ 1.36 B)

	<i>Ft.</i>	<i>In.</i>
18—To top of hill. <i>Platystrophia</i> . <i>Hebertella</i> , etc., in loose pieces....	38	6
17—Limestone with <i>Platystrophia laticosta</i>	..	3
16—Covered	19	..
15—Same as 11	..	8
14—Covered	9	6
13—Same as 11	..	3
12—Covered	5	6
11—Coarse crystalline limestone, gray mottled with yellow	..	3
10—Covered	2	..
9—Thin-bedded limestone with <i>Rafinesquina</i> , crinoids, etc	1	2
8—Covered	4	2
7—Very coarse gray crystalline limestone. <i>Rafinesquina</i> (fragments) very abundant	..	4
6—Covered	43	..
5—Limestone with Bryozoa.....	..	6
4—Covered	48	..
3—Crystalline limestone with <i>Dalmanella</i>	..	6
2—Covered to road	43	4
1—Covered to creek level	20	..
Total section.....	237	..

In the north bluff of Laughrey Creek, one mile south of the mouth of Hayes branch, is the following section: ($\frac{1}{2}$ 1.36 C.)

	<i>Ft.</i>	<i>In.</i>
45—Covered to top of hill	40	..
44—Same as 43.....	10	..
43—Limestone with <i>Platystrophia</i> and <i>Hebertella</i>	1	..
42—Covered	5	6
41—Coarse crystalline limestone streaked with yellow. <i>Rafinesquina</i> ..	..	8
40—Partly covered. Limestone with <i>Rafinesquina</i>	12	6
39—Drab to bluish compact limestone, no fossils.....	..	8
38—Coarse gray crystalline limestone	1	4

	<i>Ft.</i>	<i>In.</i>
37—Covered	10	..
36—Coarse limestone streaked with yellow. Contains Bryozoa.....	1	6
35—Covered	4	..
34—Very hard compact limestone. Lower layer contains Brachiopoda and Bryozoa	..	3
33—Lime-tone containing large numbers of <i>Rafinesquina</i>	1	3
32—Covered	5	..
31—Coarse limestone. <i>Rafinesquina</i>	..	6
30—Covered	1	9
29—Limestone with layer of sandstone at the top.....	..	8
28—Covered.....	2	4
27—Limestone with Bryozoa and crinoids.....	..	7
26—Covered	1	4
25—Coarse blue limestone streaked with sandstone	1	..
24—Covered	1	8
23—Blue coarse-grained limestone with Brachiopoda and Bryozoa....	..	4
22—Covered	..	6
21—Coarse-grained blue compact limestone.....	..	3
20—Covered	20	9
19—Coarse lumpy argillaceous limestone. Bryozoa.....	..	7
18—Covered	..	6
17—Very coarse, ferruginous, Bryozoal limestone.....	1	2
16—Covered	5	4
15—Yellow-mottled limestone. Bryozoa.....	..	5
14—Covered	5	..
13—Blue coarse limestone. Fragment of <i>Rafinesquina</i> very abundant.	..	5
12—Covered	1	2
11—Fine grained limestone. Bryozoa.....	..	6
10—Covered	3	4
9—Gray limestone with large white crystals of calcite. Many frag- ments of fossils.....	..	9
8—Covered	16	..
7—Coarse, crystalline, drab, unfossiliferous limestone	..	3
6—Covered	1	6
5—Thin limestones. Bryozoa very abundant.....	..	1
4—Coarse gray crystalline limestone. <i>Dalmanella</i> (aa)	..	5
3—Covered	22	..
2—Blue-mottled crystalline limestone.....	..	5
1—Covered	50	..
Total section.....	235	

Level of the creek.

Just south of the Weisburg station, in the bank of the creek to the west of the railroad, the upper layers of the Ordovician are exposed. From this exposure a large and very satisfactory collection of fossils was obtained. A section at this point is as follows (§ 1.34 A):

	<i>Fl.</i>	<i>In.</i>
15—A number of feet of barren limestones.....		
14—Blue compact fine-grained limestone. No fossils.....	1	..
13—Covered	5	..
12—Compact limestone. <i>Rhynchotrema capax</i>	..	6
11—Thin-bedded limestone.....	1	..
10—Very compact, fine-grained limestone	..	8
9—Calcareous shale with <i>Strophomena</i>	..	7
8—Limestone. Fragments of <i>Asaphus</i>	..	4
7—Shale	..	9
6—Limestone with <i>Hebertella</i>	..	3
5—Limestone same as 4.....	..	8
4—Blue limestone with <i>Rafinesquina</i> edgewise (aa).....	..	3
3— <i>Rafinesquina</i> flatwise (a).....	..	3
2—Shale	..	2
1—Coarse compact limestone, no fossils	..	10
Total section.....	12	—

Level of creek below railroad culvert.

Continuing on down the creek from this point, the following layers are passed over (§ 1.34 B):

	<i>Fl.</i>	<i>In.</i>
4—Limestone	..	8
3—Irrregular lumpy shale	2	6
2—Limestone and shale with <i>Rafinesquina</i> and <i>Hebertella</i>	1	4
1—Very coarse-grained limestone. <i>Rhynchotrema</i> (aa)	2	3

Down stream from this point no measurements were made, owing to the effect of rainy weather upon the barometer, but the characteristic fossils of the successive layers were noted. These are as follows from the last mentioned layer downward (§ 1.34 C):

- 16—*Plectambonites sericea* (aa).
- 15—*Strophomena rugosa* (aa).
- 14—Barren shale.
- 13—*Strophomena*.
- 12—*Streptelasma* (aa).
- 11—*Hebertella* (aa).
- 10—*Streptelasma*.
- 9—*Leptæna rhomboidalis* (aa).

- 8—*Dinorthis subquadrata* (a).
 7—*Hebertella occidentalis* (a).
 6—*Rafinesquina*, *Streptelasma*, *Platystrophia*, *Leptæna*.
 5—*Rafinesquina*, *Monticulipora*.
 4—*Dalmanella* (shaly limestone).
 3—*Rafinesquina*.
 2—*Asaphus*, *calymene*. *Rafinesquina*.
 1—*Rafinesquina*.

Rafinesquina remains the dominant fossil for some distance farther down the creek, where its place is taken by the several varieties of *platystrophia biforata*.

No good sections of the Ordovician are to be found in the vicinity of Rising Sun. Numerous exposures of the various members may, however, be seen at a number of points. These exposures show that the lower members are, as in the other localities already studied, characterized by the great abundance of *Dalmanella* and *Plectambonites*. These fossils are succeeded in the beds next above by a number of species of *Trepostomata*, which in places completely fill the rocks.

Above the Bryozoa beds *Rafinesquina alternata* becomes abundant, though of course occurring in limited numbers at almost every level. Next follows the zone of *Platystrophia biforata* and its varieties. This is in turn succeeded in the tops of the hills by a zone in which a varietal form of *Rafinesquina alternata* is abundant, to the exclusion in places of almost every other fossil. The higher zones are not present in the vicinity of Rising Sun.

Vevay, in Switzerland county, is one of the best localities in the State for the collection of Ordovician fossils, and especially of the various forms of *Platystrophia*. Two detailed sections were measured at this place. These are designated A and B. Section A begins at the head of Main Cross street and extends up the little gully just east of the Orphan Asylum.

This section (A) is as follows ($\frac{1}{2}$ 1, 38 A.):

	<i>Ft.</i>	<i>In.</i>
87—Covered to the top of the hill.....	80	..
86—Limestone with <i>Platystrophia</i> and <i>Hebertella</i>	6	..
85—Yellowish argillaceous sandstone.....	..	4
84—Thin-bedded limestone containing <i>Platystrophia</i> and <i>Hebertella</i>	12	..
83— <i>Platystrophia biforata</i>	..	6
82—Yellow sandstone.....	..	4
81—Covered	3	3
80—Argillaceous arenaceous limestone.....	..	4
79—Some covered, mostly thin layers with <i>Rafinesquina</i>	14	..
78—Limestone with <i>Rafinesquina</i> and Bryozoa.....	..	5
77—Covered	3	8
76—Compact limestone with <i>Rafinesquina</i>	..	4

	<i>Ft.</i>	<i>in.</i>
75—Covered	..	6
74—Same as 72.....	3	8
73—Covered	1	3
72—Coarse-grained limestone <i>Zygospira</i> <i>Bryozoa</i>	..	4
71—Covered	3	..
70—Fine-grained limestone. <i>Zygospira</i>	..	3
69—Shale	..	6
68—Coarse limestone <i>Rafinesquina</i> (aa).....	..	5
67—Covered	1	8
66—Thick, coarse, light gray limestone. Fragments of <i>Rafinesquina</i> (aa). <i>Zygospira</i> (c)	1	..
65—Thin-bedded light colored limestone. <i>Bryozoa</i>	8	..
64—Covered	6	..
63—Bryozoal limestone	..	6
62—Covered	..	8
61—Limestone. <i>Dalmanella</i> (aa).....	1	2
60—Covered	8	8
59—Dark drab limestone. <i>Dalmanella</i>	..	4
58—Covered	2	..
57—Compact limestone with <i>Dalmanella</i> (aa).....	..	7
56—Covered, probably limestone.....	25	..
55—Coarse limestone with large white crystals of calcite.....	..	6
54—Shale.....	..	6
53—Limestone, fragments of <i>Rafinesquina</i> (aa).....	..	3
52—Shale	..	10
51—Limestone flecked with large flakes of calcite.....	..	3
50—Shale	2	8
49—Coarse grained limestone. <i>Dalmanella</i> (aa).....	..	6
48—Shale	1	..
47—Limestone with <i>Dalmanella</i> and <i>Bryozoa</i>	..	3
46—Yellow weathering shale.....	2	..
45—Thin layers of limestone with <i>Dalmanella</i>	5	..
44—Shale	2	3
43—Layers of calcareous sandstone	..	6
42—Shale	3	..
41—Limestone	..	2
40—Shale	3	8
39—Crinoidal limestone.....	..	8
38—Shale	5	..
37—Bryozoal limestone in thin layers.....	2	6
36—Shale and thin limestone.....	2	6
35—Bryozoal limestone	5	..
34—Shale	2	..
33—Massive hard limestone. Fragments of <i>Dalmanella</i> and <i>Bryozoa</i> ..	..	10

	<i>Ft.</i>	<i>In.</i>
32—Thin limestone and shale. <i>Dalmanella</i>	2	4
31—Limestone. Very perfect specimens of <i>Dalmanella</i> (aa).....	..	4
30—Shale.....	1	8
29—Limestone. <i>Rafinesquina</i> (aa).....	..	7
28—Shale.....	..	8
27—Sandstone.....	..	4
26—Shale with thin layers of limestone.....	6	3
25—Dark crystalline limestone. Few fossils.....	..	4
24—Shale.....	5	4
23—Limestone. Crinoids. Bryozoa. Trilobites. <i>Dalmanella</i>	..	7
22—Shale.....	2	6
21—Limestone. Fragments of Trilobites and <i>Dalmanella</i>	..	3
20—Shale.....	..	7
19—Thin layers of limestone with intercalated shale.....	1	..
18—Shale.....	7	..
17—Limestone. Fragments of <i>Dalmanella</i> , <i>Rafinesquina</i> and Bryozoa..	..	3
16—Shale.....	2	6
15—Same as 13.....	..	6
14—Shale.....	..	5
13—Compact Bryozoal limestone.....	..	3 to 5
12—Shale, with occasional layers of limestone containing stems of Bryozoa.....	6	4
11—Limestone spotted with argillaceous material and containing large Bryozoa.....	..	3
10—Shale with occasional thin lenticles of limestone.....	2	3
9—Thin layers of fine-grained compact limestone containing <i>Dalma-</i> <i>nella</i> and Bryozoa.....	1	..
8—Shale.....	1	..
7—Limestone with argillaceous material in spots. Contains <i>Dalma-</i> <i>nella</i>	..	5
6—Shale.....	4	..
5—Same as 3.....	..	10
4—Shale.....	4	6
3—Dark blue crystalline limestone. <i>Plectambonites</i> and <i>Dalmanella</i> (aa) ..	..	6
2—Blue clay shale.....	6	..
1—Covered to river level.....	101	..
Total section.....	389	..

Along the road (not the pike) running over the hill back of Vevay most of the rocks of section A are exposed together with *all* of the rocks represented by No. 87 (covered) of that section. The latter are very important, inasmuch as they include the greater part of the platystrophia beds, here ideally exposed for the collection of fossils. In fact several hundred specimens of this species were

obtained, most of them in an excellent state of preservation. An exact record was kept of the layer from which each specimen came, thereby rendering the material of the utmost value for the study of variation.

This section (B) is as follows ($\frac{1}{2}$ 1.38 B):

	<i>Ft.</i>	<i>In.</i>
60—Heavy compact limestone. Few fossils	27	..
59—Shaly limestone with <i>Platystrophia lynx</i> . <i>Hebertella</i> , <i>Montculipora</i> , etc., <i>P. laticosta</i> toward the top	49	..
58—Shaly limestone. <i>Hebertella</i> (aa) some <i>Platystrophia</i> and <i>Rafinesquina</i>	10	8
57—Shaly limestone. <i>Rafinesquina</i> and <i>Hebertella</i>	2	..
56—Thin argillaceous limestone	16	..
55—Limestone. Base of <i>Platystrophia</i> zone	..	3
54—Limestone	..	3
53—Limestone. <i>Rafinesquina</i> ..	2	10
52—Limestone with <i>Zygospira</i>	..	5
51—Limestone with <i>Rafinesquina</i>	6	4
50—Very coarsely crystalline gray white-spotted limestone	..	6
49—Sandstone	..	1
48—Crinoidal limestone with fragments of <i>Raf.</i> (aa)	..	4
47—Covered	7	..
46—Mostly limestone with <i>Rafinesquina</i>	5	4
45—Fine grained limestone with <i>Rafinesquina</i>	..	2
44—Covered	2	4
43—Limestone with Bryozoa (aa)	..	3
42—Limestone with <i>Rafinesquina</i>	..	5
41—Covered	1	10
40— <i>Rafinesquina</i> . Bryozoa	..	8
39—Covered	17	..
38—Thin layer of light colored limestone with <i>Rafinesquina</i> (shells weathering red)	1	3
37—Covered	2	4
36—Same as 35	1	..
35—Limestone with <i>Dalmanella</i> (aa). Bryozoa (aa) <i>Rafinesquina</i> (frag- ments)	4	..
34—Limestone. Soft, gray. <i>Dalmanella</i> (aaa)	1	6
33—Covered: some exposed shale and limestone	12	..
32—Thin limestones	1	8
31—Coarsely crystalline light gray limestone containing <i>Dalmanella</i> and Bryozoa	..	8
30—Covered	5	6
29—Compact limestone. <i>Dalmanella</i> and Bryozoa	1	..
28—Shale	..	4
27—Limestone	..	4
26—Shale	7	..

	<i>Ft.</i>	<i>In.</i>
25—Limestone. <i>Dalmanella</i> (aa) Bryozoa. Fragments of <i>Rafinesquina</i>	1	3
24—Shale with thin layers of Bryozoal limestone	4	..
23—Bryozoal limestone with some shale.....	4	4
22—Shale	2	2
21—Limestone with Bryozoa and <i>Zygospira</i>	..	5
20—Shale	1	2
19—Bryozoal limestone	..	4.
18—Shale	..	10
17—Thin layers of Bryozoal limestone.....	1	9
16—Shale	1	6
15—Two four-inch layers of Bryozoal limestone	..	8
14—Blue shale.....	5	4
13—Bryozoal limestone	..	6
12—Mostly compact Bryozoal limestone.....	5	..
11—Coarse crystalline Bryozoal limestone.....	..	10
10—Covered, probably shale	5	6
9—Limestone and shale. <i>Dalmanella</i>	2	6
8—Layers of limestone with <i>Dalmanella</i> Bryozoa, etc.....	1	..
7—Covered, probably shale	2	2
6—Compact limestone with <i>Dalmanella</i> . Lower part consisting of sandstone	..	8
5—Covered	5	6
4—Limestone with <i>Rafinesquina</i> (aa)	..	6 to 8
3—Shale ..	5	6
2— <i>Dalmanella</i> layer	..	..
1—Covered to river level.....	140	..
Total section.....	385	..

The *Platystrophia* beds are to be seen about Mt. Sterling and in the banks of the east branch of Indian Creek. They reach the bed of the creek two miles northwest of the former place. In the bed of the creek just west of Mt. Sterling the zone of *Dalmanella* is exposed and extends up the creek for a mile and a half. Here it is succeeded by the *Rafinesquina* zone and then by the *Platystrophia* zone, as stated. One mile northwest of Bennington along the road the zone of *Rhynchotrema capax* is exposed, and between the latter place and the *Platystrophia* zone are abundant exposures of the upper zone of *Rafinesquina*. Large collections were obtained from all of these zones and await description in another paper.

The Ordovician and Silurian rocks of Madison, Jefferson County, Indiana, have for many years been the subject of more or less detailed study by geologists and paleontologists. The sections of the Madison hill in the railroad cut as given by Owen and Borden* are certainly far from being accurate. The writer

*Geol. surv. Ind., 1874, E. T. Cox; pp. 164-166.

obtained from Mr. W. B. Blake, engineer of the P., C., C. & St. L. Railway, accurate data in regard to the per cent. of grade, length and depth of the cuts, and distance between same, for the steep Madison hill grade of the road above mentioned. The elevation of the terrace upon which Madison stands is approximately 60 ft. above river level, and the elevation of North Madison above Madison is 427 ft. The old reservoir at the south end of the big cut is given in Borden's report (loc. cit.) as 210½ ft. above low water of the Ohio River. The data given me by Mr. Blake are as follows: Grade, five and eighty-nine one-hundredths per cent. (5.89%); distance of south end of south cut from low water mark on north side of Ohio River, 2,700 ft.; distance through south cut, 800 ft.; distance from north end of south cut to south end of north cut, 1,100 ft.; distance through north cut, 1,100 ft.; besides this there are north of the north cut about 1,500 ft. of cut in places 40 ft. deep. The maximum depth of the south cut is 60 ft. and of the north cut 100 ft. The section which follows was measured independently of these figures and departed very little from them. One or two corrections have been made, however, in accordance with the above data. Section of the cut at Madison (½ 1.12 A.):

	<i>Ft.</i>	<i>In.</i>
71—Massive whitish limestone	10	.
70—One layer of bluish-white limestone.....	5	..
69—Thin-bedded limestone like No. 70.....	5	..
68—Blue shale.....	2	6
67—White arenaceous limestone.....	3	10
66—Shaly sandstone and shale	8	3
65—Massive white arenaceous limestone (Niagara).....	2	6
64—From a few inches to nearly a foot of pinkish or yellowish to salmon colored crystalline limestone (Clinton?).....	1	..
63—Massive white arenaceous limestone	4	2
62—Thick-bedded argillaceous arenaceous limestone	9	8
61—Same as 62, but banded on weathered surface with pink, gray, and buff	12	10
60—One massive conspicuous arenaceous layer	3	6
59—Thin-bedded, argillaceous, arenaceous, weathering brownish, with some calcareous layers containing Bryozoa	7	..
58—Nothing to four inches of coarse limestone with Ordovician fossils ..	..	4
57—Sandstone with lenticles of limestone containing Bryozoa.....	3	..
56—Argillaceous layer. <i>Faristella stellata</i>	2	..
55—Shale	6	..
54— <i>Faristella steliata</i>	1	2
53—Thin layers of limestone alternating with argillaceous and sandy layers. Bryozoa (aa). <i>Rafinesquina</i> . <i>Hebertella</i>	5	3
52—Massive soft sandstone.....	7	8

	<i>Ft.</i>	<i>In.</i>
51—Blue fossiliferous limestone shale and arenaceous layers.....	6	..
50—Fine shale with layers of limestone, <i>Rhynchotrema</i> , <i>Hebertella</i> , <i>Monticulipora</i> , <i>Calymene</i> , <i>Rafinesquina</i>	10	..
49—Same as 50. <i>Strophomena</i> , <i>Streptelasma</i> , <i>Plectambonites</i> , <i>Dalmanella</i> , <i>Platystrophia laticosta</i> , <i>Ambonychia</i>	8	..
48—Probably shale and thin layers of limestone; covered by talus ...	22	..
47—Heavy layers of limestone seen in the <i>west</i> side of the south cut, at the top.		
46—Heavy layers of limestone seen in the <i>east</i> side of the south cut, at the top.		
The lowest layers in the big cut (north cut) are 24 feet above the top of No. 45 if the foot of the big cut be taken as 210 feet above the river. Part of the layers of No. 46 would therefore be repeated in 45. Allowance is made for this fact. Nos. 46 and 47 together	24	..
45—Shale. The top of No. 45 is at the culvert just north of the south cut.....	10	..
44—Several layers of limestone with <i>Cyclonema</i> , <i>Rafinesquina</i> , <i>Calymene</i> , etc	1	2
43—Shaly limestone. <i>Cyclonema</i>	2	8
42—Limestone. <i>Ambonychia</i> , <i>Cyclonema</i> , <i>Rafinesquina</i> , <i>Monticulipora</i> , Crinoids.....	2	..
41—Limestone and shale. <i>Ambonychia</i>	5	..
40—Compact close-grained limestone. <i>Rafinesquina</i>	..	3
39—Limestone and shale. <i>Zygospira</i> , <i>Ambonychia</i>	2	4
38—Limestone. <i>Rafinesquina</i> edgewise (aaa)	..	4
37—Argillaceous compact limestone. <i>Rafinesquina</i>	6	9
36—Limestone. Bryozoa	..	6
35—Shaly limestone.....	5	8
34—Limestone	..	8
33—Shaly limestone.....	2	8
32—Limestone. <i>Rafinesquina</i> , <i>Calymene</i> , <i>Hebertella</i> (?), Gastropoda, Bryozoa	..	8
31—Shale, with occasional 2-inch to 3-inch layers of limestone.....	10	8
30—Limestone. <i>Rafinesquina</i> edgewise (aaa).....	..	3
29—Shaly limestone. <i>Rafinesquina</i> (aa), <i>Modiolopsis</i> (aa), <i>Zygo-</i> <i>spira</i> (aa).....	6	9
28—Similar to 26.....	..	4
27—Shaly limestone.....	1	4
26—Blue fine-grained limestone. <i>Zygospira</i> (aaa).....	..	3
25—Shaly limestone. <i>Rafinesquina</i> , etc	13	..
24—Very compact fine-grained limestone; no fossils.....	..	6
23—Shale and limestone, with excellently preserved specimens of <i>Ra-</i> <i>finesquina</i> (aa).....	4	2

	<i>Ft.</i>	<i>In.</i>
22—Limestone, with top of layer composed of immense numbers of <i>Zygospira modesta</i> ..		3
21—Rather coarse shale.	2	..
20—Lumpy, shaly limestone. <i>Asaphus</i> , <i>Rafinesquina</i> ..	3	..
19—Coarse to fine-grained barren limestone ..		8
18—Lumpy, shaly limestone. <i>Rafinesquina</i> (aa), <i>Trilobites</i> (a), <i>Zygospira</i> , <i>Streptelasma</i> , <i>Bryozoa</i> ..	12	..
17—Limestone, with <i>Rafinesquina</i> , <i>Zygospira</i> (aa), <i>Bryozoa</i> , <i>Orthoceras</i> . ..	5	10
16—Shale, with thin layers of limestone ..	1	..
15—Very compact, fine-grained blue barren limestone.	..	6
14—Shale ..	..	8
13—Compact limestone. <i>Calymene</i> , <i>Zygospira</i> , etc ..	..	5
12—Limestone. <i>Calymene</i> (aa), <i>Bryozoa</i> , <i>Rafinesquina</i> , <i>Orthoceras</i>	1	3
11—Shale, with thin layers of limestone ..	3	8
10—Thin argillaceous limestone with <i>Calymene</i> and <i>Bryozoa</i> (a)	1	..
9—Massive blue limestone. <i>Rafinesquina</i> , <i>Trilobites</i> , <i>Bryozoa</i>	..	7
8—Limestone. <i>Rafinesquina</i> , <i>Zygospira</i> , <i>Bryozoa</i>	2	9
7—Thin argillaceous yellow-spotted limestone. <i>Platystrophia</i> , <i>Hebertella</i> . <i>Rafinesquina</i> , <i>Bryozoa</i>	1	..
6—Limestone. <i>Hebertella</i> (aa), <i>Rafinesquina nasuta</i> , <i>Platystrophia lynx</i> . ..	1	2
5—Bryozoal limestone ..	..	4
4—Covered, probably shale.	1	..
3—Limestone with <i>Trilobites</i> , <i>Zygospira</i> , etc ..	..	2
2—Coarse crystalline limestone. <i>Hebertella</i>	..	6
1—Covered to river level.	62	..
Total section.	357	

Number 7 of this section represents the top of the *Platystrophia* zone. At Vevay the top of the same zone is 358 feet above river level, and at Lawrenceburg about 390 feet. The Madison section affords an excellent opportunity to study the upper *Rafinesquina* zone. It is in the upper zone that this fossil is so constantly associated with *Zygospira modesta* and a number of species of *Lamellibranchs*. In the lower zone it has no such constant associates.

Section along Clifty creek (§ 1.12 B):

	<i>Ft.</i>	<i>In.</i>
22—Limestone. <i>Rafinesquina</i> , <i>Lamellibranchiata</i> , <i>Gastropoda</i> , <i>Crinoids</i> ..	..	6
21—Limestone and coarse lumpy shale.	7	4
20—Shale and limestone. Top, a heavy layer of limestone with conspicuous wave-like markings ..	21	4
19—Partly covered, but represented by heavy layers of limestone in the bank above 18 ..	11	..
18—Limestone and shale.	14	4
17—Limestone. <i>Rafinesquina</i> (aaa), <i>Hebertella</i> ..	5	..

	<i>Ft.</i>	<i>In.</i>
16—Shale, shaly limestone, some thick layers of limestone. <i>Rafinesquina</i> , Bryozoa, Trilobites, <i>Zygospira</i> (aaa) in some layers.....	40	..
15—Heavy layer of limestone.....	..	6
14—Shale and shaly limestone. Trilobites (a).....	9	5
13—Limestone. <i>Rafinesquina</i> , <i>Asaphus</i> , <i>Calymene</i> , <i>Platystrophia</i>	8	6
12—Mostly shale	4	10
11—Argillaceous compact layer. Trilobites, Gastropods.....	..	6
10—Shaly limestone.....	2	9
9—Limestone and shale. <i>Platystrophia</i> . <i>Hebertella</i>	3	..
8—Limestone. <i>P. lynx</i> and <i>laticosta</i> . <i>Hebertella</i>	3	6
7—Covered	10	..
6—Limestone, more shaly than 5. <i>Hebertella</i> (form with dorsal fold), <i>P. lynx</i> and <i>laticosta</i>	3	..
5—Same as 4 but <i>P. laticosta</i> more abundant	3	10
4—Thin shaly limestone. <i>Hebertella</i>	1	2
3—Thin shaly limestone. <i>Hebertella</i> , <i>P. laticosta</i> , <i>Monticulipora</i> (aa). ..	1	..
2—Thin shaly limestone. <i>P. lynx</i> (aa), <i>laticosta</i> (a), <i>Hebertella occidentalis</i> (c) Trilobites, <i>Monticulipora</i>	1	..
1—Covered to river level.....	45	..
Total section.....	198	

This section shows some 30 feet more of the *Platystrophia* beds than the Madison section; otherwise it is the same in the main as the basal part of that section.

P. lynx is here abundant in the lower layers and *laticosta* in the upper layers.

From the detailed sections now described of the Ordovician rocks of Indiana it will at once be seen that there are certain well-defined faunal zones which may be traced without fail over the whole area. It has long been known that the zone characterized by the presence in abundance of *Platystrophia*, forms a well-marked and persistent stratum; but apparently the other zones, if recognized at all, have been minimized in importance. Any one of them is however as persistent and as easily traced as the *Platystrophia* zone.

These zones are in ascending order as follows (the thickness is given in parentheses):

- 1—*Dalmanella multisecta* (200–240 feet).
- 2—*Rafinesquina alternata* 50–70 feet).
- 3—*Platystrophia* (60–80 feet).
- 4—*Rafinesquina alternata* var. *fracta* (100 feet $\pm$).
- 5—*Dalmanella Meeki* (20 feet $\pm$).
- 6—*Streptelasma*.
- 7—*Strophomena* (10 feet $\pm$).
- 8—*Rhynchotrema capax* (10 feet $\pm$).