

145. *Samolus Valerandi*, L. Var. *Americanus*, Gray. Water Pimpernel. Brook weed. Bank of Pinnebog River. Hume Township.
146. *Fraxinus sambucifolia*, Lam. Black Ash. Swamps in central part of county.
147. *Apocynum androsaemifolium*, L. Spreading Dogbane. Near Port Austin.
148. *Apocynum cannabinum*, L. Indian Hemp. Stream banks near Port Austin.
149. *Asclepias tuberosa*, L. Butter-fly weed. Pleurisy-root. Sand dunes near Port Austin.
150. *Asclepias incarnata*, L. Swamp milkweed. Swampy margins of streams.
151. *Asclepias Cornuti*, Decaisne. Common milkweed or silkweed. Roadsides and fields. Grows in bare sand in some places and serves to help keep it from drifting.
152. *Menyanthes trifoliata*, L. Buckbean. Bog in Chandler Township.
153. *Cynoglossum officinale*, L. Hound's-tongue. Roadsides near Port Austin.
154. *Echinopspermum Lappula*, Lehm. Waste places. Port Austin.
155. *Lithospermum hirtum*, Lehm. Puccoon. Sand dunes near Port Austin.
156. *Convolvulus sepium*, L. Hedge. Bind weed. Wild Morning Glory. Low grounds along the Pinnebog River. Hume Township.
157. *Cuscuta Gronovii*, Willd. Dodder. Parasite on various plants, valley of the Pinnebog River.
158. *Solanum nigrum*, L. Common Nightshade. Waste places, Port Austin.
159. *Verbascum Thapsus*, L. Mullein. Sterile soil, especially where fire has burned the other vegetation off within a few years.
160. *Linaria Canadensis*, Dumont. Sand dunes west of Port Crescent.
161. *Linaria vulgaris*, Mill. Butter and Eggs. Roadside, Bay Port.
162. *Chelone glabra*, L. Snake head. Banks of streams.
163. *Mimulus ringens*, L. Monkey-flower. Damp, open ground about Port Austin.
164. *Veronica Americana*, Schweinitz. American Brooklime. Brooks near Port Austin.
165. *Gerardia pedicularia*, L. Dry, sandy woods. North Charity Island.
166. *Gerardia quercifolia*, Pursh, Smooth False Foxglove. Dry sandy woods, North Charity Island.
167. *Gerardia purpurea*, L. Var. *paupercula*, Gray. Purple Gerardia. Very common on the shore near the hotel, Bayport. Also at Charity Island.
168. *Utricularia intermedia*, Hayne. Holes in the bog, Chandler Township.
169. *Utricularia cornuta*, Michx. Bladderwort. In shallow pool left by the retreat of the lake, on the beach just east of Port Austin. A small flowered stunted form of the species, common at Bayport on the flats along the Bay shore.
170. *Verbena urticaefolia*, L. White Vervain. Port Austin.
171. *Verbena hastata*, L. Blue Vervain. Low grounds, common.
172. *Mentha piperita*, L. Peppermint. Roadside near Port Austin.
173. *Mentha Canadensis*, L. Wild Mint. Low grounds and along streams.
174. *Calamintha clinopodium*, Benth. Basil. Dry banks and dunes about Port Austin.
175. *Monarda fistulosa*, L. Wild Bergamot. Sandy fields near the dunes. Port Austin.
176. *Nepeta Cataria*, L. Catnip. Waste places. Port Austin.
177. *Scutellaria lateriflora*, L. Low grounds. Pinnebog River, etc.
178. *Scutellaria galericulata*, L. Skullcap. Bog in Chandler Township.
179. *Marrubium vulgare*, L. Horehound. Roadside near Port Austin.
180. *Leonurus Cardiaea*, L. Motherwort. Waste places. Port Austin.
181. *Brunella vulgaris*, L. Self-heal. Woods and thickets.
182. *Amarantus albus*, L. Tumble weed. Growing in the sand at Port Austin and Port Crescent.
183. *Chenopodium Botrys*, L. Jerusalem Oak. Feather. Geranium. Ambrosia. Growing abundantly in the dune sand at Port Austin and about the old salt block at Port Crescent.
184. *Chenopodium album*, L. Pigweed. Common in waste places and cultivated ground.
185. *Chenopodium capitatum*, Watson. Strawberry Blite. Occasional in woods.
186. *Rumex crispus*, L. Curled Dock. Yellow Dock. Too common.
187. *Rumex obtusifolius*, L. Bitter Dock. Common in waste places.
188. *Rumex Acetosella*, L. Field or sheep sorrel. Common.
189. *Polygonum aviculare*, L. Knotweed. Common.
190. *Polygonum erectum*, L. Common along roadsides.
191. *Polygonum orientale*, L. Prince's Feather. Port Austin.
192. *Polygonum Persicaria*, L. Lady's Thumb. Gull Island, Lake Huron. Also in wet places.
193. *Polygonum cilinode*, Michx. Bindweed. Waste heaps about the quarries at Grindstone City. Rocky places west of Port Austin.
194. *Polygonella articulata*, Meisn. Abundant on the outer row of sand dunes.
195. *Saururus cernuus*, L. Lizard's-tail. Pinnebog River. Hume Township.
196. *Shepherdia Canadensis*, Nutt. Point Aux Barques on sandstone rocks overhanging the lake. Also on sand dunes west of Port Crescent.
197. *Comandra umbellata*, Nutt. Dry woods near Port Austin.
198. *Euphorbia Cyparissias*, L. At Bayport, where it covers considerable area. Also at Port Austin and Huron City in sand.
199. *Ulmus Americana*, L. White, or American Elm. Low grounds, common.
200. *Humulus Lupulus*, L. Common Hop. Near Port Austin.
201. *Betula lutea*, Michx. f. Yellow Birch. Common in low woods.
202. *Betula papyrifera*, Marshall. Paper or Canoe Birch. White Birch. Common.
203. *Alnus incana*, Willd. Speckled or Hoary Alder. Borders of streams.
204. *Quercus alba*, L. White Oak. Sand dunes at Port Austin.

205. *Quercus rubra*, L. Red Oak. Common on the sand dunes, where it is sometimes a large tree, but not usually. Evidently the large specimens have been cut for timber.
206. *Quercus coccinea*, Wang. Scarlet Oak. The most abundant species of oak in the dunes.
207. *Fagus ferruginea*, Ait. Beech. Common throughout the county on heavier soils.
208. *Salix*. Several species of Willows are common but were not found in favorable condition for study.
209. *Populus alba*, L. White Poplar. Port Austin.
210. *Populus tremuloides*, Michx. American Aspen. Quaking asp. Common in the east half of the county.
211. *Populus grandidentata*, Michx. Large-toothed Aspen. Common.
212. *Populus balsamifera*, L. Balsam Poplar. Perhaps the most abundant species in the districts most affected by the great fires.
213. *Populus monilifera*, Ait. Cottonwood. Occasional.
214. *Vallisneria spiralis*, Tape Grass. Eel Grass. Mouths of Pinnebog and Pigeon Rivers.
215. *Calopogon pulchellus*, R. Br. Marsh at Rush Lake.
216. *Iris versicolor*, L. Blue Flag. Low grounds. Common.
217. *Smilax hispida*, Muhl. Port Austin.
218. *Smilacina stellata*, Desf. False Solomon's Seal. Common on sand dunes west of Port Crescent.
219. *Juncus effusus*, L. Soft Rush. Common in low ground.
220. *Juncus balticus*, Dethard. Var. *littoralis*, Engelm. Very common in the beach sand at Port Austin where it forms large masses in the sand for several hundred feet back from the shore, especially up the creek valley.
221. *Juncus bufonius*, L. Forming extensive tracts on the marshy area left by the fall of the waters of the lake during the past few years.
222. *Juncus alpinus*, Villars, Var. *insignis*, Fries. Abundant in the creek valley at Port Austin, also not uncommon along the Lake shore.
223. *Juncus nodosus*, L. Common with the last species.
224. *Juncus Canadensis*, J. Gay. Same habitat as the last species.
225. *Juncus Canadensis*, J. Gay, Var. *coarctatus* Engelm. Port Austin.
226. *Juncus Canadensis*, J. Gay. Var. *brachycephalus*, Engelm. Port Austin.
227. *Luzula vernalis*, DC. Wood-rush. Common in moist woods.
228. *Typha latifolia*, L. Cat-tail Flag. Rush Lake. Marsh in Chandler Township.
229. *Sparganium eurycarpum*, Engelm. Burr-reed. Pinnebog River.
230. *Alisma Plantago*, L. Water Plantain. Common in streams.
231. *Sagittaria variabilis*, Engelm. Stream borders.
232. *Triglochin palustre*, L. Arrow-Grass. Marshy border of Lake Huron. Port Austin.
233. *Potamogeton natans*, L. Pondweed. Terrestrial forms of this species noted on shore of partly dried up lake in Chandler Township and in bottom of dried up pond on Charity Island.
234. *Potamogeton heterophyllus*, Schreb. Small form in shallow pools above low water mark, on beach east of Port Huron.
235. *Potamogeton heterophyllus*, Schreb. Forma *longipedunculatus* (Merat) Morong. This form was collected in water nearly four feet deep off the beach at Point of Pines Hotel, Port Austin. The root stocks of the plants grow in crevices in the rocks, and the plants thrive in spite of the violent surf which frequently breaks on this shore.
236. *Potamogeton pauciflorus*, Pursh. Var. *Niagarensis*, Gray. Pinnebog River.
237. *Potamogeton pectinatus*, L. Pigeon River, Caseville.
238. *Potamogeton marinus*, L. Shallow water, less than one foot deep on beach between Port Austin and Port Crescent. Also at North Charity Island in water six inches deep, abundant at both localities.
239. *Najas flexilis*, Rostk and Schmidt. Willow River, Huron Township.
240. *Cyperus diandrus*, Torr. Var. *castaneus*, Torr. Very common along the lake shore, and along margins of streams.
241. *Cyperus Houghtonii*, Torr. Abundant on the sand dunes west of Port Crescent, where it grows in the purest sand, often in the wagon tracks across the dunes.
242. *Cyperus strigosus*, L. Common in marshy places along the lake at Port Austin.
243. *Dulichium spathaceum*, Pers. Rush Lake.
244. *Eleocharis ovata*, R. Br. Common along the shore of the lake.
245. *Eleocharis olivacea*, Torr. Lake shore.
246. *Eleocharis palustris*, R. Br. Var. *glaucescens*, Gray. Common in wet places.
247. *Eleocharis acicularis*, R. Br. Spike-rush. Very abundant along the lake shore.
248. *Eleocharis pauciflora*, Link. Forming large masses on the marshy belt left by the retreat of the lake near Port Austin, Bayport.
249. *Scirpus pungens*, Vahl. Growing in moist sand for several hundred feet away from water at Port Austin Harbor. Bayport.
250. *Scirpus lacustris*, L. Common, especially at Rush Lake, where it forms large masses.
251. *Scirpus atrovirens*, Muhl. Damp soil, common. Very abundant near the R. station, Port Austin. Bayport.
252. *Cladium mariscoides*, Torr. Twig-rush. Marsh about pond on North Charity Island.
253. *Carex lupulina*, Muhl. Common along ditches, etc.

253. *Carex filiformis*, L. Bog in Chandler Township.  
 254. *Carex flava*, L. Var. *viridula*, Bailey. Abundant at Bayport and Charity Islands in the marshy tract left by retreat of lake. Less common at Port Austin. At North Charity Island, some plants were 18 inches high.  
 255. *Carex riparia*, W. Curtis. River banks.  
 256. *Carex eburnea*, Boott. Crevices in sandstone bluff overhanging the lake.  
 257. *Carex Pennsylvanica*, Lam. Common throughout.  
 258. *Carex communis*, Bailey. Port Austin Township, near Grindstone City.  
 259. *Carex stipata*, Muhl. Common in low places.  
 260. *Carex vulpinoidea*, Michx. Meadows, common.  
 261. *Carex Muhlenbergii*, Schb. Dry soil on the bluffs. Point aux Barques.  
 262. *Carex tribuloides*, Wahl. Common in low grounds.  
 263. *Carex tribuloides*, Wahl. var. *cristata*, Bailey. Swales, common.  
 265. *Spartina cynosuroides*, Willd. Marsh or cord grass. Sand dunes.  
 266. *Panicum sanguinale*, L. Crab or Finger Grass. At Port Crescent in drifting sand where it was getting a foothold and may help hold the sand in place.  
 267. *Panicum virgatum*, L. Charity Islands on sand soil.  
 268. *Panicum capillare*, L. Old Witch-Grass. Common.  
 269. *Panicum dichotomum*, L. Sand dunes west of Port Crescent.  
 270. *Setaria viridis*, Beauv. Green Foxtail. In loose sand at Port Crescent, with *Panicum sanguinale*.  
 271. *Zizania aquatica*, L. Indian Rice. Water oats. Wild rice. Marshy places along the lake shore, usually small in such locations. Off Bayport, however, it grows in shallow water to the height of several feet, covering large tracts, and undoubtedly acting as an important factor in the filling up of the portions of the Bay in which it grows, by decreasing wave and current motion of the water, hence hastening deposit.  
 272. *Andropogon furcatus*, Muhl. North Charity Island.  
 273. *Oryzopsis asperifolia*, Michx. Sides of older dunes about Port Austin.  
 274. *Oryzopsis Canadensis*, Torr. Sand dunes, where it is common.  
 275. *Phleum pratense*, L. Timothy. Herd's Grass, common. Extensive crops of this grass may be raised in the swampy tracts south and east of Bad-axe when they are cleared and drained.  
 276. *Agrostis scabra*, Willd. Hair-grass. Dry pastures in Huron Township.  
 277. *Calamagrostis longifolia*, Hook. Sand dunes about Port Austin.  
 278. *Ammophila Arundinacea*, Host. Sand dunes nearest lake. Common.  
 279. *Deschampsia flexuosa*, Trin. Common Hair-Grass. Abundant in the dunes of Port Austin.  
 280. *Phragmites Communis*, Trin. Reed. Border of dry pond in Charity Island.  
 281. *Danthonia spicata*, Beauv. Wild Oat-Grass. Sand dunes, common.  
 282. *Koeleria cristata*, Pers. Slopes of the older sand dunes.  
 283. *Eragrostis reptans*, Nees. Along the lake shore and borders of streams.  
 284. *Poa compressa*, L. Wire-Grass. Blue-Grass. The top of the bluffs at Point aux Barques.  
 285. *Poa pratensis*, L. June Grass. With the last and common everywhere.  
 284. *Festuca tenella*, Willd. Common on sand dunes and on the dry soil at Broken Rocks, Port Austin.  
 287. *Festuca ovina*, L. Var. *pseudovina*, Hack. Broken Rocks near Port Austin. ?  
 288. *Agropyrum dasystachyum*, Vasey. Common on the sand dunes.  
 289. *Elymus Virginicus*, L. Wild Rye. Valley of Pinnebog River, Hume Township.  
 290. *Elymus Canadensis*, L. Growing on the sand dunes nearest the lake at Port Austin. Abundant.  
 291. *Asprella Hystrix*, Willd. Bottle Brush Grass. Woods near Port Austin.  
 292. *Pinus Strobus*, L. White Pine. Formerly very abundant throughout a large portion of the county, mostly confined in the dunes near the lake.  
 293. *Pinus Banksiana*, Lambert. Jack Pine. Scrub Pine. Common on the sand dunes. Not seen east of Broken Rocks, Port Austin. West of Port Crescent it is common even on the crest of the dune line nearest the lake.  
 294. *Pinus resinosa*, Ait. Norway Pine. Red Pine. Common on the sand dunes.  
 295. *Picea nigra*, Link. Black Spruce. In low woods west of Filion.  
 296. *Larix Americana*, Michx. Black Larch. Tamarack. Swamps in the southern part of the county.  
 297. *Tsuga Canadensis*, Carriere. Hemlock. Banks of Willow River in Huron Township.  
 298. *Abies balsamea*, Miller. Balsam fir. Balm-of-Gilead Fir. A few specimens about a boggy place on the dunes east of Port Crescent. Swamp just west of Port Austin.  
 299. *Thuja occidentalis*, L. Arbor Vitæ. White Cedar. Wet places near Port Crescent.  
 300. *Equisetum arvense*, L. Horsetail. Low grounds, common.  
 301. *Equisetum hyemale*, L. Scouring-Rush. Shave-Grass. Sand dunes east of Port Austin.  
 302. *Equisetum variegatum*, Schleicher. What seems to be this species was not uncommon in the sand near Port Austin.  
 303. *Polypodium vulgare*, L. Under overhanging rocks along the Lake shore, Point aux Barques, etc.  
 304. *Adiantum pedatum*, L. Maidenhair fern. Rich woods.  
 305. *Pteris aquilina*, L. Common brake. Very common in northern part of county.  
 306. *Phegopteris polypodioides*, Fée. Under overhanging rocks of old shore cliff, east of Point aux Barques.  
 307. *Phegopteris Dryopteris*, Fée. With the last species.  
 308. *Onoclea sensibilis*, L. Sensitive fern. Common in low grounds.

309. *Osmunda regalis*, L. Flowering Fern. Deep woods in the middle of the county.  
 310. *Woodsia obtusa*, Torr. Growing abundantly in crevices in the overhanging rocks on the Lake shore near Port Austin.  
 311. *Lycopodium complanatum*, L. Var. *Chamaecyparissus*, D. C. Eaton. Common on the sand dunes, east of Port Crescent.  
 312. *Selaginella apus*, Spreng. In old quarry at Grindstone City.  
 A visit of a day's duration to Bayport in July, 1898, indicates that the flora of that part of the county is especially interesting to botanists, as a number of species of plants were found there which have not before been found so far north in Michigan and some reach their most northern recorded limit here.  
 14a. \**Hypericum Kalmianum*, L. St. John's-wort. Marshy land south of Bayport.  
 30a. *Medicago sativa*, L. Alfalfa. Lucerne. Along the line of the sewer from the Bayport Hotel to the Bay.  
 66a. *Lythrum alatum*, Pursh. Purple Loose-strife. Marshy borders of ditches, between Sebewaing and Bayport.  
 96a. *Liatris spicata*, Willd. Blazing-star. Marshes north of Sebewaing.  
 103a. *Solidago Ohioensis*, Riddell. Golden-rod. Marsh near Bayport.  
 111a. *Silphium terebinthinaceum*, L. Prairie Dock. Along the S. T. & H. R. R. nearly as far north as Bayport.  
 121a. *Cacalia tuberosa*, Nutt. Tuberous Indian Plantain. North of Sebewaing nearly to Bayport, in rich soil.  
 128a. *Lactuca scariola*, L. Prickly lettuce. A bad weed common about the railroad stations.  
 129a. *Lobelia Kalmii*, L. Wet flats along the shore of the Bay at Bayport.  
 144a. *Steironema longifolium*, Gray. Marshes south of Bayport.  
 181a. *Plantago Patagonica*, Jacq. Var. *aristata*, Gray. Bristly Plantain. Grounds of the Bayport Hotel under trees, sandy soil.  
 207a. *Salix amygdaloides*, Anders. Bayport.  
 213a. *Spiranthes cernua*, Richard. What seems to be this species was collected by Dr. Lane in the neighborhood of Bayport.

\*These numbers refer to the place which these plants would occupy if arranged in the foregoing list.

## CHAPTER X

## THE FOSSILS.

## § 1. Introduction.

When we attempt to study and name the forms of life which have left their traces in the rocks of Huron county we find ourselves in much difficulty. The earlier papers on the subject by Winchell, Strong and Stevens, were published without illustrations. All the illustrations that Douglas Houghton prepared seem to have disappeared. At the Ann Arbor Museum and Grand Rapids High Schools, however, are numerous forms labelled, so that after diligent study by one who has access to the complete literature of other states (especially whenever Winchell's unpublished drawings become accessible), we shall know better just what forms have been named by the gentlemen above, and how far they are equivalent to forms described in other states. In the meantime geologists in other states have worked perforce without very much regard to what had been done in Michigan, though Herrick and others have occasionally referred to Winchell's types. The material is in large part so imperfect that Winchell has in a number of cases referred a form now to one genus and now under another, retaining the same specific name. Rominger, too, collected extensively in the county, but his identifications are generally not specific and by no means always harmonize with those of previous authors. In consequence the following cases of difficulty arise:

We may be almost certain that a form has been given a certain specific name by a previous author, but doubt if his reference of it to a certain genus is correct; or we may not be certain whether we have the exact form described by a certain author. Or we may find the same form referred to by different authors under different names. In some cases we know that this is so, as when Hall uses Winchell's figures of *Centronella Julia* to illustrate *Cryptonella*. The same form is now known as *Romingerina*.

The snarl thus involved can not be straightened out at once. But we can at least take out some kinks, and make it easier for the next one, and at the same time give lists which show what names have been applied to the fossils of the county.

We treat the fossils of the Marshall and underlying shales together, for even if we did not wish to imply thereby very much, as to the controverted question of their relation to the line between Devonian and Carboniferous, since the literature is the same, and we shall have occasion to compare the forms, it seems better to treat them thus.

We have illustrated part of the Marshall fauna in Plates X and XI, but have not tried to do so for the faunas of the Bayport, i. e., Maxville limestone, reserving that for a Kent county report when the collections of the Kent Scientific institute shall be accessible, and shall have been properly worked up.

It is impossible, too, to do complete justice to the Marshall fossils until Winchell's collection is also accessible to the investigator, which we trust will be soon, now that it is acquired by the Francis Hood Museum of Alma College. But I am particularly indebted to Mr. W. F. Cooper who is familiar with Mr. Herrick's parallel work in Ohio for his assistance in that section. Most of the forms illustrated in Plates X and XI are not Marshall, but come from the Point aux Barques lighthouse. I hope to illustrate the Marshall more fully later from Winchell's own drawings but most of his specimens came from the southern part of the state.

§ 2. Recent shells (of the marl), by Bryant Walker and A. C. Lane.

It has been suggested by certain recent observers\* that the former extension of the Great Lakes so well marked in raised beaches around the lower peninsula of Michigan, were really connected with the ocean and their deposits of marine origin, and for this and other reasons, during the progress of the investigations of the Geological Survey, in Huron county, last summer, some attempt was made by Prof. Davis and Mr. Lane to gather shells from recent deposits, where they would be likely to throw light upon the subject. These shells have been referred to Mr. Bryant Walker and the Pisidia to Dr. V. Sterki to whom all that is valuable of this paper should be

\*Spencer, J. W., Science, 1888, Jan. 27, p. 49, Pop. Sci. Monthly, 1896. Bela Hubbard, back in 1840, correctly described them as fresh water deposits.

attributed. All that Mr. Lane adds is something concerning the localities.

*Locality (1).*—Near Badaxe, about one-fourth mile N. of the southeast corner of Sec. 24, T. 16, R. 12; altitude about 180 feet above the present lake level, or say 760 feet A. T. Here the E.—W. drain exposes a section showing an alternation of above a marshy deposit, then a shell marl, then another marshy deposit, then a second bed of shell marl. Mr. Lane's attention was called to the alternation by Dr. Jas. Henderson. At the time it was visited, the section was exposed by a ditch which was so filled with water that a careful separation could not be made of the two marls, but without doubt, the forms were very largely derived from the lower marl. It seems geologically very likely that the lower marl is associated in this region with, and nearly contemporaneous with, the Forest Beach of Lake Warren.\* A collection was made from a marl at a similar altitude and in association with marshes also behind the Forest Beach on Sec. 6, Sherman, T. 15 N., R. 16 E., in 1897. The fauna was similar and *Pisidium contortum* occurred again.

*Locality (2).*—Close to the Stone Wall also referred to by Taylor (loc. cit., page 44), in the swamp in which the Stone Wall is connected and at a similar elevation. This is in the southeast corner of Sec. 32, T. 14 N., R. 11 E. This, too, is very possibly to be correlated with the time of the Forest Beach and Lake Warren,—according to Taylor this marsh lies in the Cumber spillway, a channel by which the waters on the two sides of the thumb were connected when the ice front was standing near Verona.

This locality is more fully described in Part III of this volume.

*Locality (3).*—Sand which was exposed in burning off the bog near the corner of Secs. 26 and 27, T. 16 N., R. 9 E. Fairhaven township, Huron county, Michigan. These sands lie at an elevation of a little above 20 feet (605 ft. A. T.). They are to be connected with the Algonquin Beach, according to Taylor. They certainly are connected with the old lake shore directly in a way that the two marl deposits just mentioned are not.

*Locality (4).*—On the north side of Sec. 34, T. 16 N., R. 9 E., about  $\frac{1}{4}$  mile E. of the N. W. quarter where the section line road crosses the dunes. They are connected with the same Algonquin lake level as the previous locality, though somewhat higher, and are evidently

fragments thrown up on the beach directly connected with the dune deposits.

Finally collections were also made of recent forms for comparison.

*Locality (5).*—Living forms collected by C. A. Davis at Port Austin.

*Locality (6).*—Living forms collected by Mrs. A. C. Lane, in flats laid bare by the recent fall of the waters in front of Bayport during the last eight years. It will be seen from the lists that with two exceptions, all the species found are identical with forms now existing in the same region. Such variations as now exist are no more than can be attributed to local peculiarities of environment. The fauna of the older marls as a whole is undoubtedly a northern one, and indicates, though not necessarily conclusively, a colder climate than exists in that region today. This inference is based on the uniformly small size of the same species, i. e., *Valvata tricarinata*, *Planorbis deflectus*, *Planorbis bicarinatus* and the *Campeloma*, also the peculiar sculpturing of the *Planorbis bicarinatus*.

The single example of *Campeloma* is a very interesting one, though it is unfortunately very imperfect. It is apparently mature, and is remarkable for its small size and cylindrical shape. It also resembles the northern recent form known as *Campeloma milesii* Lea, but is smaller and more cylindrical. If the form of the living species is the result of its northern situation, it would perhaps be a fair inference that severer climatic conditions had so to speak intensified the form. However, while *C. milesii* is today a northern form, there are other species of the same genus ranging from the same territory, as well as further north, which do not show the same peculiarity. Then there is a little *Limnæa* from Badaxe, locality (1), which is also interesting. It resembles the species from the Moose River, in the Hudson Bay territory, described by Lea as *L. artica*, but differs in its compressed shape and in being decidedly umbilicate.

In regard to the *Pisidia* in particular, Dr. V. Sterki, who examined the material, says that the Badaxe specimens are of especial interest and correspond with those from the marl in Aroostook county, Maine. There is in both *Pisidium contortum* Pme., a form which has been referred to or near *Pisidium milium* Held, from Europe, and certainly is nearly related, but the species is very variable. The extreme forms might be regarded as quite distinct species, but for intermediate forms. *Pisidium contortum* is known only as fossil, but may

\*See F. B. Taylor, Bull. Geol. Society of America, Vol. VIII, p. 49.

yet be found living further north.\* *P. ventricosum* Pme. so common in the Maine marl was not represented in the Michigan material. In the Fairhaven material location (3) or (4) were a few broken fossils, one of them to be identified as *Pisidium contortum*, the balance too far gone.

It is obvious from the comparison of these lists appended and observations made upon them that so far the shell collections point, not to marine conditions, but to fresh water conditions something similar to those present, but to a more northern climate, which is in every way agreeable to the other geological indications, that their erstwhile denizens dwelt in lakes left upon the retreat of the ice, the shells from localities (1) and (2) being probably more nearly contemporaneous with the ice front and with the mastodon.†

In the list, the names of the genus, species and describer are first given, in order, grouped by genera, and then in the seven following columns, their occurrence in Walker's list of shells of the Saginaw valley‡ and in the six localities above mentioned. An X indicates the presence of form, XX its abundance, a number added refers to foot note.

? indicates that the specimen is too imperfect for certain identification.

Genus.	Species.	Author.	Walker's list.	Loc. 6.	5.	4.	3.	2.	1.
<i>Circinaria</i>	<i>conca</i>	Say	x						
<i>Zonitoides</i>	<i>nitidus</i>	Mull	x						
"	<i>arboreus</i>	Say	x					x	
"	<i>minusculus</i>	Alder	x						
<i>Vitrea</i>	<i>hammonis</i>	Ström.	x						
"	<i>indentatus</i>	Binn	x						
<i>Conulus</i>	<i>fulvus</i>	Dr.	x						
<i>Gastrodonta</i>	<i>multidentata</i>	Say	x						
<i>Pyramidula</i>	<i>alternata</i>	Say	x						
"	<i>perspectiva</i>	Say	x						
"	<i>striatella</i>	Anth.	x						
<i>Helicodiscus</i>	<i>lineatus</i>	Say	x						
<i>Punctum</i>	<i>pygmaeum</i>	Drap.	x						
<i>Polygra</i>	<i>multilineata</i>	Say	x						
"	<i>thyroides</i>	Say	x						
"	<i>albolabris</i>	Say	x						
"	<i>albolabris dentata</i>	Tryon	x						
"	<i>exoleta</i>	Binn	x						
"	<i>sayii</i>	Binn	x						
"	<i>monodon fraterna</i>	Say	x						
"	<i>leaii</i>	Ward	x						
"	<i>tridentata</i>	Say	x						
"	<i>palliatata</i>	Say	x						
"	<i>virgata</i>	DaCosta	x						
<i>Vallonia</i>	<i>pulchella</i>	Mull	x						
<i>Strobilops</i>	<i>labyrinthica</i>	Say	x						
<i>Bifidaria</i>	<i>corticaria</i>	Say	x						

\*It has recently been found living in northern Maine.  
 †See articles by B. Walker in the Nautilus March, 1893, Vol. XI, p. 121, and Sept., 1899, Vol. XIII, p. 55.  
 ‡Nautilus, 1894, p. 125.

Genus.	Species.	Author.	Walker's list.	Loc. 6.	5.	4.	3.	2.	1.
<i>Bifidaria</i>	<i>armifera</i>	Say	x						
"	<i>contracta</i>	Say	x						
"	<i>pentodon</i>	Say	x						
"	<i>curvidens</i>	Gld.	x						
<i>Vertigo</i>	<i>ovata</i>	Say	x						
"	<i>gouldii</i>	Binn	x						
"	<i>ventricosa elatior</i>	Sterki	x						
<i>Cochlicopa</i>	<i>lubrica</i>	Mull	x						
<i>Succinea</i>	<i>ovalis</i>	Say	x						
"	<i>acara</i>	Say	x						
"	<i>relusa</i>	Lea	x		x				
"	<i>peoriensis</i>	Wolf	x						
"	<i>sp.</i>		x						
<i>Carychium</i>	<i>exiguum</i>	Say	x						
<i>Limnaea</i>	<i>stagnalis</i>	L.	x		x				
"	<i>catascopium</i>	Say	x	x					
"	<i>reflexa</i>	Say	x		x				
"	<i>reflexa scalaris</i>	Walker	x						
"	<i>palustris</i>	Mull	x		x				
"	<i>n. sp.</i>								x(1)
"	<i>cubensis</i>	Pfr.	x						
"	<i>desidiosa</i>	Say			x			xx	x
"	<i>emarginata</i>	Say			x				
<i>Physa</i>	<i>ancillaria</i>	Say	x		x				x
"	<i>sayii</i>	Tappan	x	x					
"	<i>gyrina</i>	Say			x				x
"	<i>var. hildrethiana</i>	Lea	x						
<i>Aplexa</i>	<i>hypnorum</i>	L.	x						
<i>Planorbis</i>	<i>trivoltis</i>	Say	x						
"	<i>multivolvis</i>	Case	x		x				
"	<i>bicarinatus</i>	Say					x	xx	xx(2)
"	<i>truncatus</i>	Miles		x	x				
"	<i>deflectus</i>	Say					x	xx	xx
"	<i>campanulatus</i>	Say	x				x	x	xx
"	<i>albus</i>	Mull	x						
"	<i>parvus</i>	Say	x		x				
"	<i>exacutus</i>	Say	x						
<i>Segmentina</i>	<i>armigera</i>	Say	x		x				
<i>Ancylus</i>	<i>fuscus</i>	Ad.							
"	<i>sp.</i>								
"	<i>parallelus</i>	Hald	x						
<i>Lyogyrus</i>	<i>pupoidea?</i>	Gld.	x						
<i>Valvata</i>	<i>tricarinata</i>	Say						xx(4)	xx(3)
<i>Campetoma</i>	<i>milesii</i>	Lea		x					
"	<i>decisa</i>	Say	x						
<i>Amnicola</i>	<i>sp.</i>				x				
"	<i>porata</i>	Lea	x						
"	<i>limosa</i>	Say					x	x	
<i>Bythinella</i>	<i>obtusa</i>	Lea							
"	<i>nickliniana</i>	Lea	x		x				
<i>Goniobasis</i>	<i>livescens</i>	Mke	x	x	x	x			
"	<i>semicarinata</i>	Say	x						
"	<i>depygis</i>	Say	x						
"	<i>milesii</i>	Lea	x						
<i>Unio</i>	<i>alatus</i>	Say	x						
"	<i>asprimus</i>	Lea	x						
"	<i>cornutus</i>	Bar	x						
"	<i>ellipsis</i>	Lea	x						
"	<i>coccineus</i>	Hild			x				
"	<i>gibbosus</i>	Bar	x						
"	<i>gracilis</i>	Bar	x						
"	<i>ligamentinus</i>	Lam	x						
"	<i>luteolus</i>	Lam	x	x	x				
"	<i>nasutus</i>	Say	x						
"	<i>novi-eboraci</i>	Lea	x						
"	<i>phaseolus</i>	Hild	x						
"	<i>rectus</i>	Lam	x						
"	<i>rubiginosus</i>	Lea	x						
"	<i>schoolecraftii</i>	Lea	x						
"	<i>ventricosus</i>	Bar	x		x				
<i>Margaritina</i>	<i>deltoides</i>	Lea	x						
<i>Anodonta</i>	<i>edentula</i>	Say			x				
"	<i>fragilis</i>	Lam			x				
"	<i>benedicti</i>	Lea	x						
"	<i>footiana</i>	Lea	x		x				
"	<i>umbellata</i>	Say	x						

Genus.	Species.	Author.	Walk-ers list.	Loc. 6	5	4	3	2	1
<i>Sphaerium</i> ...	<i>striatinum</i> .....	Lam....	x	x			x		
"	<i>simile</i> .....	Say....			x				x
"	<i>securis</i> .....	Prime						x	x
"	<i>rhomboideum</i> .....	Say....	x						
"	<i>occidentale</i> .....	Pme....	x		x				
"	<i>partumeium</i> .....	Say....	x						
"	<i>truncatum</i> .....	Lind....	x						
<i>Pisidium</i> ...	<i>virginicum</i> .....	Lam....	x						
"	<i>abditum</i> .....	Hald....	x					x	x
"	<i>compressum</i> .....	Pme....	x					x	x
"	<i>variable</i> .....	Pme....	x					x	x
"	<i>contortum</i> .....	Pme....				x	?x	x	x
"	"	Var ?						x (6)	x (6)
"	<i>rotundatum</i> .....	Pme....						x	x
"	<i>scutellatum</i> .....	Sterki ?							x

(1) Peculiar, two specimens, lacking the spire, whorls strongly shouldered, beneath which is a well marked constriction, which modifies the form of the aperture, by sinuous, drawn back and somewhat expanded posteriorly, body whorl almost cylindrical.

(2) Spiral lines much more developed than is usual in living specimens. Many of the adult specimens are considerably corrugated transversely toward the aperture and after the period of the first growth. According to R. E. C. Stearns (Proc. Phila. Acad. Nat. Science, 1881, p. 104), such a tendency is evidence of considerable changes in temperature or environment.

(3) Exhibiting all stages from the unicarinate to the tricarinate form,—none ecarinate.

(4) Mostly bicarinate.

(5) See above, p. 249.

(6) See above, p. 249.

### § 3. Fossils of the Marshall and Coldwater by A. C. Lane and W. F. Cooper.

A list is given in the Proceedings of the American Philosophical Society (1870), Vol. XII, p. 389 including all the fossils which Winchell has described from this group. We can divide the 260 feet of the Lower Marshall (the Upper Marshall or Napoleon is so far as yet known unfossiliferous in the county) in two to three divisions, two of which we can also trace in the previous writers. The shales and intercalated sandstones below we can also divide into three zones. Having regard indeed only to our own collections we might subdivide some of these divisions, but as the subdivision grows finer the danger of placing forms in the wrong division increases with no compensating advantage, so that the division given below will suffice. At the same time in discussing our collections, the exact place in the column will be noted as far as possible.

The divisions we make are then:

(1) Lowest, the Rock Falls, Cuyahoga series, 176-553, especially 460 feet below the bottom of the Lower Marshall, =541 feet above the top of the Berea grit, with *Chonetes scitulus*, Plate X, Figs. 1 and 2.

(2) The Lighthouse Point series 100-176, especially 160-176 feet below the bottom of the Marshall as defined, very fossiliferous, with

*Syringothyris pharovicina* (Plate X, Figs. 5-7) and numerous spirifers, and a fair sized *Proetus missouriensis* and abundant Schizodus forms (Plate XI, Figs. 7, 9, 14, 15), generally larger than corresponding forms in higher horizons, which are, however, faunally closely allied.

(3) The Huron City series. 0—100 feet below the Lower Marshall, especially 84 feet below the bottom of the Marshall, Rhynchonelloids and *Productus* more abundant and smaller than in the Lower Marshall.

(4) The Point aux Barques series 85-260 feet below top of Lower Marshall, including the gritstones themselves (235-260), with fish remains and *G. Oweni*, zone of *Romingerina julia* above, at 220 feet, and all the strata up to the top of the Port Austin sandstone.

(5) The Solen series (65-85 feet below top), characterized by the abundance of Solen like forms and *G. marshallensis* including the richly fossiliferous zone of Hardwood Point, with *Prothyris meeki* (Plate XI, Fig. 10).

The upper beds, as exposed on the Port Austin and Port Crescent road,—thin-bedded flags, especially rich in small aviculoid forms, Leiopteria and Sanguinolites, Figs. 2, 11, 12, 13, Plate XI, this last zone not having been before observed in the county—are not an essentially new series.

#### (1). The Rock Falls series (Cuyahoga).

Like the corresponding Cuyahoga shales of Ohio, the blue shales are very poor in fossils, except in thin sandy seams and nodules of carbonate of iron, but Dr. Gordon discovered *Chonetes scitulus* a small delicate species, (? *Chonetes* of Rominger, Sp. 19147), and *Conularia gracilis*.\* Fucoidal remains, as suggested by Rominger (Caudagalli) in our specimen more likely worm-produced marks (Sp. 19148-19150), together with the *Chonetes* and *Goniatites* noticed by Rominger (III, 76) are not unlike the fauna of the Bedford and Cuyahoga (cf. Ohio VII, p. 32, 507) shale. Mr. G. H. Girty collected in the summer of 1897 with me also *Productus laevicosta*, and two other species, one probably *Productus blairi*, *Spirifer centronota*, *Syringothyris*, lamellibranchs, and heads as well as stems of crinoids. Cooper identified *P. Shumardianus*, and *P. newberryi* var. *annosus*, and *Streblopteria media*, *Phaethonides spinosus*. The other localities from from Port Hope down have not added to the list of species, but these suffice to identify it with the Cuyahoga of Central Ohio. The fauna is somewhat Devonian in aspect.

\*Ohio VII, Pl. XIX, Sp. 19146.

(2). **Lighthouse zone.**

Most of the fossils of this section come from the conglomerate and from one belt of sandstone about 3 inches thick.\* The fauna is exceedingly rich. Not less than forty species and all the principal groups are represented. A characteristic feature of this fauna to be noted, is the comparatively large size of the forms. This is to be noted, not only as a whole, but in comparing any particular form with its nearest ally in the formations above. The minute *Romingerina julia* of series (4) is represented by larger terebratuloid forms, perhaps the form described by Winchell as *Merista Houghtoni*, compare Plate X, Fig. 13 (for in default of knowledge of the internal structure, these forms may be wrongly attributed to different genera). The Proeti have glabellas 15 mm. or so long (Plate XI, Fig. 14), while the next trilobite that we notice (Sp. 19094) is almost microscopic. The lamellibranchs and brachiopods are also large, often attaining a length of 20 to 40 mm, and the rhynchonellas attain about twice the size of those higher up in the series (Plate X, Fig. 8, 9, 10).

*SPIRIFER SUBATTENUATUS*, Hall? (Proc. Acad. Nat. Sci., Phila., 1862, p. 405).

Winchell says merely that the form agrees with Hall's descriptions and in the Proceedings of the American Philosophical Society he speaks of it as a doubtful identification. At least four, probably more of the Spirifer family are found by us, some with, some without striations in the sinus, sometimes fasciculated. Compare Sp. 19049, 19045. This is a small Spirifer, but our forms appear rather too elongate, more of the mucronatus type.

*SPIRIFER MEDIALIS*, Hall? The specimens, here and there, through the whole series 19044 to 19089 show another type of flatter, and not very large spirifer. Winchell's identification is almost certainly erroneous.

*SPIRIFER HURONENSIS*, Win. is described as follows, P. A. N. S., Phil., 1862, p. 407. This we have figured, Plate X, Fig. 3. Compare *S. deltoideus*.

"*Spirifera Huronensis*, n. Sp. Shell of medium size, transversely semi-elliptic, with acuminate hinge-extremities; entire hinge-length nearly three times the length of the shell; anterior and anterolateral borders regularly curved. Ventral valve ventricose, especially towards the beak, which is erect over a high triangular area,

\*See pp. 25, 87.

triangularly foraminated at the apex; sinus beginning near the beak, not well defined, round at its margins and bottom; entire surface covered with about forty rounded ribs, of which the lateral half on each side terminate upon the cardinal border, while about four of the same size as their neighbors, occupy the sinus. Dental plates standing at an angle of 58°. Dorsal valve equally tumid with the ventral; beak incurved over a narrow area; mesial fold indistinct, with three or four ribs; occlusor and pedicle scars lanceolate, deep. Surface of shell with one or two squamous incremental lines.

"Length of shell, in inches, .49 (100); length of hinge line 1.3 (265); convexity of ventral valve .25 (50).

"Locality. Lighthouse Pt. aux Barques, in a hard, gray, pyritous, coarse, often conglomeritic bed of sandstone two feet thick, intercalated in the argillaceous slates of the Huron group."

Specimen 18263 and 19048, seem to show this type of spirifer well. It will be noted that there is nothing in the description of this and the next species to prevent its being a *Syringothyris*, which it may be.

*SYRINGOTHYRIS PHAROVICINA*, Win. described, Proc. Acad. Nat. Sci. Phil., 1862, p. 406, as follows, under the name *Spirifer pharovicina*:

"Shell large and ventricose. Ventral valve with a gentle sinuation which extends to the beak; dental plates moderately long, forming an angle of 80°; area very elevated, with a narrow triangular fissure reaching to the apex, which scarcely overhangs the area; surface faintly marked each side of the sinus by rather remote radiating ribs, which, near the margin, are somewhat distinct. Some impressions of areas supposed to belong to this species, are 2.1" [inches] "long, and .95 high, with a fissure .44 wide at base; deltoidal impression grooved in the direction of the fissure; surface of area flat, slightly incurved at apex and marked by very distinct transverse striae. Dorsal valve with a low rounded fold, marked (in the cast) by a single small median groove, beak prominent, incurved over a small area."

Locality. Lighthouse, Pt. aux Barques, with *Rhynchonella Huronensis*, *Spirifera Huronensis*, etc.

This well known species is known only by imperfect casts.

I feel quite confident that this is a *Syringothyris* (and so do Cooper and Girty). The large suite of specimens, 19044, 19265, and 19266, Plate X, Figs. 5, 6 and 7, show a *Syringothyris*, which is one of the commonest and most characteristic fossils of the series, as Rominger also noticed. It is hardly possible that Winchell could have not found any representative of it, and it is doubtless his species which we figure and his description of *Spirifer pharovicina*

agrees precisely with our specimens of *Syringothyris*, except obviously that the characteristic structure of *Syringothyris* did not show and is not described by him, but there is nothing inconsistent in his descriptions. In fact he did not found the genus until next year. It is very common and some variation in the height of the area, suggests that a form like *Syringothyris herricki* may be present also.

*SPIRIFERA?* (cf. *ATHYRIS*) *INSOLITA*. Described as follows, Proc. Acad. Nat. Sci., Phil., 1862, p. 406.

"*Spirifera* (?) *insolita*, n. sp. Shell large, smooth. Ventral valve with a broad, concave sinus reaching to the beak, and forming at its lateral margins angles with the shell surface; area short and imperfectly bounded, though the beak is rather high; dental plates very long, reaching the middle of the shell or beyond, and forming with each other an angle of 25°, which is the same as the rostral angle of the mesial sinus.

"Locality. Lighthouse. Pt. aux Barques.

"The species has the short hinge line of *Brachythyris*, and the smooth surface of *Martinia*—characters which, with the very long and approximate dental plates render it unique among *Spiriferæ*."

Schuchert classes this as a *Martinia*, and it is surely not a *Spirifer*.

*EUMETRIA* (?) *POLYPLEURA*. Plate X, Figs. 13 and 14. Described as follows, Proc. Acad. Nat. Sci., Phila., 1862, p. 406.

"*Retsia Polypleura*, n. sp. Shell of medium size or rather large, cuneate-oval, tumid. Ventral valve with a prolonged, isolated, nearly erect, perforate beak, which projects one-fourth the valve length beyond the dorsal valve, a swollen umbo, and depressed central and anterior region. Dorsal valve rotund, with a subcuneate rostral margin; beak obtuse, closely appressed against the ventral valve; umbo ventricose; entire valve with a regular cardium-like convexity; median ridge extending one-third the length of the valve, with a lanceolate occlusor impression on each side of it. Surface marked by about forty small, rounded, radiating ribs. Spires not seen.

"Length, breadth and thickness of a rather small specimen: .70" inches "(100), .58 (83) and .34 (50). Length of dorsal valve .52 (74). Length and breadth of another dorsal valve .69 and .66."

"Locality. Lighthouse, Pt. aux Barques with *Rhynchonella Huronensis*, etc. This species resembles *R. serpentina*, de Kon. (Anim. Foss., 291, pl. xix, 8), but the ventral valve is most ventricose in the umbonal instead of the middle region, and has a nearly erect instead of a straight beak. It differs from *R. vera*, Hall (Iowa Rep. 704, pl. xxvii), in the absence of wings, and in its more erect beak."

These forms seem to be represented by specimens 19073, 19267, 19268. The two specimens which we have figured are from the conglomerate where they are most abundant.

*MERISTA HOUGHTONI*. Described as follows, Proc. Acad. Nat. Sci., Phila., 1862, p. 407.

"Shell of medium size, subrotund and subtumid. Ventral valve a little produced at the straight, obtuse foraminated beak, somewhat truncate in its contour, along the cardinal slopes, and very slightly elongate in front across the width of the sinus; regularly convex in all directions from the middle, except along the shallow sinus, which takes its origin near the middle of the valve. Impressions of the divaricator muscles longitudinally striate. Dorsal valve circular; beak scarcely projecting beyond the hinge; occlusor impressions small, spatulate, separated by a rostral septum reaching one-fourth the length of the valve; mesial fold represented by an undulation at the anterior margin. Surface of cast smooth.

"Length, breadth and thickness .70 (100), .68 (97) and .36 (51).

"Locality. Lighthouse, Pt. aux Barques, with *Rhynchonella Huronensis*, etc."

It will be noticed that the description does not rule out some allied genera. A number of specimens contain terebratuloid forms, as Sp. 19073.

*PLEUROTOMARIA HURONENSIS* described, Proc. Acad. Nat. Sci., Phila., 1862, p. 425, as follows:

"*Pleurotomaria Huronensis*, n. sp. Shell rather large, depressed-turbinate, consisting of about four very rapidly enlarging whorls. Body whorl flattened from above, moderately convex above; the base a twisted plane bounded on one side by the slope into a large open umbilicus, on the other, by the sharp whorl marked by eleven raised plications and intervening broad sulci, of which, counting from the umbilicus, the sixth rests upon the carina, and the eleventh is close to the suture. These are crossed by striae of growth rising from the umbilicus, stretching far forward upon the base, curving backwards and just before reaching the carina, and apparently curving forward again after passing it.

"Height of shell 1.00 'in inches' (100); diameter of base 2.00 (200); transverse diameter of aperture .92 (92).

"Locality. Lighthouse, Pt. aux Barques, in intercalated sandstones of the Huron group.

"This species recalls *Euomphalus carinatus*, Sow., (Murch. Sil. Syst. 616, Pl. VI, Fig. 10)."

Our specimens, 19051, 19070, 19075, agree exceedingly well.

*CAMAROTÆCHIA HURONENSIS*, described as follows: Proc. Acad. Nat. Sci., Phila., 1862, p. 409:

"*Rhynchonella Huronensis*, n. sp. Shell of medium size, tumid, transversely oval, or nearly circular, with rounded lateral, and cuneate rostral margins. Ventral valve with a straight beak, flattened in the central region, and rather abruptly inflected around the margin toward the plane of the valve; mesial sinus beginning with the last third of the shell-length, and consisting of a sudden

depression in the antero-marginal slope. Dental lamellae well developed, very slightly divergent. Dorsal valve with an inconspicuous beak and a mesial fold abruptly elevated and confined to the anterior third of the valve; median septum reaching two-fifths the length of the valve. Occlusor muscular impressions semi-elliptic, lying close to the median septum. Shell structure fibrous. Surface marked with 23 small rounded ribs, of which five occupy the mesial sinus.

"Length of the ventral valve .48 "inches" (100); breadth .58 (121); convexity .10 (21).

"Locality. Lighthouse, Pt. aux Barques, in a hard pyritous sandstone, intercalated in the argillaceous slates of the Huron group.

"Var. *precipua* differs from the typical forms in being more flattened on the ventral side, with mesial sinus consisting of an abrupt deflection of nearly the whole anterior margin of the valve, forming a right angle with the plane of the valve; surface with 18 rounded radiating ribs, of which 6 fall in the sinus; dental plates diverging at an angle of 40°."

Both these varieties can be recognized in Specimens 19051, 19271, 19272 and numerous other specimens of the suite, and are like *R. sappho*, etc., Sp. 19058, Fig. 1 and Fig. 18 of Herrick's Plate XXI.\* The forms figured on Plate X, Figs. 8, 9 and 10, are the variety *precipua*.

*ORTHIS VANUXEMI HALL.* The shells referred here by Winchell are not quite like the type and are thus described (Proc. Acad. Nat. Sci., Phila., 1862, p. 409). The kindred forms in the Lighthouse section are a little larger. (Sp. 19072.)

"*Orthis Vanuxemi*, Hall (10th Ann. Rep. N. Y. Reg., p. 135). Shell nearly circular, sub-tumid; hinge-line very short. Dorsal valve a segment of a sphere; beak not surpassing the hinge, slightly incurved; a thick median plate or ridge reaching nearly to the centre of the valve, bisecting the right angle formed by the well developed socket ridges. Ventral valve flat, or slightly concave anteriorly, with a projecting beak; median ridge feeble, extending scarcely to the mid-valve; a barely perceptible trace of the semi-circular divaricator impressions sweeping from the beak to the anterior extremity of the median ridge, in the middle of which space are the two small semi-elliptic occlusor scars; dental plates short and thick; teeth well developed, lying in the hinge-line. One of the casts differs in having one of the occlusor scars half heart-shaped and the dental plates more slender. Surface not fully known; marked by numerous radiating striae which increase by implantation and bifurcation, and produce a crenulated anterior margin. Shell structure finely punctuate.

"Length .81 (100); breadth .81 (100); thickness .25 (31).

"Locality. Lighthouse, Pt. aux Barques, with *Rhynchonella*

\*Geology of Ohio, Vol. VII.

*Huronensis*, etc. This shell is a little more convex in the dorsal and flatter in the ventral than the figures given by Prof. Hall, but none of its characters differ materially from his description. Compared with *O. Michelini*, Lev., as described by de Koninck, it is a little more convex dorsally, and presents circular instead of digitate (from the vascular system?) divaricator impressions upon the ventral valve. *O. Vanuxemi* is described from the shales and shaly sandstones of the Hamilton group of New York and Iowa, the lithographic limestones of Missouri, and from the soft sandstones in Eastern Ohio, regarded as Chemung by Prof. Hall."

*DERBYA CRASSA* is the present name for *Orthis crenistria*. The forms which Winchell thus referred are described as follows (Proc. Acad. Nat. Sci., Phila., 1862, p. 410):

"*Orthis Crenistria*, Phillips. (Pal. Foss. Corn., etc., p. 66, Pl. 27, Fig. 113).—Hinge line equal to greatest width of shell; ventral valve semi-elliptic with shallow constrictions beneath the cardinal extremities; flat, with an umbonal elevation beginning about the middle and rising to a beak which overlooks a large triangular area inclined at an angle of 45° with the shell plane; dental plates strong, each equal to one-fourth the hinge length, forming with each other an angle of about 60°. Occlusor scars reaching nearly the middle of the shell, closely contiguous, leaving together a ligulate anteriorly acute depression upon the cast. Surface covered by fine radiating striae, interrupted by distinct or obscure concentric wrinkles. In one specimen supposed to belong here, the surface is cut by a set of sharply-cut, twice dichotomizing striae—the second set reaching half way, and the third one-third the distance to the beak. Dorsal valve hemispherically convex with sharp striae and concentric wrinkles, like the ventral.

"Length of shell, 1.27 (100); length of hinge line 1.37 (107; length of the dental plates .32 (25).

"Locality. Lighthouse, Pt. aux Barques.

"I can make no distinction between this species and that described by Phillips, from South Devon. The beak, however, seems to be perfectly symmetrical, and in this it differs from *Streptorhynchus robusta* Hall, Sp., from the coal measures of Iowa, as well as from the Punjab examples of Davidson (Quar. Jour. Geol. Soc. Lond., XVIII, p. 30), who identifies the Devon, Iowa and Punjab forms. The Michigan forms differ from all the others in the rugose exterior, giving it sometimes the aspect of *Strophomena rugosa*; but as they at the same time differ among themselves, I am not disposed to hesitate in the identification."

What Winchell seems to have in view are forms like Sp. 19045, 19060, very likely a *Streptorhynchus*, or *Derbya*.

*ORTHIS IOWENSIS?* described Proc. Acad. Nat. Sci., Phila., 1862, p. 410, as follows:

"*Orthis Iowensis?* Hall. (Io. Rep., p. 488, Pl. 2, Fig. 4.) Some casts in my possession resemble those of the above species. Ventral

valve nearly circular, regularly convex, with deep pit in the beak between the dental plates, which in the cast produces a conical projection. Middle region of cast with three faint rounded ridges radiating from the beak to the anterior margin.

"Locality. Lighthouse, Pt. aux Barques."

Perhaps this is represented in specimens 19073.

To this list of Winchell's Rominger adds without giving specific names or descriptions a number of genera which are undoubtedly present, viz.:

*Productus*. Compare our specimen 19062, probably two species, not very large.

*Syringothyris*. Compare what we have said above under *Syringothyris pharovicina*. The syringothyrids are among the abundant and characteristic fossils.

*Streptorhynchus*. The species is probably the same as that referred to *Orthis crenistria* by Winchell, the two names being more or less synonymous. Cf. Sp. No. 19067.

*Rhynchospira*, is very likely the same as the *Eumetria polypheura*, Cf. Sp. 19073, and Plate X, Figs. 13, 14.

*Spiriferina*. Most of the specimens being casts we are not able to identify this form with any certainty.

*Terebratula*. This genus we have not been able to identify. It may have been the Merista.

*Cypricardella (barquensis)*. The hinges not being generally in good state of preservation, the generic references of all the lamelli-branches are more or less uncertain. Compare Sp. 19057. Compare also Cypricardia and Sphenotus below. Winchell also mentions a *Cypricardella barquensis* (Proc. Am. Phil. Soc., 1870, p. 393) as occurring in Northern Michigan, i. e., Huron county, but if from the Lighthouse section he would not have included it in the Marshall. Rominger may have seen the species which we figure as *Microdon reservatus* (Plate XI, Fig. 3).

*Schizodus* apparently extremely common and abundant. The forms usually resemble extremely those figured by Herrick on plate XVII, of Vol. VII of the Ohio reports. Cf. Sps. 19045 and passim to 19073, 19082, 19260. We figure on Plate XI, Figs. 7 and 8, *Schizodus triangularis*. Many of these shells and many of the Spirifers seem to have been slightly crushed in making the cast, being flattened and cracked on the more tumid part.

*Aviculopecten*. Pectinoid forms are quite common, see Specimens

Nos. 19050 and 19062, but I judge belong mainly under *Crenipecten*, being similar to *Crenipecten caroli*. Compare the new form figured by Cooper as *Aviculopecten areolatus* (Plate XI, Fig. 1).

*Goniatites*.

*Proetus*, the glabellas and pygidia of a species of *Proetus* are extremely common, more rarely, a cheek spine or bit of the thorax may be found (Specimens 19045, 19280 and 19281, and passim through the suite). It is identified by Cooper as *P. missouriensis* Shumard (Plate XI, Figs. 14, 15) described below. No whole specimen has been found here.

*Cyathocrinus*. Shorewashed fragments of crinoid stems of more than two species are not uncommon. Mr. Cooper has found one head. (Specimens, 19068, '69, '70, '73.)

*Bryozoa*. Fenestelloid forms are not uncommon, but so far have been found very poorly preserved. (Specimen 19053.)

Besides the above forms we have obtained in our recent collections, forms like the following species.\*

*Nautilus strigatus*, Sp. 19047 (only a small fragment); compare also Sp. 19053.

*Nuculites*, Sp. 19056 shows a row of teeth on the hinge, the general shape is much like *Cucullella cultrata*.

*Spirifer centronatus* Win., Cf. Sp. 19061.

*Solen priscus* (not solen, solenopsis?). Sp. 19064, 19045, round with flaring ends.

In addition to the re-identification or more specific identifications which have already been mentioned Mr. W. F. Cooper has determined the following species (one of which proved, after figuring, to be new).

*SPIRIFER DELTOIDEUS* Herrick.

1888. *Spirifer deltoideus*. Herrick, Bull. Denison University, Ohio, Vol. IV, p. 27, Pl. 2, Fig. 7.

1895. *Spirifer deltoideus*. Herrick, Geol. Survey, Ohio, Vol. VII, Pl. 15, Fig. 7.

The description of this species as originally given is as follows:

"Shell of medium size, quite gibbous, triangular in outline, hinge equalling the extreme width; anterior margin angulated in the middle, forming with the hinge roughly an isosceles triangle of 45°; hinge apparently not, or but slightly mucronate. Dorsal valve prominently

\*Study has not been careful enough, nor opportunity of identification, and in many cases state of preservation good enough, to warrant any decided identifications as yet.

convex along the longitudinal axis, rather strongly arched; beak moderately prominent, fold triangular, rather high, sides of shell sloping rapidly from it toward the sides. Surface covered by nearly sixty small rounded, persistent striae, which rarely bifurcate near the front. From eight to ten striae fall upon the fold which in spite of its prominence (and because of the similar convexity of the valve) is poorly defined. Ventral valve very convex, provided with a deep, triangular, but narrow sinus and sculptured on the dorsal valve. Width of dorsal valve, 37 mm., height 29 mm.

"All the specimens are casts of separate valves in the sandy parts of conglomerate I. There is reason to accept the suggestion made in the last volume, that this species forms a link between the *S. marionensis* and *S. stratiformis*."

Formation and Locality. In the conglomerate bed at Point aux Barques light, Huron county, Michigan. This species was originally described from the same horizon at the Dugway quarry three miles west of Newark, Ohio, where it is found in conglomerate I. Michigan Geological Survey Collection, No. 19264. (Plate X, Fig. 4 of this report.

*AVICULOPECTEN AREOLATUS*, n. sp. Cooper [Crenipecten?] Plate XI, Fig. 1.

Shell sub-ovate, oblique to the hinge line; length slightly greater than the height; anterior and basal margins regularly rounded. Left valve slightly convex, reaching its greatest convexity at about one-third the length of the valve from the beak. Hinge line straight, having a length equalling three-fifths of the greatest length of the shell. Beak well defined, projecting slightly beyond the hinge line. Ears triangular, equal, the anterior one meeting the body of the shell at a more obtuse angle. Test ornamented with about 65 sharp rays of unequal size which are crossed with finer concentric striae. In the anterior portion of the shell the rays are arranged in irregular fasciculi which are crowded out towards the hinge line. On the specimen before us the first 15 rays below the anterior ear have a tripartite division and converge in three bundles towards the hinge line. This feature is sufficient to separate it from any other species of which I know.

Formation and Locality. From the sandstone layer at Point aux Barques light house in the upper Coldwater, i. e., middle Waverly group. Michigan Geological Survey, Collection No. 19278.

*EDMONDIA CF. BINUMBONATA* A. Winchell. Figured here, Plate XI, Fig. 5.

"Shell medium size, quadrate; height equal to two-thirds the

length; basal margin slightly arcuate in the middle, regularly curving into the anterior and posterior extremities. Anterior end straight, regularly rounded underneath the umbonal ridge, forming with the slightly arcuate posterior portion an expanding margin which increases dorsally. Cardinal line nearly straight. Right valve regularly convex, the greatest convexity being in front of the center of the shell. Principal umbonal slope running to the posterior extremity of the ventral border, a shorter one almost equally elevated, extending to the anterior extremity, which is more abruptly elevated than the posterior end. Beaks depressed and incurved. Surface marked by fine, concentric striae, which are unequally fasciculate, sometimes making conspicuous varices of growth."

This species is not identical with the form described by Winchell as *E. binumbonata*, which is a *Schizodus*. The hinge line is not short posterior to the beaks as in his description. From *Schizodus subovata* Hall, it may be distinguished by its straight anterior end and depressed beak which does not extend over the hinge as in that species.

Formation and Locality. The specimen here figured is from the light house at Point aux Barques, Huron county, where it occurs in the Coldwater or middle Waverly formation. Michigan Geological Survey Collection, 19277.

*SPHENOTUS AEOLUS* Hall. Figured here, Plate XI, Fig. 6.

1870. *Sanguinolites æolus*. Hall. Pal. N. Y., Vol. V, Part I, Prel. Not. Lamell, 2, p. 46.

1875. *Sanguinolites æolus*. Meek. Pal. Ohio, Vol. II, p. 307, Pl. 16, Figs. 1a-c.

1885. *Sphenotus æolus*. Hall. Pal. N. Y., Vol. V, pt. I, p. 404, Pl. 66, Figs. 31-35.

188. *Sanguinolites æolus*. Herrick, Bull. Denison University, Ohio, Vol. III, p. 70, Pl. 8, Figs. 1, 11.

This species which has been admirably described by Meek in Volume II of the Palæontology of Ohio is stated by him as coming from the Cuyahoga shale at Medina county, Ohio, from the same horizon as at Newark, Ohio. As Orton and Herrick limit the term these beds do not form a part of the Cuyahoga series. At Newark, Ohio, the sandstone beds which almost uniformly form the quarry rock in central Ohio, are a part of the middle Waverly or lower Logan and are at least 40 feet above the typical Cuyahoga, which in Licking county outcrops farther west. In Huron county this form is of value as coming from beds of the same horizon (middle Waverly), and lithological character as outcrops in a north and south line from Portsmouth, Ohio, to a point north of Wooster.

Shell elongate, ovate, posterior end regularly rounded, anteriorly it slopes abruptly from the beak with a distinctly concave outline to the most prominent part of the front margin which is above the middle, narrowly rounded below; basal margin straight or slightly elliptical, sub-parallel to the base; cardinal line nearly straight or slightly convex; beak, small, well defined, depressed, projecting forward and placed about one-seventh the distance from the anterior end of the shell.

Surface marked with rather distinct concentric lines with furrows and ridges which have a tendency to become well defined anteriorly.

Formation and Locality. From the middle Waverly or lower Marshall at Point aux Barques light house. Mich. Geol. Survey Coll. No. 19260.

*SCHIZODUS TRIANGULARIS*, Herrick. Figured, Plate XI, Figs. 7 and 8.

1888. *Macrodon ? triangularis*. Herrick; Bull. Denison University, Ohio, Vol. III, p. 74, Pl. VIII, Fig. 8.

1888. *Schizodus triangularis*. Herrick; Bull. Denison University, Ohio, Vol. IV, p. 116, Pl. VI, Figs. 10, 13.

1895. *Schizodus triangularis*. Herrick; Geol. Survey, Ohio, Vol. VII, Pl. XVII, Figs. 10, 13.

Shell medium, subtriangular in outline, convex; hinge line very short; anterior end slightly convex, contracted beneath the beak and rounded below, ventral line gently convex anteriorly, incurving anterior to the umbonal ridge; posterior margin nearly straight, very oblique to the hinge; post-umbonal slope abrupt, slightly concave, anteriorly the umbonal ridge is gently rounded and depressed anterior to the ridge, producing a deflection in the ventral margin; umbones rather broad, depressed, projecting beyond the hinge line.

This species is more nearly related to *S. aequalis* Hall, than any other form, but the beak is not sub-central as in that species, and the posterior margin is less produced.

Formation and Locality. Abundant in the middle Waverly or lower Logan sandstone above the conglomerate at Point aux Barques lighthouse, Huron county, Michigan. This species is also found in the same horizon at Granville, Licking county, Ohio. Michigan Geological Survey Collection 19256, 19257.

*SCHIZODUS BINUMBONATA* cf. *ÆQUIMARGINALIS* Winchell. Proc. Acad. Nat. Sci. Phila., 1862, p. 413. Figured here; Plate XI, Fig. 9.

The original description reads as follows:

"Shell of moderate size, rotund quadrate, very tumid. Hinge line short, posterior to the beaks; posterior margin forming with it a very obtuse angle; anterior slope straight, forming a rounded right angle with the slightly curved ventral border which is nearly parallel with the hinge line, and joins the posterior slope by a regular curve. Beaks depressed and incurved; greatest thickness through the middle of the shell; principal umbonal slope running to the posterior extremity of the ventral border; a subsidiary one running to the anterior extremity; between these the surface is subcylindrical; anterior to them it descends abruptly to the anterior margin, while behind them it sinks at first rather abruptly, and near the posterior border presents a little flattening. Surface (of cast) marked by eight or ten concentric furrows. Anterior lunule excavated.

"Distance measured along the principal umbonal slope (in inches) .85 (100); length from anterior to posterior extremity .85 (100); anterior slope .59 (69); convexity of right valve .24 (28); angle between anterior cardinal slope and principal umbonal line 70°."

Formation and Locality. The type species is described as coming from Marshall. The form here figured is from the Upper Coldwater (Cuyahoga) as that term is now understood; from Point aux Barques lighthouse, Huron county, Michigan. This is equivalent to the middle Waverly or lower Logan of Ohio. Michigan Geological Survey Collection, 19262.

*PROTHYRIS MEEKI*, Winchell. Plate XI, Fig. 10.

1875. *Prothyris meeki*, Winchell (Ms.) Pal. Ohio. Vol. II, p. 305, Pl. XV, Fig. 2.

1888. *Prothyris meeki*, Herrick, Bull. Denison U., Ohio, Vol. III, p. 66, Pl. VIII, Fig. 7.

1888. *Prothyris meeki*, Herrick, Bull. Denison U., Ohio, Vol. IV, Pl. IV, Fig. 2.

1895. *Prothyris meeki*, Herrick, Ohio Geol. Survey, Vol. VII, Pl. XVI, Fig. 2.

Shell varying from narrowly elongate to elongate; rhombic in shape, greatest width about one-third the length; dorsal and ventral margins sub-parallel, the lower margin being either straight or slightly arcuate, while the cardinal line in normally preserved specimens is convex, the greatest convexity being usually about one-third distant from the posterior end; umbonal ridge well defined trending

towards the ventral portion; ventral portion of the umbonal ridge depressed from the central portion of the basal margin to the beaks; beak depressed, situated about one-sixth the distance from the anterior end.

Surface marked with concentric lines of growth.

Formation and Locality. This species is found in central Ohio in strata either above or below the conglomerate II in the Waverly. The specimen here figured is incompletely preserved. It is from the sandstone beds over the conglomerate at Point aux Barques lighthouse, Mich. Geol. Sur. Collection No. 19261.

*PROETUS MISSOURIENSIS*, Shumard. Plate XI, Figs. 14, 15.

1855. *Proetus missouriensis*, 1st and 2d Geological Rep. Missouri, p. 196.

1862. *Proetus auriculatus*, Hall, 15th Rep. N. Y. State Cab. Nat. Hist., p. 107, and Pal. N. Y. Vol. VII, p. 133, Pl. III, Fig. 32.

1895. *Proetus auriculatus*, Herrick, Geol. Surv. Ohio, Vol. VII, Pl. XIV, Figs. 14, 15.

For description of this species the student is referred to the preceding publications. The glabella and pygidium (head and tail shields) are figured here on account of the value in connection with the associated fauna. In Licking county, Ohio, it only occurs in the freestones of the middle Waverly between conglomerate I and II. Its position at Point aux Barques lighthouse is just over the conglomerate where it is found very abundantly along with *Schizodus triangularis*. The specimens here illustrated came from that horizon and place. Mich. Geol. Sur. Collection, 19280, 19281.

*ORTHOCERAS BARQUIANUM*, Win. described as follows, Am. J. Sci., (Second series) XXXIII, p. 356.

"Septate portion of shell more than  $4\frac{1}{4}$  inches long; greater apical angle (i. e. the one formed by the sides which are not compressed), about  $10^\circ$ ; transverse section an ellipse whose minor axis is to the greater as .35: .50 = 1.43; septa somewhat oblique, making an angle of  $8^\circ$  to  $10^\circ$  with a transverse plane; most elevated near one extremity of the longer diameter; amount of concavity and position of siphon unknown; distance between the septa about one-fifth the greater axis at the same place. No surface markings evident from an examination of casts.

"Locality. Near the lighthouse at Point aux Barques in a hard bluish sandstone embraced in the shales of the Huron group. (See Huron group, (c) of the preceding table).

"This species may possibly prove identical with the preceding, but its apical angle is somewhat less, its septa more oblique, its section more eccentric, and its geological position considerably lower."

In the shaly beds of the Lighthouse Point section we find much the same fauna as that which is from the sandstone layers, mainly D. of p. The Producti and *Orthis vanuxemi* or Chonetes are more prominent. We have also Camarotoechia and apparently ostracoda. Sp. 19076, 19077. There are also flattened spirifers (Sp. 19075-19078).

A very calcareous facies shows Syringothyris and crinoids still abundant. The very purest shale is, however, nearly destitute of fossils. Among the bryozoa there are two types well recognized though poorly preserved, the one like *Fenestella*, the other rounded branching forms, Sp. 19082, more of the *Stictopora* type preserved only in casts.

Though not a fossil, the interesting bit of black shale, almost coal, rounded and polished like jet, which occurs as a fragment in the conglomerate should be noted in this connection.

Taking the lamellibranchs first, the abundance of Schizodus, and Pecten forms, indicate the Carboniferous. Among the more obscure forms, the thin shelled casts of forms like Sanguinolites, Cypricardella, Sphenotus, Solon or Solenopsis, thin gaping mollusks with anterior beaks is also according to Zittel indicative of the Carboniferous.

Among the brachiopods the Terebratula, Retzia and Merista forms, are too uncertain in generic identification, and too little characteristic anyway to count for much, though the Athyris or Martinia is rather Carboniferous.

The numerous species of Spirifers, have both Devonian and Carboniferous forms, though the presence of so many forms with a striated sinus, leads one to think of the Carboniferous. The Spiriferina would point the same way; the Syringothyris is even more strongly indicative. The trilobite almost certainly *Proetus missouriensis* points to the early Carboniferous or Devonian. The *Orthis* points the same way, though the large flat forms like *O. michelini*, and the forms like Streptorhynchus and Derbya, are also early Carboniferous.

The Rhynchonellas mean little, but the Producti are significant of the Carboniferous. Being rather small we think first of the lower Mississippian.

The Orthoceras is pre-eminently early Palæozoic, though abundant yet in the Carboniferous.

Taken altogether we incline to override Winchell's judgment\*

\*A. Phil. Soc., 1870, p. 336.

and assign this horizon as well as those above to the Carboniferous. On this connection we must not overlook the pebble of coaly shale. If this be from the Genesee, the Devonian black shale, it indicates that some part of the Devonian, had been turned to coal, elevated and eroded before the epoch of the Lighthouse conglomerate. This test is commonly used in Archæan geology for making the greater divisions.

We have noticed in Chapter II that Winchell in assigning these strata to the Devonian seems to have done so on the principle of giving your opponent the most possible. On a doubtful identification of four species, he yields this much to those who wished to claim the whole series as Devonian, saying "that the equivalencies of these rocks are not very precisely indicated from palæontological data."

When we compare with Herrick's lists, we see that we can find possible synonyms for almost every one of our forms in his lists of forms within 30 feet above and below Conglomerate I, at the base of his division II or Kinderhook. Yet the lists and forms do not appear to be precisely the same. The extreme wealth of fauna, and especially the occurrence of different species of the same genera, suggests an intermixture of two faunas in process of migration (and rapid evolution?) so that, for example Syringothyris may have existed a little earlier in Michigan than in Ohio, and Orthoceras like *O. rushensis* a little later. Plate X, Figs. 3 to 10, 13, 14 and Plate XI, Figs. 1, 5, 6, 7, 8, 9, 14, 15, give a view of some of the more characteristic forms.

### (3). Huron City zone.

No fossils appear to have been collected from this belt by Winchell, and he probably\* considered these sandy beds at Huron City as equivalent to the quarry beds at the base of his Marshall, whereas they are really some 84 feet below the quarry beds. Rominger notes a Rhynchonella as abundant, and Productus as also present. He mentions *Fucoides Cauda galli?* on surface of the same bed.

*CAMAROTÆCHIA (RHYNCHONELLA) CAMERIFERA*, Sp. 19036, 19273, 19274, Plate X, Figs. 11, 12; many specimens agree better with this species than any other described by Winchell, and are very abundant, somewhat smaller than the rhynchonellas of Lighthouse Point. Others show hardly any mesial sinus, and otherwise agree with Winchell's descriptions of other species.

\*Report 1860, p. 74.

The original description of the species is given by Dr. Winchell:

"Shell of moderate size, tumid; beak of ventral valve projecting and slightly upturned; cardinal slopes straight, at right angles; sides of the shell rounded; front margin similarly rounded or somewhat straight, not infrequently produced on one side of the mesial sinus. Dorsal valve nearly circular, a little more covered than the ventral, most convex anterior to the middle, and rather abruptly bent down in front. Ventral valve with a shallow sinus, which extends back about one-fourth the length of the valve, corresponding to the fold in the dorsal valve; most convex between the beak and the middle; dental plates parallel, well developed, teeth at right angles, elongate, growing stouter anteriorly, with handsomely crenulated margins; mesial partition of the dorsal valve, extending nearly one-half its length, thickening near the beak, to give place for the excavation of a small chamber near the septum. Shell with 20 or 21 (a variety ? with 16) sharp plications, of which three or four are comprised in the mesial sinus; these are crossed by a few squamose concentric wrinkles; shell structure fibrous.

"Length of an average specimen" [inches] ".38 (100); breadth .34 (90); thickness .19 (50)."

Formation and Locality. The type species is found most abundantly on the road leading west from Grindstone City and in the valley of Willow river about 3 miles south of Huron city, with *Romingerina julia*. The species here figured are from the bed of Willow River near Huron City.

"Locality. Point aux Barques, in a conglomeratic ferruginous sandstone overlying the gritstones of the Marshall group—myriads of casts sometimes forming, with *Centronella julia*, the whole mass of the rock.

"The small chamber in the mesial septum of the dorsal valve is an interesting and unique character. On a similar cameration of the septum of the ventral valve of some Cyrtiæ the genus Cyrtina has been founded; and Prof. King established his Camarophoria on the formation of an arch in the ventral valve by the approximation of the dental planes.

"This species has the external appearance of the young of *R. increbescens*, but amongst thousands, none attain proportions very different from those given above."

This associated with *Romingerina julia*, makes a well marked zone, 220 feet below the top of the Lower Marshall and forty feet above the grindstone beds.

*Productus* is still small.

*Scolithus*, flattened, nearly vertical tubes, worm borings or as likely tracks of some lamellibranch. Sp. 19036.

*Schizodus triangularis*, smaller than some at Lighthouse Point, but almost exactly like others, about 20 mm. long, Sp. 19037.

*Myalina*, cf. *whitfieldanus*, Sp. 19037, a small pointed form.

*Sphenotus*? Sp. 19037.

*Crenipecten winchelli*? There are a number of pecten fragments. Sp. 19039, and it is characteristic that the ribs are bifurcated. What seems to be a smaller species is more marked by squamous lines of growth. These are not *Lyriopecten*, but may be *Crenipecten*.

There is also the cast of the umbilicus of some gastropod like *Pleurotomaria*? Sp. 19041.

There is a small *Nucula* form about like *N. iowensis*. Sp. 19040. Specimens 19038 and 19042 are fossil forms that I cannot determine, even approximately.

*MICRODON RESERVATUS* Hall. Figured here. Plate XI, Fig. 3.

1870. *Microdon reservatus*, Hall, Pal. N. Y., Vol. V, Part I, Prel. Not. Lamell., 2, p. 33.

1885. *Microdon reservatus*, Hall, Pal. N. Y., Vol. II, Pt. I, p. 312; Pl. 74, Figs. 11-13.

1888. *Microdon reservatus*? Herrick, Bull. Denison Univ. Vol. III, p. 75, Fig. 14.

1895. *Microdon reservatus*, Herrick, Geol. Survey, Ohio, Vol. 7, Pl. 17, Fig. 9.

This species which is found abundantly in the freestones of the middle Waverly or lower Logan, Licking county, Ohio, and in the valley of Willow river, south of Huron City, Michigan, is rather above medium size, rhomboid ovate, slightly convex; beak (situated two-sevenths from the anterior end of the shell) depressed small, projecting little above the hinge line; anterior end declining somewhat abruptly from the beak; cardinal line and ventral margin gently curved; anterior and posterior muscular impression situated in the upper half of the shell connected by a pallial line.

Formation and Locality. From the valley of Willow river just south of Huron City, Michigan, in yellow sandstone beds of the lower Marshall or middle Waverly. Also found in Licking county, Ohio, in strata of the same age and character. Michigan Geological Survey Collection 19258. Similar forms occur in blue shales. Sp. 19043. Sp. 19106 is in this division also, and is perhaps a rush impression. The extreme abundance of rhynchonelloids reminds one of the zone of *Romingerina julia*, a little higher up.

(4). **Point aux Barques** zone; 85-260 feet below the top of Lower Marshall.

We can distinguish here two or three slightly different faunal stages but as they cannot be certainly distinguished in Winchell's descriptions we are obliged to group them, and there is after all no great difference. Winchell describes a number of *Rhynchonellas*, Proc. Acad. Nat. Sci., Phil., 1862, pp. 407-409, viz.:

*Rhynchonella camerifera*, described above and figured here on Plate X, Figs. 11, 12.

*RHYNCHONELLA SUBCIRCULARIS*, characterized by lack of mesial fold, described as follows:

"n. sp. Shell small, cuneate-rotund, subtumid. Ventral valve, unknown. Dorsal valve with a blunt depressed beak, equalling the hinge, a moderately elevated umbo from which the surface slopes with gentle convexity to the lateral and anterior margins, and abruptly, with slight excavation, toward the superior portion of the rounded hinge-margins. Surface marked by about 32 fine rounded plications, which reach from the margin half way to the beak. Mesial fold wanting. Mesial septum extending one-fifth the length of the shell.

"Length of dorsal valve .25 (100); breadth .259 (100); convexity .08 (34).

"Locality. Grindstone quarries, Point aux Barques, with *R. camerifera*. This species is a close analogue of *R. radialis*, Phillips, sp. Geol. Yorks. 223, Pl. XII, pp. 40, 41, from the Carboniferous limestone of Bollard."

*ROMINGERINA [CENTRONELLA] JULIA*, described Proc. Acad. Nat. Sci., 1862, p. 405.

"*Centronella julia*, n. sp. Shell small, nearly circular, ranging from slightly elongate to transverse, and squarely rounded; both valves with regular lens-like convexity, sometimes with a gentle ridge running the length of the ventral valve, and a slight sinuation near the margin of the dorsal. Ventral valve with a moderate beak, circularly foraminated, turned up at a right angle, covering the beak of its fellow. Area entirely wanting. Shell obsoletely striate concentrically, and having a minutely punctate structure. Apophysary system as follows: A delicate ribbon-like loop, originates from the stout blunt crura of each side of the socket valve, having its flat sides at first vertical; the two branches of the loop proceed at first in lines parallel or a little convergent, and then gradually diverge, widening as they proceed, and assuming an inclined position, until, approaching the front of the valve by a regular curvature, the lower edge has become anterior, giving the band an angle of 30° with the plane of the shell; approaching the median line the band rapidly widens and the front margin is drawn forward in a long acumination, while the inner margin is regularly concave, except that near the median line it turns abruptly forward so as to meet that line at an acute angle. The loop thus forms an urceolate figure on its inner margin, and on the outer a somewhat

oval one truncated behind and attenuately acuminate before. In the median line where the two branches meet, both are suddenly deflected downwards, forming a double vertical plate, not quite reaching the ventral valve, the upper edge of which, when viewed from the side, is flatly roof-shaped, while the lower edge describes two convexities, the greater anterior, leaving a notch between them. The surfaces of the loop and median plate are covered with minute obliquely conical pustules, in some places seeming to become spinulose. The casts exhibit on the ventral side a delicate impressed line extending from the beak to the middle, and on the right and left of this a fainter one; on the dorsal side a median impression with two fainter ones on the right, and two on the left—the median terminating rostrally upon a small pyramidal process (filling the beak of this valve) separated by a short slit (made by the socket ridge) from a smaller isolated process on each side.

"Length, breadth and thickness of an average specimen: .31 (100), .29 (94) and .15 (48)."

Locality. Grindstone quarries, Point aux Barques, in a conglomeritic ferruginous sandstone overlying the gritstones of the Marshall Group, abundant. Figured and assigned to *Cryptonella* by Hall, Am. J. Sci., XXXV, p. 400, but reclaimed by Winchell in the Proc. Acad. Nat. Sci. Phil., 1865, p. 123, and the figure used again in his Geological Studies. Figured also by Hall, Pal. New York, IV, 1867, p. 419. Pl. 61A. Figs. 41-46; Herrick, Bull. Denison Univ., Vol. III, p. 49, Pl. II, Fig. 5. Made type of this genus and named after State Geologist C. Rominger by Hall and Clarke, "Introduction to study of Brachiopods," Pt. 2, Pl. 52, Figs. 14, 15 and Pal. N. Y., Vol. VIII, Pt. 2, Pl. 79, Figs. 28-30. It occurs with *Camarotæchia Camerifera*, and makes a marked zone, to which belong specimens 19012, 19094, 19092.

*PTERINEA CARDINATA* (Cf. Sp. 19094). Described Proc. Acad. Nat. Sci. Phila., 1862, p. 412.

"*Pterinea cardinata*, n. sp.—Shell small, hinge line extremely elongate, posteriorly terminating in an angle of 40°, separated by a slight sinuation from the body of the shell; ventral margin transversely semi-elliptic; anterior wing short, saccate; anterior margin forming with dorsal line an angle of about 45°. Beak flattened, not elevated above the hinge; umbonal slope terminating at the middle of the ventral border, opposite which is the greatest width of the shell; descent from the umbonal slope to the antero-ventral border very abrupt. Surface of cast showing numerous faint concentric grooves which are most conspicuous in the postumbonal region.

"Length of hinge .65 in. (100); greatest width of shell .21 (32); convexity of right valve .06 (9); length of anterior wing .06 (9).

"Locality. Grindstone quarry, Point aux Barques, with *Camarotæchia (Rhynchonella) camerifera*, etc.

"This species differs from *P. elongata*, Goldf. (Petref. Germ. i, 135 Taf. CXIX 5), in having a much smaller body, and less distinct from the alate extremities."

*MYALINA PTERINÆFORMIS*, described same page.

"n. sp. Shell small, equivalve, obliquely elongate, with an alate posterior expansion, which is suddenly thickened above to form the basis of the straight elongated hinge line. Beaks subterminal, obtuse, incurved, elevated a little above the hinge; midumbonal slope making an angle of about 35° with the dorsal margin; from the upper portion the declivity is steep to the hinge on the posterior side, while on the anterior side the shell swells out into a sort of pouch, projecting beyond the beak; posterior margin of shell showing a sinuation just below the hinge, from which a regular curve sweeps around to the anterior side. Shell thin, with fine incremental lines.

"Length of shell along dorsal margin .44 inch (100); length from beak along midumbonal slope .38 (86); distance from beak to anterior extremity .10 (22); to posterior .34 (78); diameter of shell through umbo .12 (24).

"Locality. Point aux Barques, from a friable and ferruginous sandstone overlying the grindstones."

*BELLEROPHON GALERICULATUS*, Win. Proc. Acad. Nat. Sci. Phila., 1862, p. 426 (also Report 1860, p. 80) described as follows:

"*Bellerophon galericulatus*, n. sp.—Shell, small, globose, involute, ecarinate, exumbilicate, longitudinally striate, and deeply notched. Dorsum broadly and regularly rounded, without any evidences of a band, except in approaching the aperture of adult shells, where a rather broad band with ventrally concave incremental lines can be faintly traced. Aperture crescentic, not suddenly expanded strongly auriculate, with the ears hanging detached from the inner whorl. Notch infundibuliform, deep and broad, obtuse, its sides reaching to the tips of the auriculations. Umbilicus closed, scarcely indented. Dorsal and dorso-lateral surface marked by about 28 longitudinal, sharply raised striæ, separated by much wider flutings, and not perceptibly modified by the dorsal band until within half a whorl of the aperture of the adult shell, when the two middle striæ become slightly raised and enlarged, and the entire set simultaneously die away. Between these striæ and the umbilical point similar striæ diverge spirally and irregularly until intercepted by the former set, or by each other. Cast smooth, perforately umbilicate.

"Average diameter of adult .47 inch (100); height of last whorl at the aperture .26 (55); height of aperture .35 (74); depth of notch .22 (47); width of peripheral belt at notch .06 (13); separating distance between tip of auriculations and inner whorl .10 (21); number of striæ in one-tenth of an inch (ten), and this is the same in young and old specimens. Diameter of largest specimen seen .53.

"Localities. Marshall, Battle Creek, and nearly all other Southern outcrops of the Marshall Sandstone.

"The shell bears a close resemblance to *B. Urei*, of authors, but seems to differ in essential points, as follows: From *B. Urei*, de

Kon. (An. Foss. 356, XXX. 4) in being only half the size, having the dorsal belt elevated instead of compressed, in its very deep notch, less proportional width and distinct auriculariations; from McCoy's *B. Urei* (Brit. Pal. Foss. 554) in having the striae much narrower than the intervening grooves and not at all modified by the dorsal band, and in having the width of the aperture less than the diameter of the shell. Prof. Phillip's figures differ in the absence of auriculariations, and in the lateral striae. To Fleming's original description I have not access."

This form is figured by Herrick, Bull. Denison Univ., Vol. III; p. 89; Pl. II, Fig. 34; Plate IX, Fig. 32.

Above forms all belong in this zone, the locality of other forms are more uncertain, viz.:

*CARDIOPSIS MEGAMBONATA*, Proc. Acad. Nat. Sci., Phila., 1863, p. 17, 1862, p. 417.

"The specimen here referred is many times larger than the types of the species, being of the size of *C. crenistriata*, Win., from which it differs principally in the coarser and more rigid ribs and more prominent beak.

"The ribs in the Burlington specimens do not increase in number with age, and scarcely increase in size; the intercostal spaces are flat, gradually widening.

"Height from beak to ventral margin .91 inches (100); length .85 (97); thickness of left valve .55 (60).

"*Cardiopsis Megambonata*, n. sp.—Shell very small, ovate, with an elevated little incurved, nearly ventral beak, gibbous umbo and regularly rounded margins, of which the ventral is most abruptly so. Slopes from the umbo convex in all directions to the very margin. Anterior and posterior cardinal margins similar and equal. Surface of casts striately ribbed, most distinctly so toward the ventral border, and in some cases marked by rather strong concentric wrinkles toward the pallial margin.

"Height from beak to ventral margin .25 inch (100); length from posterior to anterior margin .23 (92); convexity of left (?) valve .11 (44).

"Locality. Grindstone quarries, Pt. aux Barques, with *Rhynchonella camerifera*, etc."

*RHYNCHONELLA BARQUENSIS*, Win. described Proc. Acad. Nat. Sci., Phila., 1862, p. 408, as follows:

"*Rhynchonella Barquensis*, n. sp. Shell small, transversely oval, thin. Ventral valve with a moderately prominent beak and slightly curved cardinal slopes; greatest tumidity near the beak, from which the surface descends in right and left margins. Dorsal valve flat-tish, most inflated in the middle. Mesial fold and sinus small, traceable one-fifth or sixth the length of the shell, embracing two or three sharp plications, of which the entire surface of each valve receives about 12 or 13. Dental plates of ventral valve parallel; mesial septum of dorsal valve camerated as in *R. camerifera*.

"Length .30 inches (100); breadth .32 (107); thickness .13 (43).

"Locality. Grindstone quarries, Pt. aux Barques, with *R. camerifera*."

*CAMAROTÆCHIA HUBBARDI*, Win., Proc. Acad. Nat. Sci., Phila., 1862, p. 407. Described as follows:

"*Rhynchonella Hubbardi*, n. sp.—Shell small, subquadrantal in outline; cardinal slopes straight, forming a right angle or more; lateral extremities about midway of the shell; anterior border gently curved; the two valves equally convex; ventral valve most tumid near the beak, the dorsal in the middle. Surface marked by 21 small rounded radiating plications. Mesial sinus represented by a broad shallow flattening of the mid-frontal slope of the ventral valve, occupying the two middle fourths of its width, and corresponding to 8 or 9 plications. No fold perceptible in the dorsal valve, but a shallow depression extends from the beak about one-third of the length of the shell, corresponding to the extent of the median partition beneath it. Dental plates of the ventral valve well developed, diverging at an angle of about 30°. Shell thin, fibrous.

"Length of a ventral valve .26 inch. (100); breadth .31 (119); convexity, .08 (31).

"Localities. Marshall and the grindstone quarries at Pt. aux Barques, belonging to the Marshall group.

"The dorsal valve greatly resembles that of *R. circularis*."

*SANGUINOLITES BOREALIS*, Proc. Acad. Nat. Sci., Phila., 1862, p. 415, thus described:

"*Sanguinolites borealis* n. sp.—Shell rather small, ventricose, transversely elliptic; beak somewhat projecting and incurved, less than one-fifth the shell length from the anterior extremity, with a lunuliform excavation in front of it; dorsal margin straight, ventral margin slightly arcuate; posterior extremity regularly rounded; anterior sharply bent in front of the lunulae, from which it slopes with a truncate backward curve to the ventral border; umbonal slope extending diagonally to the infero-posterior margin, somewhat angulated behind the beak, and inflected toward the cardinal region. Surface of shell of northern specimens unknown; cast showing several distinct concentric grooves. Shell of southern specimens thin, marked both with concentric and minute radiating striae. Greatest height of shell along the perpendicular from the beak; greatest convexity in the middle of the same line.

"Length 1.10 inch. (100); breadth .44 (40); thickness of right valve .15 (44).

"Locality. Grindstone quarries, Pt. aux Barques above the gritstones, and Moscow, Hillsdale county.

"Distinguished from *S. unioniformis* and *S. Marshallensis* by its terminal beaks, greater relative gibbosity, greater length and its posterior attenuation."

We identify this species somewhat doubtfully with the form fig-

ured in Plate XI, Fig. 11, which, however, comes from a higher horizon.

*BELLEROPHON BARQUENSIS*, Proc. Acad. Nat. Sci., Phila., 1862, p. 427, described as follows:

"n. sp. Shell small, globose, involute, rapidly enlarging, dorsally depressed; umbilicus small, but deep; dorsal broadly convex, with a distinct raised band; sides sharply rounded into the umbilicus; aperture crescentic, expanded with a deep broad construction behind it, notch deep and narrow. Surface marked by fine, regular, longitudinal lines, which cover the band as well as the other parts. Diameter .48 inch. (100); transverse diameter of aperture .54 (112); height of aperture to middle of umbilicus .27 (56).

"Locality. Pt. aux Barques, above the gritstones.

"Most nearly resembles *B. Michiganensis*, but the apertural construction and single set of striae render it easily distinguishable."

It is quite likely that Winchell assigned the form here described at first to *B. galericulatus* as in his latest list he does not mention *B. galericulatus* from northern Michigan.

(*Dentalium barquense*, Proc. Acad. Nat. Sci., Phila., 1862, p. 425, 1865, p. 131 is of uncertain affinities and should be expunged.)

(*Sanguinolites strigatus*, Proc. Acad. Nat. Sci., 1865, p. 129, was undescribed, and specimen lost and should be expunged.)

*Lepidodendron*, Proc. Acad. Nat. Sci., Phila., p. 387, 1870, mentioned but not described.

*Productus concentricus*, Proc. Acad. Nat. Sci., Phil., 1862, p. 411, fragments only of a productid from the grindstone quarries which may not be this species, and were not described. We have also *Productus* fragments from the *Romingerina julia* zone, Sp. 19094.

*Chonetes illinoisensis* smaller than typical, Proc. Acad. Nat. Sci., Phil., 1863, p. 5; 1865, p. 116.

[*CTENODONTA*] (*NUCULA*) *SECTORALIS*, Proc. Acad. Nat. Sci., Phil., 1862, p. 418, described at first as *Nucula*, and corrected, Proc. Acad. Nat. Sci., Phil., 1865, p. 129, but now all the *Ctenodontas* are referred to *Nucula*.

"n, sp.—Shell rather small, ventricose, sectoriform, with nearly central beaks. Anterior cardinal slope straight; posterior, nearly so, making with the former an angle of 88° to 91°; ventral border sub-circular. Beaks prominent, acute, direct, incurved. Anterior hinge plate with about 17 teeth; posterior with about 13, much smaller. Adductor scars subterminal, profound, roundly, oval. Surface of casts perfectly smooth.

"Length .86 inch. (100); height .74 (86); thickness .44 (51); distance from beak to line joining extremities .40 (46); length of anterior end .51 (59); of posterior end .35 (41).

"Locality. Battle Creek and Grindstone Quarries, Point aux Barques."

*NUCULA STELLA*, Proc. Acad. Nat. Sci. Phila., 1862, p. 419, abundant in the lower peanut conglomerate, Sp. 19032, with *Nuculana bellistriata*, described thus:

"n. sp. Shell very small, elliptic-ovate, with subcentral beaks. Anterior cardinal slope arched, posterior nearly straight, extremities rather sharply rounded; ventral side semi-elliptic. Anterior hinge plate with 17 minute, acute teeth; posterior with 5, angulated in both cases towards the beak. Beaks a little attenuated near the extremity, curved inwards and backwards. Pallial line entire, connecting the muscular scars, which are oval, and situated considerably above the middle line of the shell. Shell thin, with delicate concentric striae.

"Length .33 inch. (100); height .24 (73); thickness .14 (42); length of anterior end .20 (61); of posterior end .13 (39); distance from beak to line adjoining extremities .14 (42); length of anterior end .20 (61); of posterior end .13 (39); distance from beak to line adjoining extremities .14 (42).

"Locality. At every outcrop of the formation in the southern part of the state. Also at the Grindstone Quarries, Point aux Barques.

"This beautiful little shell has affinities with *N. ventricosa*, Hall, (Iowa Rep., 716, Pl. 29, Fig. 4), from the coal measures of Iowa. It is easily mistaken for the young of *N. hubbardi*, but is proved distinct by its more rounded sides and fewer teeth, as well as by its occurrence in a region of the state where the larger species is as yet unknown."

*CYTHERE CRASSIMARGINATA*, Proc. Acad. Nat. Sci. Phila., 1862, p. 429, thus described.

"*Cythere Crassimarginata*, n. sp. Carapace minute, ventricose, regularly oval, microscopically wrinkled—scrobiculate; hinge line impressed, and hinge margin a little hollowed; valves margined by a smooth bead, which projects slightly beyond the general surface, behind which is a small groove; cast smooth, but margined by a raised band terminating near the hinge anteriorly and posteriorly.

"Length .08 inch; breadth .05.

"Localities. In the Marshall Sandstone, at Battle Creek, Liberty (Jackson county), Moscow, near Napoleon and at the Gritstone Quarries, at Point aux Barques, with *Rhynchonella camerifera*."

Also near Wheatfield. Cooper has noticed them.

"Beside the species already enumerated from the Marshall group there yet remain a few too imperfect for adequate description, or belonging to classes not yet investigated. Among these are *Lepidodendron* and *Neuropteris*?; a coralline structure, like *Fistulipora* encrusting foliaceous or branching, with minute, short, crowded polygonal cells .0088 of an inch in diameter, without visible lamellae, but with some indications of transverse floors; some undetermined *Lamellibranchs*; two sorts of *Chiton*-like scales; two or three *Nautili*,

of which one is nodulous; and sundry remains of spines, teeth and bones of fishes."

*Munsteroceras* [*Goniatites*] *oweni*, Cf. Win. Am. J. Sci. XXXIII, 364, Sp. 19014; we can recognize this form probably, as well as other species of *Goniatites* in the fragments from the Grindstone quarries. They seem to have been originally beach broken fragments, and are at times right in the overlying conglomerate (Sp. 19017), and also in nodules in the sandstone (Sps. 19014-19016).

*Goniatites propinquas* and—

*Goniatites shumardianus*, described in the same article, all are forms like his, with simpler sutures than occur higher up in the series.

*Orodus* a genus of fish, and—

*Calamites*, a rush, are added by Rominger.

From our collections we may add:

*Orthoceras*, two species, Sp. 19033 from the lower peanut conglomerate is a large form; *Orthoceras*, Sp. 19014, has marked rings about 8 to 1 inch.

*Crinoid* stems, are abundant in certain layers, and two, or more species are represented. Some of the stems are very large.

*Pleurotomaria?* Sp. 19014. Fragment.

*Spirifer*, Sp. 19014 a small depressed form.

*Ctenacanthus?* Sp. 19013 and 19014. These hollow spines have the rear angles much sharper than any species I know.

Principal cusp of a shark's tooth, Sp. 19016. Cf. *Orodus*. The teeth known as *Orodus* and the spines as *Ctenacanthus* have been supposed to belong to the same fish.

*Melonites* is reported by Geo. H. Girty.

As we go up toward the Point aux Barques sandstone fossils become scarcer, and yet no essential change in the character of the fauna is noticed. Rominger recognized the cast of a *Rhynchonella*, and an impression of a *Goniatite* right under the Point aux Barques sandstone. Of the fauna between the Point aux Barques sandstone and Flat Rock we know little.

One specimen, 19204, not absolutely in place shows *Schizodus*, or *Posidonomya*, and coaly bits of vegetation.

Almost directly beneath the heavy beds of Flat Rock Point (Point au Pain Sucre), comes a peanut conglomerate, and ripple marked beds, with traces of rushes, a *Goniatite*, Sp. 19016, and as Rominger remarks (Vol. III, p. 71), *Camarotoechia camerifera*.

Somewhat uncertain as to their exact position in the column, and not assuredly in place are: Sp. 19089, a coarse, friable, very red sandstone containing—*Productus*, *Orthis michelini*, and a *Merista* or *Cryptonella*-like form. Sp. 19090 which appears to be just about the horizon of the Port Austin sandstone, and is a very similar rock to 19089, and beside the same *Merista* form (cf. *Athyris ohioensis*), apparently contains a *Schizodus* and *Crenipecten caroli*, gastropods and *Rhynchonella*, but the fossils in these red sandstones drop to pieces as you look at them, and to get the best results should be studied thoroughly by a competent palæontologist upon the ground. Mr. Cooper has not visited them.

Taking this fauna as a whole, we may notice as characteristic the abundance of *rhynchonelloids*, and fish fragments and coaly remains. Many of the specimens, especially the *Goniatites*, and fish remains, are evidently beach worn and broken. It is distinctly littoral. Compared with the Lighthouse Point fauna the smaller size,—forms is noticeable. Comparing with the fauna next following the comparative simplicity of the sutures of the *Goniatites*, like those of *Munsteroceras oweni* rather than those of *Goniatites lyoni* is noticeable. The *Goniatites* are too fragmentary to lend themselves to reproduction, and the fish teeth and spines hardly characteristic enough.

(5.) **Hardwood Point Zone**, 85 feet below top of Lower Marshall.

Immediately above Flat Rock Point, immediately to the southeast on a 14 foot terrace, and traceable to the water's edge at the southwest corner of Sec. 24, T. 19 N., R. 12 E., we find beds abundantly fossiliferous and easily recognizable. The most striking feature is perhaps the abundance of *Solen* forms, of which we have hitherto seen only traces, and bryozoa. In the lowest horizon immediately over the Flat Rock sandstone, from which we find previous mention only of a "Cypris like shell\* we obtained *Fenestella*, Sp. 19428, *Crinoid* buttons," *Solen quadrangularis*, *Rhynchonella*, traces of *Goniatites*, *Nuculama*, cf. *Nuculana similis*, Ohio, VII, 17, and about the same size. Cf. *N. bellistriata?* or *N. diversa* or some form markedly produced at rear. We find above some blue not so fossiliferous micaceous shales with even here bits of rushes, and *Goniatites*, faintly impressed, and borings or burrows of mollusks like *Nucula* or

\*Winchell's report, 1860; p. 80.

Nuculana, Sp. 19132, and Sp. 19032. A little higher at Hardwood Point we find a calcareous band rich in fossils, from which Winchell enumerates:

*ORTHO CERAS INDIANENSE*, Hall Cf. Am. J. S., Vol. XXXIII, p. 354. Cf. *O. cinctum* or *O. goldfussaneum*. Winchell's description is as follows:

"Septate portion of shell more than 3.75 inches in length; inclination of sides forming an apical angle which varies in different specimens from 6° to 11°; transverse section circular; septa at right angles with the central siphon; ratio of depth of chamber to its diameter, in different specimens 2.0, 2.67, 2.71 and 3.46; ratio of concavity of septum to its diameter 2.81; ratio of diameter of siphon to diameter of shell 5.67. No surface marks discernible on the cast.

"Localities. The most abundant *Orthoceras* in the Marshall sandstone. I have specimens from Marshall, Calhoun county, Holland, Ottawa county, Moscow and various other points in Hillsdale county, and from Hardwood Point (one mile S. W. of Point au Pain Sucre) on the shore of Saginaw Bay in Huron county.

"The specimens from Michigan exhibit all the characters published of *O. Indianensis* Hall, except the apertural constriction, with reference to which I have not been able to make any observations. The casts of these species cannot be distinguished from those of *O. cinctum* Sowerby, as defined by de Koninck ("Animaux Fossiles," p. 513, Pl. XLIII, Fig. 6; XLIV, 5; XLVIII, 3). It is equally indistinguishable from *O. Goldfussanum* de Kon. (pp. cit., 510; Pl. XLIII, 3, 4), except that the septa of this species are separated by only one-eighth of their diameter."

*ORTHO CERAS CLINOCAMERATUM*, Win.; in Am. J. Sci., XXXIII, p. 356 described as follows:

"The only specimen of this quite distinct form is only 1½ inches in length, partly septate. It is a fragment of a shell about 3.3 inches long, having a major apical angle of 11°. The section is elliptical, with the minor axis to the major as .24: .45 = 1.88. The first two septa are .08 apart, and the relation of this interval to the larger diameter at the same point is 6.25. The septa are deeply concave, oblique, and slightly sinuous, having one side .12 in. in advance of the other. The greater diameter of the specimen is .7 in. at one end and .45 in. at the other.

"Locality. In the Marshall sandstone at Hardwood Point, one mile S. W. of Point au Pain Sucre, [Called also Flat Rock Point] on the shore of Saginaw Bay."

Compare our specimens 19143, and 19011, 19136, 18118; the forms of *Orthoceras* seem to be on an average a little smaller than those below.

*Cyrtoceras tessellatum*, doubtfully mentioned from a small fragment.

*GONIA TITES MARSHALLENSIS*, Am. J. S. Win., Vol. XXXIII, p. 362, described as follows:

"Shell rather long, consisting of at least four whorls, the inner moderately impressed into the outer; transverse section varying from an ellipse of small excentricity to an oblong figure, surface smooth. Aperture and outer chamber not seen. Septa close, the lobes also reaching the next posterior saddles. Dorsal lobe twice as long as its greatest width, clavate, with a long cuspidate acumination, at the extremity of which can sometimes be seen the outline of the minute siphon; first and second lateral lobes similar to the dorsal in form, but successively a little smaller and not acuminate; accessory lobe obtuse, half the size of the second lateral; ventral lobe profound. Dorsal and lateral saddles of form similar to the principal lobes, but regularly rounded at the extremity; first accessory saddle, half the size, the second, imperfectly developed.

"Diameter of largest specimen seen 1.75 (100); major axis of transverse section .59 (34); minor axis .47 (27); length of dorsal lobe .26 (15), of which the cusp is about .07 (4); greatest breadth .12 (7). Diameter of siphon .015 (0.9).

"Localities. The most abundant *Goniatite* in the feebly cemented, ferruginous sandstone at Marshall. Found also in a similar rock at Moscow, and numerous other localities in Hillsdale and Jackson counties. It occurs in the hard bluish calcareous sandstone at Battle Creek and in the hard purple sandstone at Hardwood Point, Saginaw Bay.

"This *Goniatite* belongs to the group which embraces *G. Henslowi* Sow, *G. serpentinus*, *cyclobolus* and *mixolobus* of Phillips, but after careful study it seems sufficiently distinct from all. Its closest European analogue is *G. mixolobus* Phil., from the Mountain limestone of the Isle of Wight and the "Posidonomyenschiefer" of Wiesbaden. Its nearest American analogue seems to be *G. Lyoni* Meek and Worthen, (Proc. Acad. Nat. Sci. Phil., Oct., 1860), with which Prof. Hall's *G. Hyas* is identical (See 13th Rep. Regents N. Y., p. 102). The Michigan species, however, differs from the Rockford one in the addition of an accessory lobe and saddle, and in the dorsal lobe being broader and relatively longer. It is also somewhat more involute."

Our specimens, Sp. 19113, 19011, 19137 have a suture much like *Goniatites lyoni*, but with one denticle on a number of the lobes, i. e., an approximation to *Ceratites*. This is not clearly indicated in Winchell's description but is shown in his specimens and drawings. To these forms we add from the 1860 report, p. 80, *Nucula*, which Rominger says is *Nucula hubbardi*, i. e.,

*Palaeoneilo sulcatina*, Proc. Acad. Nat. Sci. Phil., 1862, p. 418 and 1865, p. 128. Sp. 19011; Sp. 19140 shows muscle scar and pallial line, slightly sinuate. This has been frequently figured, by Conrad, Hall and Herrick.

*Solen quadrangularis*, Win. Proc. Nat. Sci., 1862, p. 422, an abundant and characteristic form often in purple micaceous shales. Sp. 19010, 19028, 19136.

(*Clymenia?* Cf. pp. 85 and 86). As no *Clymeniae* are returned from the Marshall in Winchell's final list, he undoubtedly concluded to refer the forms in question to the *Goniatites*.

Beside the forms mentioned by Winchell, Rominger adds *Rhynchonella* and *Productus*. We may add a variety of fish remains, to wit: Sp. 19011, 19023 shark spines in considerable variety, cf. *Acanthaspis*;

*Fish teeth*; as in the grindstone beds there are often small black rounded fish teeth, but occasionally we have something better, e. g. *Cladodus (concinus?)* Sp. 19139, very well preserved, one large, four small cusps, two on each side, the outer larger.

*Psammodus* or cf. *cochliodus*, a large pavement tooth, Sp. 19133 *Ganoid* scales, Sp. 19027.

*Conularia*, Sp. 19109, cf. 19146, a mere fragment.

*NUCULITES FALLAX*, n. sp. Cooper, Plate XI, Fig. 4. Sp. 19259.

Shell, small, elongate, ovate, width equal to three-eighths the greatest length of the shell, cardinal and ventral line equidistant for the greatest length of the shell, anterior end truncate, posterior portion of the shell meeting the ventral margin at the end of the umbonal ridge where it is abruptly rounded; beak depressed anteriorly, about one-tenth distant from the end of the shell, clavicle extending ventrally marked with imperfectly preserved concentric markings. Teeth not shown in any specimen yet found.

Formation and Locality.—In the lower Marshall along the shoreline just west of Port Austin, Huron County.

*SANGUINOLITES MICHIGANENSIS*, Herrick. Figured here Plate XI, Figs. 12, 13, Sp. 19283, 19284.

1888. *Sanguinolites Michiganensis*, Herrick or Winchell. Bull. Denison Univ., Ohio, Vol. III, p. 70, Pl. 7, Fig. 10.

Shell quadrangular, ovate, dorsal and ventral lines subparallel, posterior end slightly large. Beaks one-fourth distant from the anterior end, slightly appressed, not projecting beyond the hinge line. Umbonal ridge well defined, extending to the abruptly rounded posterior ventral margin. Umbonal slope slightly concave dorsally, having a well defined depression extending from the middle of the ventral margin towards the beak. Anterior end ab-

ruptly rounded, with a well marked lunule on the dorsal part. This species was identified by Alexander Winchell at the time the Ohio specimens were being studied as his *S. Michiganensis*, but no description or figure from him is extant. The species was figured by Prof. C. L. Herrick without any definition.

"Formation and Locality. From the Marshall or upper Waverly immediately west of Port Austin."

*SANGUINOLITES BOREALIS?* Winchell. (Plate XI, Fig. 11, Sp. 19282.)

1862. *Sanguinolites borealis*. Winchell, Proc. Acad. Nat. Sci., Philadelphia, p. 415.

"Shell rather small, ventricose, transversely elliptic; beak somewhat projecting and incurved, less than one-fifth the shell length from the anterior extremity, with a lunuliform excavation in front of it; dorsal margin straight; ventral margin slightly arcuate; posterior extremity regularly rounded; anterior sharply bent in front of the lunule, from which it slopes with a truncate backward curve to the ventral border; umbonal slope extending diagonally to the infero-posterior margin, somewhat angulated behind the beak, and inflected toward the cardinal region. Surface of shell of northern specimens unknown; cast showing several distinct concentric grooves. Shell of southern specimens thin, marked both with concentric and minute radiating striae. Greatest height of shell along the perpendicular from the beak; greatest convexity in the middle of the same line.

"Length (in inches) 1.10 (100); breadth .44 (40); thickness of right valve .15 (44)."

"Locality. Grindstone quarries, Pt. aux Barques above the gristones and Moscow, Hillsdale county. The specimen here illustrated is from Hardwood Point, Huron county, Michigan, where it was found in red, friable, ferruginous sandstone."

Michigan Geological Survey Collection, number 19282.

Leaving Hardwood Point and going southeast after passing a relatively massive sandstone we come to a fossiliferous shingle, and on the bluff of the Algonquin terrace, which the Port Austin-Port Crescent road skirts, we find rock exposed, only certain narrow belts being fossiliferous; similar beds occur on Sec. 2, and on the hill of Sec. 31 adjacent, with fauna so much alike as to make them essentially one horizon. Sp. 19112-19128, 19140-19143, 19145, 19279.

From them we have:

*Ganoid scales*, rhomboid diagonally wrinkled, Sp. 19117.

*Goniatites marshallensis*, as mentioned; also Sp. 19117, 19113, 19128,

*Goniatites allei?* Sp. 19142, 19113, 19126, 19127, 19140, a fragment.

*Orthoceras indianense* or *multicinctum*?, 19118, Sp. 19143.

*Fenestella*, Sp. 19121.

*Bellerophon*, cf. *B. nautiloides* or *B. galericulatus*; Sp. 19113, 19140, 19141.

Characteristic of these beds in a wealth of lamellibranchs, especially pterinoid forms, inclined, with a straight hinge line, e. g., *Leiopteria torreyi* cf. *ortoni*, Ohio, VII, Pl. XXIV, Figs. 1, 8, 9, 10, 11, 12. If recognized by Winchell it was probably as a Pterinea or as *Myalina Pterinaeformis*. The forms are about the size of Herrick's Fig. 10; cf. *Anthracopectera elongata* Q. J. G. S., 1893, XLIX, Pl. VII, Fig. 16. Sp. 19114, 19127, 19128, 19145.

*LEIOPTERIA TORREYI?* Hall. (Plate XI, Fig. 2).

1884. Hall. Pal. New York, Vol. V, Part I, Pl. I., p. 174.

This species which is described by James Hall from the sandstone and conglomerate of the Chemung group at Panama, N. Y., is defined as follows:

"Shell of medium size, rhomboidal, sub-falcate; body narrow ovate, arcuate, oblique at an angle of less than 45° with the hinge, height equal to about two-thirds of the length; anterior and basal margins broadly curving from the byssal sinus; post basal margin produced and abruptly recurved.

"Left valve very convex, gibbous in the middle and above. Right valve unknown.

"Hinge line straight, about equal to the height of the valve. Beak sub-anterior, directed forward, acute, prominent and arching over the hinge. Umbonal region narrow, ventricose, well-defined, subtending an acute angle.

"Ear large, bending downward, marked by a strong oblique fold, limited by a broad, vertical byssal depression and shallow sinus margin convex; extremity apparently obtuse. Wing joining the body above the posterior extremity, limited by the nearly verticle post-umbonal slope which makes a more or less marked sulcus; margin concave; extremity produced, acute.

"Surface marked by a fine striæ of growth which are somewhat regularly lamellose on the body of the valve.

"A left valve has a length of 29, height 22, hinge line 21."

Formation and Locality. From the Marshall group along the Port Crescent road immediately west of Port Austin, Huron county, Michigan.

*Nuculana*, cf. *bellistriata*. Sp. 19125 ill preserved.

*Nuculites fallax*, as described above.

*PALÆONEILO SULCATINA*, Sp. 19140, 19141, shows the posterior muscle scar and slightly sinuate pallial line.

Sp. 19145 is concentrically striated and very much like Winchell's

forms, *Sanguinolites* (*Cardinia*, *Inoceramus*) *concentricus*, but traces of ligamental pits on a straight hinge line make the genus much more akin to *Inoceramus*; cf. also *Sanguinolites amygdalinus*.

The usual state of preservation of these fossils is in yellow fragile casts in a bluish to purplish impure sandy matrix. It will be noticed that the fauna of these upper beds, is (with the exception of some lamellibranchs), practically the same as that of Hardwood Point. Taking the two together they differ unmistakably from the fauna below the Port Austin sandstone by the replacement of brachiopods by lamellibranchs and the more complex sutures of the *Goniatites*.

From the Lighthouse Point beds to the top of these upper beds is (260 + 176) some 436 feet, with two considerable sandstone belts, perhaps three or four, included. Yet if we compare our fauna with those of Herrick's zones we find that though the Lighthouse Point section seems to correspond decidedly better with the Waverly freestone, than any lower horizon, on the other hand the upper beds also find their nearest analogues in the same stratum. So that either the Waverly freestone corresponds to a much larger series of deposits in Michigan, or the fauna lasted much longer in Michigan, see below p. 288, or two faunas consecutive in Michigan were migrating so as to meet and be contemporaneous in Ohio. In that case we might suggest that the brachiopods, *Syringothyris*, *Rhynchonella*, and *Spirifer*, and *Romingerina* were moving southwest while the solens and aviculoids came north. The generally smaller character of the upper faunas in Michigan suggests that in some way the conditions were becoming more unfavorable to life, a supposition in entire accordance with the fact that hitherto the out-crops of the Upper Marshall or Napoleon have proved unfossiliferous.\* Finally the fauna of Marshall and Battle Creek, seems as already stated by Winchell to correspond to the upper zones of our section.

#### Ohio correlations

by W. F. Cooper.

The correlation with the Ohio is as follows:†

To Prof. C. L. Herrick, President of the State University, Albuquerque, New Mexico, I am especially indebted for favors which have always been extended, and through which this work has been begun.

\*See Rominger III, p. 88.

†From this point to the end of the section is solely by W. F. Cooper and expresses his views.

The lower Carboniferous of Michigan, beginning at the bottom, has been separated into the Bedford shale, Berea grit, Berea shale, Coldwater (Cuyahoga in part) shales, lower Marshall sandstones, Napoleon or upper Marshall, Michigan series, and Bayport (Maxville) limestone.

In Ohio the same strata are represented by the Waverly formation, which with some modifications from the reports of Professor C. L. Herrick and Dr. Edward Orton, may be divided into the Bedford shale, Berea grit, Berea shale, Buena Vista flags, Cuyahoga shales, Raccoon shales and sandstones, and conglomerate I; the middle Waverly or lower Logan, conglomerate II; the upper Logan or Burlington and Keokuk and Maxville.

The Bedford shale which forms the lowest member of this series has in southern Michigan a thickness of fifty feet in places, according to the records of the well borings (Geol. Surv. of Mich., Vol. V., Pt. II). In Ohio the horizon extends in its line of outcrop from Pennsylvania west and south as far as the Ohio river, and doubtless beyond into Kentucky. It contains a recurrent fauna with a Hamilton facies. Some of the characteristic New York Hamilton species which are found in Ohio are: *Orthis vanuxemi*, *Chonetes scitulus*, *Ambocoelia umbonata*, *Macrodon hamiltonae* and *Cypricardella bellistriata*. In northwestern Pennsylvania these strata are said to be represented by the Cussewago shales.

In Huron county, Michigan, the Bedford shale is succeeded by the Berea grit, which serves very well as a datum plane as is shown elsewhere in this report. In Ohio the Berea grit varies considerably in thickness, being anywhere from five to one hundred and fifty feet thick. In the upper layers it exhibits a tendency to become flaggy and more fossiliferous. *Atrypa reticularis* and *Lepetaena rhomboidalis*, together with several other species of a local fauna, have been found in the flags of Delaware county, Ohio. In Pennsylvania it has been identified with the Corry sandstone. The Berea shale is immediately over the Berea sandstone. In Huron county, Michigan, it is easily traced in the well borings and has an average thickness of 115 feet while in the southern part of the state it is in places only twenty-five feet thick. This horizon which has also been called the Waverly black shale, by Andrews, varies in Ohio from 15 to 50 feet in thickness, throughout the line of outcrop, and is an exceedingly persistent and well defined horizon. In north-

eastern Ohio, near the Pennsylvania line, it lies immediately under the Carboniferous millstone grit; a fact of importance in the development of the lower Carboniferous of that state, which has heretofore been misunderstood.

Lying upon this horizon are the Buena Vista flags which are deserving of recognition as a horizon separable from the Cuyahoga shales above. The Dictyophyton, Producti, and *Atrypa reticularis*, which are found in them, apparently sustain the same relation to the Chemung of New York as does the Bedford to the Hamilton of that state. They are extensively quarried at Buena Vista on the Ohio river. Northward they extend into the valley of the Cuyahoga river and to the east as far as Warren county, perhaps farther. In Michigan their position has not been determined as yet, but they will probably be found south of Harbor Beach or White Rock along the lake shore.

The Cuyahoga shales vary in lithological character, throughout any one continuous section, but can, within certain limits, be distinguished by a dark blue nodular shale which very often contains fossils exquisitely preserved. These fossils may be found at Coldwater in Branch county and in less limited numbers at Rock Falls near Harbor Beach, Huron county, along the lake shore. The same nodules are found forty feet below the Carboniferous conglomerate at Cuyahoga falls, at Moot's run in Licking county nearly 225 feet below the same horizon, and at the level of the Ohio river at Sciotoville nearly 200 feet below the coal measures. There are sections in Warren county, Ohio, where this horizon is absent. Judging from the gradually extending shore line southward on which the later zones in part were deposited it is probable that the elevation of the strata had then begun in Warren county before the deposition of these beds.

This zone which is embraced in the Coldwater series of Michigan is 200 feet thick more or less in the southern part of the state. In Huron county it is difficult to draw the line between the horizons below and above these strata. The top of the beds outcropping near Harbor Beach must be about 1200 feet below the Coal Measures, while the top of the Berea shale is given by Dr. Lane from the well records as 500 feet lower at that locality which measures the approximate thickness of the zone. I think it probable, however, that a portion of the lower part of these strata may be included in the

Buena Vista horizon. There is south of Harbor Beach at the mouth of Allen creek a section at Rock Falls where I collected *Chonetes scitulus*, *Productus shumardianus*, *Productus newberryi*, var. *annosus*, *Streblopteria media*, *Conularia gracilis*, and *Phaethonides spinosus*.

These forms are also found in the Cuyahoga in Ohio. Lithologically and paleontologically this outcrop is more closely paralleled by the exposures which occur in Licking county than in the northern portion of the state in the valley of the Cuyahoga river. There is cumulative evidence to indicate that the strata of this zone were laid down in a basin rather limited to the eastward in central Ohio; which existed before the Cincinnati anticline had developed, and which may have obtained its sediment from the northward. At Moot's run, Licking county the Cuyahoga is represented by a series of light blue flags containing concretions and a *Chonetes scitulus* in the greatest numbers, which are overlain by a shale which contains nodules often with perfectly preserved fossils. The section at Rock Falls is identical in character, superposition and habitat which can hardly be accidental when taken in connection with its relative position. The same strata at Coldwater I have not yet had an opportunity to study fully.

The Waverly shale, which is a term Professor C. L. Herrick has given to the upper 40 or 50 feet of the lower Waverly or division I is rather apt to be confusing as thus limited. I have adopted the name Raccoon shales which was earlier used by L. E. Hicks to include all the strata between the middle Waverly or Lower Logan and the Ohio black shale, for this particular zone, which is the uppermost part of his series. A typical outcrop is found on Raccoon creek half way between Granville and Newark, Ohio, where no less than thirty species have been collected, most of which are confined to these beds. Over two-thirds of the number are lamellibranchs. Some of the characteristic species are: *Palæoneilo concentrica*, *P. attenuata*, *Sanguinolites flavius*, and *Sanguinolites unioniformis*. North of Licking county this formation thins out about half way between Wooster and Lodi, Ohio. In Michigan I have been unable to correlate it in Huron county, but stratigraphically and lithologically it corresponds to the 196 feet of strata outcropping below the conglomerate at Point aux Barques lighthouse and southward almost to Harbor Beach. In Hillsdale county and at Verona mills near Battle Creek the same layers are apparently rep-

resented by a coarse grained, yellowish, somewhat friable sandstone which contains in great abundance *Palæoneilo concentrica* and *P. attenuata*. At Waverly junction, near Holland in Ottawa county, the same strata are extensively quarried. At that place over 35 feet of rock are exposed which is abundantly fossiliferous, almost all the species being lamellibranchs. *Sanguinolites flavius*, *Palæoneilo concentrica*, *P. attenuata*, *Nucula iowaensis*, *Nuculana similis*, *Athyris lamellosa*, and *Bellerophon galericulatus* were the only species identified which are characteristic of the Raccoon shales in the Ohio basin. The almost entire absence of brachiopods rather tends to emphasize the relationship, but the cephalopods are relatively much more abundant than in Ohio.

We have, separating the lower Waverly from the middle Waverly or lower Logan, a band of conglomerate which varies considerably in thickness and which extends in variously modified phases from southern Ohio to Point aux Barques lighthouse. In Licking county it is well exposed in the bed of a small "run," in a quarry about one mile south of Newark, Ohio; at the "dug way" three miles west of Newark; and at Wooster, Ohio, immediately north of the city on Christmas run; and on the shore of Lake Huron at Point aux Barques lighthouse. (See fig. 5.) It is not found in the valley of the Cuyahoga river which was elevated before the formation of this bed. In otherwise continuous sections north of Wooster and south of Burbank the Cuyahoga shale lies immediately underneath conglomerate. I. In this connection it may be well to notice the observation of A. C. Lane that in the conglomerate at Point aux Barques lighthouse rounded pebbles of a black shale were found which could hardly have come elsewhere than from the Devonian black shale. The deposition of this bed must have been a time of important geologic action. In Ohio nearly all of the species became extinct as the result of the change of environment, and but few forms are found in the horizon in question, so that its correlation rests to a large extent on stratigraphical and faunal relations. For in the underlying shales and sandstones the fauna is largely lamellibranch, almost entirely so in point of numbers; in the conglomerate it consists altogether of brachiopods. *Spirifer deltoideus* is one of these characteristic species which occurs in Ohio and in Michigan along with several peculiar brachiopod species which are not found in the Ohio basin. There is evidence to indi-

cate that this bed was in Ohio deposited by river action coming from the north or north-westward.

The lower Logan or middle Waverly, the "quarry rock" of Central Ohio, is represented in sections from the Ohio river to Burbank; in Michigan from the Point aux Barques lighthouse to the *Romingerina julia* stratum west of Grindstone City. In the southern and central part of Ohio it is 40 feet in thickness on the average, while in a quarry northwest of Wooster it is 60 feet thick. In Michigan the series which is in part a representative of the Marshall exposed in Calhoun county and the upper Kalamazoo valley is made up of grits, sandstones, conglomerates and shales with an abundant fauna. The thickness of this division which should be made to extend from the Point aux Barques lighthouse to the *Romingerina julia* layer west of Grindstone City, and perhaps the 20 feet of strata resting upon it, is approximately 215 feet in thickness and includes the lower 40 feet or so of the Marshall as defined by Winchell. At Point aux Barques lighthouse the horizon is 935 feet and more below the Bayport or Maxville limestone as exposed on Wild Fowl Bay northeast of Bay City. Within this greatly increased thickness of sedimentation there are at least four horizons each with their characteristic fauna.

Thirty or forty feet below the top of the series as it has here been limited we have a layer which outcrops along the roadside leading to Port Austin, and on the old lake shore line west of Grindstone City. In it occur *Romingerina julia* and *Camarotoechia camerifera* in the greatest abundance, in places making up the entire stratum. On Sec. 17 in the valley of the Willow river the layer again outcrops. At this locality the specimens are better preserved, while *Romingerina julia* is relatively more abundant. These species are distinctive of the lower Logan in central Ohio, and while it is impossible to demonstrate the same relationship here, there is evidence when taken in conjunction with the underlying beds that they form an integral part of this series and of the middle Waverly in general. About 15 feet below are the fine grained and uniform blue grits which make the famous Huron county grindstones. In and near these grits occur a great variety of fossils, especially of cephalopods which afford little data for comparison. Some of the species which are found there and admit of identification in the "quarry rocks" of central Ohio, are: *Syringothyris carteri*, *Edmondia*

*burlingtonensis* and *Goniatites lyoni*. Incidentally it might be observed that these species are considered by some authors as characteristic of the Kinderhook beds of Illinois. The lower bed of "peanut conglomerate" exposed just west of the gristmill at Grindstone City is characteristically full of *Nuculana bellistriata*, a form which has not yet been found in Ohio. If we continue along the coast to Point aux Barques lighthouse we find overlying the conglomerate, streaks of sandstone imbedded in the shale and filled with a great variety of fossils, from which both Rominger and Winchell have mentioned many species, and which will undoubtedly yield more material to any one who will take the pains to work them up. From this bed we have collected many species which are more distinctly Carboniferous in character than those from the Cuyahoga strata farther south. Lithologically the formation both here and in the valley of Willow River is typically lower Logan, faunally the species which are here given may be considered typical of the same horizon along with some species which have not yet been identified in Ohio. Of the former we have identified the following forms: *Syringothyris carteri*, *Camarotoechia sageriana*, *Cryptonella eudora*, *Crenipecten winchelli*,? *Sanguinolites naiadiformis*, *Schizodus triangularis*, *Bellerophon cyrtolites*, *Pleurotomaria strigellata* and *Proetus missouriensis*. To these characteristic species may be added *Derbya crassa*, *Spirifer centronatus*, *Spirifer huronensis*, *Eumetria polypleura*, *Palaeoneilo marshallensis*, *Leiopteria halli*? and many other forms which are in part generally distributed throughout the lower Carboniferous in Ohio, along with others not yet found in that region.

Extending from the beds at Flat Rock Point west of Port Austin to the heavy bedded dark sandy flags overlying the *Romingerina julia* layer west of Grindstone City we have 110 feet of strata which are almost barren of fossil remains. These layers which are embraced in the lower Marshall have their base 200 feet below the top of the lower Marshall and 40 feet or less above the *Romingerina julia* zone. I have placed the base at this point only on account of the negative evidence afforded by the almost entire absence of organic remains, together with the physical and geographical changes which occurred at the time of the deposition of its beds.

The base of this series consists of flags succeeded by about eighteen feet of massive white sandstone at Point aux Barques hotel. Above this strata for about sixty-five feet are soft, greenish, slightly

micaceous, then bedded slaty or sandy blocks rather insufficiently exposed in which the only fossil found was a species of *Conularia* too poorly preserved for identification, but which may be the species described in Ohio as *Conularia newberryi*. This series of strata affords a problem that it is not yet possible to explain. Stratigraphically it may be relatively represented in part by conglomerate II in Ohio which separates the lower and upper Logan, and I am inclined to believe that this may be proven true. Conglomerate II does not extend as far south as the Ohio river. In Ashland county southeast of Mansfield it varies in within a distance of two miles from 3 to 20 feet in thickness. At Wooster, Ohio, it is very nearly one foot thick, while northwest of that place it is 15 feet in thickness. Going directly east from there it is not represented in the valley of the Kilbourn river where the strata afford an otherwise continuous section. It is largely problematic to attempt to bridge over the hiatus from this point to the outcrops in Huron county, but as in the case of the overlying and underlying beds, I think that it will prove true, that the sediments which make up in part at least the remnant of strata which are in the Ohio basin will be shown to have come from the northwest and that these barren strata above mentioned are partially represented by the bed of conglomerate which was deposited at the close of the lower Logan, in Ohio.

Above these unfossiliferous beds there is an abundant fauna, which is the typical Marshall according to Winchell and in all probability is represented by the lower beds of the upper Logan in central and southern Ohio. These species are smaller than in the fossiliferous beds at Grindstone City, indicating somewhat more unfavorable conditions for life quite in harmony with the series of unfossiliferous beds below and above as A. C. Lane says: "The sutures of the *Goniatites* are more complex than they are below, and there are several species of lamellibranchs, especially aviculoid and solenoid forms and a scarcity of brachiopods." This gives the fauna a facies considerably resembling that over Conglomerate II at Newark, Ohio. This series comes down some eighty-five feet or less below the upper Marshall. The only species identified thus far with the Ohio species from approximately the same horizon are *Otenodonta hubbardi*, *Grammysia hannibalensis*, *Prothyris meeki*, and *Solen quadrangularis*. In other parts of the state this last species is quite generally distributed. There also occur in the same beds *Nuculana similis*, *Myalina michiganensis*, *Sanguinolites amygda-*

*linus*, *Goniatites lyoni*? and several other forms which do not afford any data for correlation. In a general way these beds of the lower Marshall conform stratigraphically and palæontologically to the upper Logan, and in the absence of any definite data they might be provisionally regarded as forming a part of that series.

Immediately above this series of strata we have about 300 feet of sandstone which is exposed in the Babbitt quarry near Little Oak Point, at Hat Point, and various places near Tyre, but has proven unfossiliferous. These beds form the Napoleon formation of Winchell, and are succeeded by the beds of the Michigan (Salt Group) Series having a thickness of almost two hundred feet and containing gypsum, which indicates that it was laid down in a body of water largely shut off. It is possible, as Mr. Lane suggests, that this occurred at the time the upper Logan was being deposited in central and southern Ohio, when the strata in the north part of Ohio were above water, until the time of the formation of the Carboniferous millstone grit and thus occupies the gap in the geological column in northern Ohio.

The Grand Rapids or Bayport limestone is extensively quarried in the Grand Rapids and Bayport quarries. It seems to mark without doubt the culmination of the depression during which the sea extended quite far north not long before the deposition of the Coal Measures. In Muskingum county, Ohio, these beds are twenty-five feet thick, while in Licking county a few miles further north they are absent, besides a considerable portion of the upper Logan. However, in the lowest coal measure conglomerate eight miles northeast of Newark, Ohio, a large number of fragments of limestone were broken out which contained a few fossils which can only be referred to the age of the St. Louis or Kaskaskia. These conglomerates are also full of impressions of *Lepidodendron* and *Calamites*. The quartz and igneous material are rounded as though transported from a distance. The fragments of limestone, however, are angular and badly decomposed which indicates that they were eroded and carried from no considerable distance, certainly from a source nearer than that which furnished the mass of the rock. We have here then apparently, an explanation of the gap which exists above the highest formation of the lower Carboniferous in northern Ohio, and incidentally of the hiatus which is found in the upper horizons of the different basins in Ohio and Pennsylvania. This correlation is based

upon the following species: *Lithostrotion canadense*, *Spirifer glaber*, *Athyris subtilita*, *Allorisma clavata*, *Allorisma elongata*, *Schizodus chesterensis*, *Bellerophon sublaevis*, and *Phillipsia longispina*.

The correlations which have here been stated may be modified, but in so far as they relate to Huron county I do not think that any modification will materially alter the relationship. It is reserved for a future time to determine how far the same sequence holds good for the other parts of the state.

Newberry Library, Chicago, Illinois, April 1, 1898.

§ 4. Fossils of the Soule and Bayport limestones.

As we have said the outcrops of the Napoleon sandstones, whether at Hat Point, the Babbitt sandstone quarries, or at any other of the exposures have not yet yielded fossils.

(a). **Soule and Oak Point, Michigan series.\***

The Michigan series has also proved sparingly fossiliferous to our researches, but Rominger seems to have been more successful.

Around Oak Point on Sec. 18, T. 18, R. 11, he gives the following list, p. 103.

*Productus* ventral valve very convex, shallow, sinuated in the median line, and covered by from 40 to 50 sub-equal ribs.

*Retzia*, like *R. vera*, i. e. *Eumetria marcyi*.

*Terebratula* like *Cryptonella eudora* (generic reference doubtful).

*Spirifer (marionensis)?*

*Spiriferina (spinosa)*.

All these specific identifications are very doubtful and the specimens in loose fragments not absolutely in place; crinoids, bryozoa, brachiopods, and bivalves were well represented.

In dredging Caseville Harbor rounded strongly driftworn boulders, of similar lithological character enclosing similar fossils are found, and among them are dark bluish colored fine grained rocks crowded with shells of *Myalina*, *Modiolopsis*, *Schizodus*, with some *Rhynchonella*, *Terebratula*, *Retzia*, etc., intermingled. These may very likely be from sublacustrine outcrops of the Marshall. Winchell found no fossils.

The *Productus* seems to be near *Productus arcuatus* (Sp. 19009) though our one specimen is badly crushed. One specimen of *Spirifer* with five striations in the sinus, appears to be *Spirifer forbesi*, the hinge line being quite long. We doubt Rominger's identification of

\*See pp. 12 to 16, 103 to 113.

*Sp. marionensis*, and probably he only intended to express general resemblance. Quite likely there are other *Spirifers* present, but all seem to have a striated sinus. The investigations indicate a brachiopodous fauna quite in contrast with that of the Marshall, though apparently most of the specimens come from near the lower part of the series, say the lowest hundred feet.

Geo. H. Girty has found *Nautilus*, *Lituites*, *Orthoceras*, *Spiriferina kentuckyensis* (?), *Productus rushvillensis* (?), *Rhynchonella*, *Derbya* and plant remains.

The fauna certainly is not inconsistent with the Augusta (Burlington-Keokuk) group; lithologically it is most allied with the Keokuk. Both Rominger and Winchell assume a closer affiliation of this group with the Bayport rocks than is warranted as it seems to me. Not only is there the difference already described, in lithological character and character of well water, but also a different fauna, so far as I can judge. I have seen fossils from this group in the quarries at Alabaster, Iosco county, and studies in that county will doubtless throw more light upon the subject.

(b). **(Bayport) Maxville limestones.** (200-247 feet above the top of the Napoleon sandstone.) The general equivalent of the outcrops around Bayport, and the islands off the shore, and the outcrops around the Shebeon, and the Charity islands has been remarked by all observers. Under the *Lithostrotion* beds, are certainly the more compact beds with chert nodules and *Syringopora*, *Allorisma* and *Productus*.

The following table shows the fauna so far as it has been determined. In the first column is given the names of the fossil forms. There is undoubtedly a great deal of synonymy, and probable synonyms so far as the names have been applied to forms in this limestone are grouped together. Identifications which I strongly question are bracketed. In the following columns I have given reference to the author who has mentioned the form in the present connection, and also given the numbers of the Survey specimens, which appear to contain the given form, indicating 19000 by '000, etc. In some cases the numbers and references may not refer to exactly the same but only a similar species, as is more fully explained in the foot notes. I have divided the references into four columns. The first contains all references to the exposures at Bayport, including also the islands of Wild Fowl Bay; the second includes all the references to the Charity islands. The third includes

all references to the Shebeon locations, and the last contains references to other places, particularly to Grand Rapids, and to the Maxville limestone outcrops of Ohio.

The palæontological evidence thus accumulated as to the age of these limestones is quite satisfactory. Winchell at first was inclined to think that the limestones in question might include attenuated representatives of the Mississippi limestones from the "geode bed," i. e., upper Augusta up into the Kaskaskia, and in Walling's Atlas he considers that the St. Louis and part of the Keokuk are represented, from the presence of *Lithostrotion canadense* and *Spirifera keokuk*. Rominger does not attempt to assign the horizon closely. Dr. C. H. Gordon visited the Shebeon localities at my request, and from a brief observation, was inclined to place them as Upper Lower Carboniferous, at least as high as the Saint Louis. Whitfield refers the equivalent Maxville limestones of Ohio, to the Saint Louis-Chester groups. Thus there is a prima facie case that the limestones belong in part at least to the St. Louis. But when we come to study the affinities closely, it seems to me that the affinities are more strongly with the Kaskaskia—(Chester) than with the Keokuk. *Allorisma clavata*, *Zaphrentis spinulosa*, *Athyris sublamellosa*, *Spirifera glaber*, v. *contractus*, *Terebratula sub-retziaeformis*, and the form which Winchell took for *Spirifer keokuk*, which I think to be near *Spiriferina spinosa*, all point that way, thus agreeing in placing it close to the dividing line between the St. Louis and the Kaskaskia. But the highly characteristic *Lithostrotia*, *L. canadense* and *L. proliferum* and numerous other forms closely like those in the Saint Louis, viz., *Productus altonensis*, *Athyris trinucleus*, *Bellerophon sub-lævis*, together with the fact that it must mark an era of continental depression seem to make it nearly coeval with the top of the Saint Louis, even though the fauna has as strong or stronger affinities with the Kaskaskia. One might be tempted to separate off the Shebeon outcrop with *Zaphrentis*, and *Spiriferina spinosa* and refer them alone to the Kaskaskia, but the *Spiriferina* is not a typical *S. spinosa*, but is almost certainly the form referred to by Winchell as *Spirifer keokuk* and occurs associated with a form exceedingly like *A. trinucleus* and a *Phillipsia*. Moreover we are not sure that the Shebeon specimens are above those of Bayport, but even if they are, there is not more than fifty feet or so in the section.

Winchell's general idea seems to be very nearly right, except that the horizon is a little higher than he supposed.

The *Lithostrotia* are illustrated by Rominger in Vol. III. Pl. LV. The remaining forms must await a closer study of the Kent Scientific Institute, Strong's and the Winchell collection before they can be gone into more thoroughly, and that will be the time to illustrate them.

The fragments of vegetation as yet discovered from the Sebewaing Coal mines do not deserve an elaborate description. Ferns are notably absent, rushes, stems and *Stigmaria*, are the commoner forms.

References are indicated for the first column thus: R = Vol. III of our reports on p. 120; W. = Winchell's lists given in the 1860 report, pp. 100, 103-110: Our specimens, from 19000-19008 are from the quarries; Sps. 19170 — 19173 from 725 paces N., 2000 W. in Sec. 36, T. 17 N., R. 9 E.; Sps. 19206 — 19207 from the shore of Wild Fowl Bay; Sps. 19208 — 19219 are from North Island. St. I refers to Stone Island.

For the second column the references are: G. W., list from Charity island by Winchell, 1860 report, pp. 101-110; L. W. list from little Charity, same reference; R. Rominger's list, p. 119; our numbers may be compared with the description of the locality in Chapter V, § 4. For the Shebeon (Cheboyong) W: refers to Winchell's list, 1860 report, pp. 100-113; and possibly some of the forms of Rominger's Bayport list come from the Shebeon.

In the last column M. refers to fossils from the Maxville limestone of Ohio, described by Whitfield, in Vol. VII, of the Ohio reports.

G. R. S. refers to fossils collected by Strong at Grand Rapids, and described in No. 3 of the Proceedings of the Kent Scientific Institute. No. 8 of these proceedings I have not yet seen.

G. R. W. refers to Winchell's lists from Grand Rapids, 1860 report, pp. 103-110.

Wh. refers to lists of fossils from Grand Rapids, given in a paper by Mr. C. A. Whittemore before the Michigan Academy of Science in December, 1895, (First Report, p. 63), or furnished in MSS by him from the labels of the Kent Scientific Institute Collection. There are a number of other lists given by Rominger at various pages and cited by R. with reference to the page number (111 to 119).





tions of *A. andrewsi* Whitfield and *A. elongata* Strong *A.* seem to be applicable.

Strong's descriptions of *A. elongata* and *A. quadrata* are as follows:

"No. 46. *Allorisma elongata*. (n. sp.) Like the above [*A. sinuata*]," except more elongated posteriorly, wholly without sinus upon the ventral margin or depression upon the valves, and beaks nearer the anterior end. An undistorted specimen of medium size gives the following measurements: Length, 64, height to hinge line, 23.5; height to summit of beaks, 25.4; greatest thickness, 20. Beaks one-ninth the length of the shell from the anterior end (varying in different specimens from one-seventh to one-tenth); twenty-eight concentric ridges—which in this case are pretty persistent—can be counted upon each valve. A specimen one and one-half inches long gave analogous results.

"No. 47. *Allorisma quadrata*. (n. sp.) Like the above, except smaller, relatively broader, with posterior end more quadrate. A specimen of full size, and *undistorted* gives the following measurements: Length, 31; thirty-nine concentric ridges in fasciculi of two, three, or four which often unite upon the posterior end.

"(The author has recently endeavored to refer to the above species described several years since, about seventy specimens, collected this season. He finds none of No. 45, fourteen of No. 46, forty-one of No. 47, and a remainder of heterogeneous material including a few individuals strongly resembling Owen's figure of *A. regularis*; a few not unlike *A. clavata*, and almost every degree of variation between these forms and the three described above. Many resemble Fig. 2, Pl. 22, Vol. V., Pal. Ills. He had formerly believed, that Nos. 46 and 47 were distinct from No. 45, as he had never found them in the same horizon; but recently he has found the two former associated in strata 3 and 4, Taylor's quarry. It is questionable whether we have more than one species of this genus)."

It will be seen that he is inclined to consider them both varieties of *A. sinuata*. As varietal names I think they will stand.

(8.) Strong's description of *Phillipsia longispina* is as follows:

"No. 14. *Phillipsia longispina*. (n. sp.) Outline elongated elliptical sides nearly straight, ends evenly rounded; head, thorax and pygidium nearly equal in breadth.

"Glabella with posterior lobes small, anterior moderately large, evenly convex, without margin; facial suture nearly as in *P. Portlockii* neck segment about as wide as the thoracic, and continued backward in a narrow spine which extends beyond the thorax and is applied so closely to it as not to interfere with the elliptical outline; neck furrow shallow, curving backward strongly and terminating at the lateral furrows of the cheeks. Thorax and pygidium much as in *P. Portlocki* except that the border of the latter is very broad, equaling in breadth the lateral lobes. One specimen from Scribner's quarry yields the following measurements: Length, 44.4; of head 15.3; of thorax, 12.1; breadth of head, 21.2; of thorax, 21.9; of pygidium 20.4."

We may add as applicable to our specimens, eye faceted, kidney shaped, very prominent.

Axis of pygidium very high, continued nearly to the end, with 11 or more segments, margin smooth. The axis and the thoracic segments on each side are ornamented with a row of tubercles. All of our specimens show pygidium or glabella or eye, or cheek spine as separate fragments, but Strong had a nearly complete specimen, and I have seen one in the collection of Mrs. W. L. Webber of Saginaw. The species is a well marked one and wherein it differs from *P. portlocki*, approaches coal measure forms.

(9.) In the Bayport quarries I could see traces of large coiled shells, but was not able to extract them, and do not know whether they belong to *Euomphalus* or *Nautilus*, beside the *Bellerophon* form.

Girty collected some large coiled shells from the Bayport quarries which proved to be a robust species of *Bellerophon*—all internal casts and species not yet determined.

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DESCRIPTION OF PLATE X.

Figs. 1, 2. *Chonetes scitulus* Hall. View of pedicle valve and of brachial and pedicle valve in conjunction. Upper Coldwater horizon. Point aux Barques lighthouse, Huron county, Michigan.

Fig. 3. *Spirifer huronensis* A. Winchell. Pedicle valve of an average individual. Upper Coldwater horizon. Point aux Barques lighthouse.

Fig. 4. *Spirifer deltoideus* Herrick. Brachial valve. The striae are not preserved towards the hinge line. Upper Coldwater horizon. Point aux Barques lighthouse.

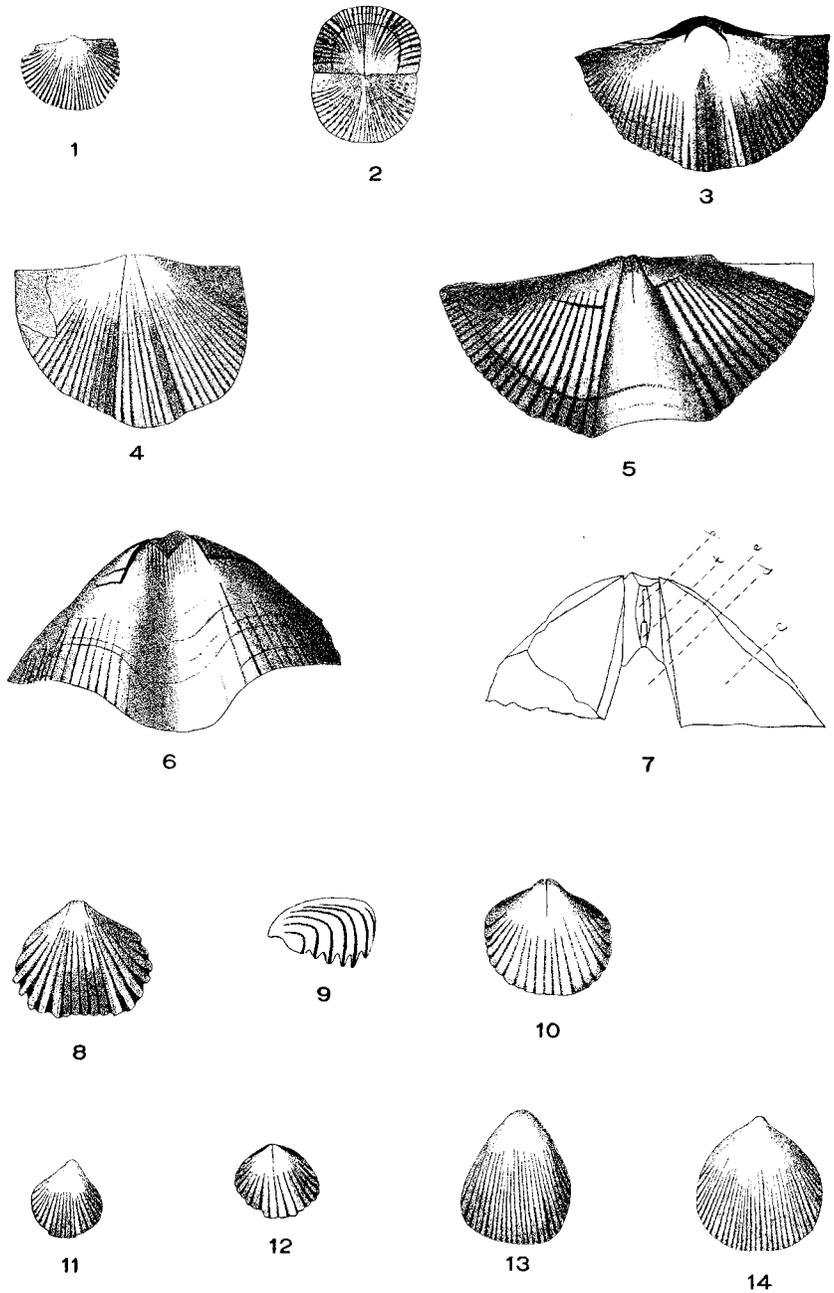
Figs. 5, 6. *Syringothyris pharovicina* A. Winchell. Brachial and pedicle view of two individuals.

Fig. 7. Specimen showing: c, cardinal area; d, delthyrium; e, dental plate; p, tubular portion of transverse plate; t, internal cast of tube. Upper Coldwater. Point aux Barques lighthouse.

Figs. 8, 9, 10. *Camartochia huronensis* var. *precipua* A. Winchell. Pedicle, profile and ventral view of this species. Upper Coldwater. Point aux Barques lighthouse.

Figs. 11, 12. *Camartochia camerifera* A. Winchell. Lower Marshall. Valley of Willow river, Huron City, Michigan.

Figs. 13, 14. *Eumetria polyplorea* A. Winchell. Pedicle and brachial view of two individuals. Upper Coldwater. Point aux Barques lighthouse.



DESCRIPTION OF PLATE XI.

Fig. 1. *Aviculopecten areolatus* n. sp. (Cooper.) Left valve showing the irregularly striated test. Upper Coldwater. Point aux Barques lighthouse.

Fig. 2. *Leiopteria torreyi* Hall. Left valve magnified two times. Marshall group. Port Austin, Michigan.

Fig. 3. *Microdon reservatus* Hall. Left valve showing muscular impressions and connecting pallial line. Upper Coldwater. Valley of Willow river, two miles south of Huron City

Fig. 4. *Nuculites fallax* n. sp. (Cooper.) Left valve enlarged two times. Marshall group. Port Austin, Michigan.

Fig. 5. *Edmondia binumbonata* A. Winchell. Right valve of this form. Upper Coldwater. Point aux Barques lighthouse.

Fig. 6. *Sphenotus aolus* Hall. Right valve of a specimen of this species. Upper Coldwater. Point aux Barques lighthouse.

Figs. 7, 8. *Schizodus triangularis* Herrick. Left and right valve. Upper Coldwater. Point aux Barques lighthouse.

Fig. 9. *Schizodus binumbonata* A. Winchell. Right valve of a normal specimen. Upper Coldwater. Point aux Barques lighthouse.

Fig. 10. *Prothyris meeki* A. Winchell. Left valve showing a variable form of this species. Upper Coldwater. Point aux Barques lighthouse.

Fig. 11. *Sanguinolites borealis?* A. Winchell. Right valve magnified two times. Marshall group. Port Austin, Michigan.

Figs. 12, 13. *Sanguinolites michiganensis* A. Winchell. Right and left valve drawn two times. Marshall group. Port Austin, Michigan.

Figs. 14, 15. *Proetus missouriensis* Shumard. Head and tail of this form. Upper Coldwater. Point aux Barques lighthouse.

