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UPPER ORDOVICIAN AND LOWER DEVONIAN STRATIGRAPHY AND PALEONTOLOGY OF PERCÉ, QUEBEC.

CHARLES SCHUCHERT AND G. ARTHUR COOPER.

PART I. STRATIGRAPHY AND FAUNAS.

CHARLES SCHUCHERT.

Introduction.—For many years it has been stated that Middle Ordovician and Silurian fossiliferous formations occur about Percé in the eastern part of Gaspé peninsula, Quebec Province. More extensive collecting during the past ten years has brought to light a thick development (at least 1,000 feet and possibly 2,000 feet) of Upper Ordovician (Middle and Upper Richmondian with probably some of the Gamachian); but no Middle Ordovician seems to be faunally represented, though such is probably beneath the Percé fold-structure, since rocks of this age occur farther west, certainly about Port Daniel and probably around Little River East. Of Silurian there is also none, the corals supposedly of this period being of the Atlantic Richmondian (Anticosti). Other "late Silurian" fossils turn out to be of the Lower Devonian like that of the Dalhousie area of New Brunswick (Helderbergian), while the well known Devonian forms of Percé Rock and the Murailles are of the lower part of the Grande Grève series farther north, and therefore of Oriskanian time.

Aside from these changes in correlation, the object of the paper is to present the local faunas of the Upper Ordovician found about Percé. It was noted long ago by the writer that these Percé faunas are very peculiar, and that the bulk of the species are different from those of the same age on Anticosti Island, only 70 miles to the northeast and of the same seaway. The description of some of the fauna by Doctor Cooper, which forms Part II of this paper, shows clearly the presence at Percé of North European elements. Such are,

curiously, lacking in the Anticosti faunas, now fully described by Twenhofel, but older ones are present in the early Trenton of New York (Rysedorph conglomerate near Albany) and the Appalachian geosyncline (Chambersburg formation).

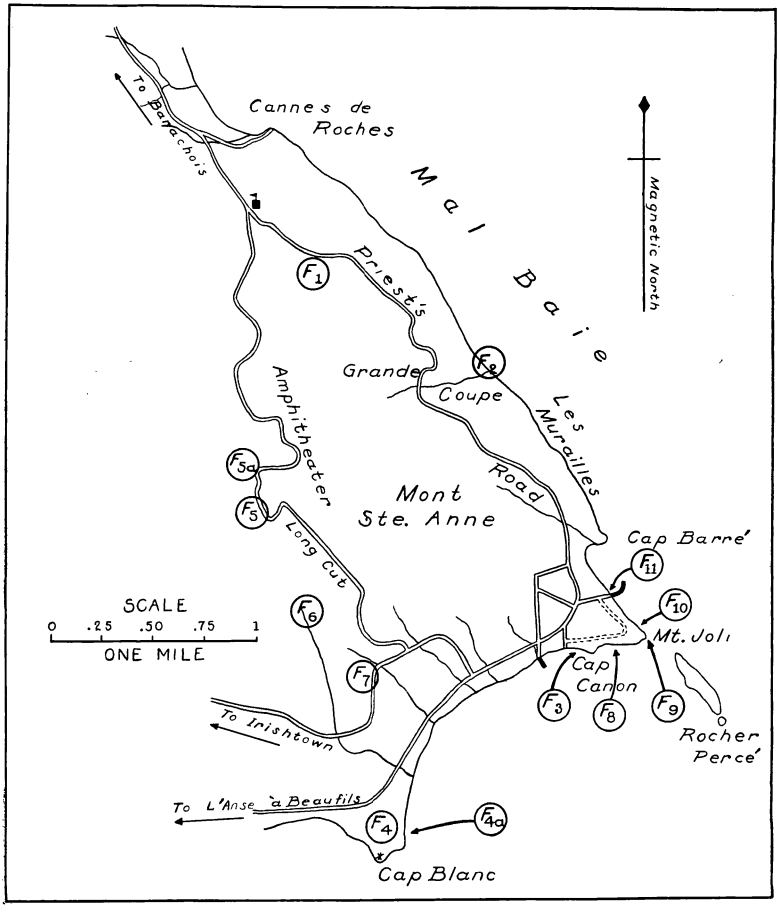

Fig. 1. Sketch map of the Percé area showing the localities discussed. Drawn by Cooper.

As the Percé area is being mapped by Cecil Kindle for the Geological Survey of Canada, no comment is made on the folded structure that is so greatly complicated by the pre-Bonaventure faulting. Until detailed topographic maps are available, however, this faulting can not be correctly shown cartographically.

The latest geological map of the area is by Clarke, published in 1917-1919.

Ordovician Strata and Faunas.

In the summer of 1900, Doctor Clarke and the writer spent a month studying the Silurian stratigraphy at Arisaig, Nova Scotia, and especially the Lower Devonian at Dalhousie, New Brunswick, and about Gaspé and the Forillon, the land's end of southeastern Quebec. The writer in 1905 again collected fossils in Gaspé with his friend Robert H. Gordon, and discovered the Upper Ordovician fauna at the Grande Coupe west of Percé. On his return to Yale he sent some of the bryozoans to Dr. R. S. Bassler at the United States National Museum for identification, and the latter pointed out the presence of the very widely distributed *Sceptropora facula,* an unmistakable Richmondian bryozoan. Clarke was told of this discovery but made no use of it. Later and larger collections from the Ordovician about Percé were made in August 1927 by the writer, with the assistance of Dr. Stuart A. Northrop, and again in August 1929 with the help of Dr. G. Arthur Cooper. It is the knowledge gained from these several collections of fossils and what they mean in stratigraphy that the present paper sets forth.

Cape Canon Formation.—The oldest known formation in the Percé area is what John M. Clarke (1908:57) calls the "Cape Canon massive" (see Fig. 2). It is a series of light-blue, thin-bedded limestones separated by thin zones of black argillaceous shales. This series is much more disturbed than any other, with the strata standing nearly on end but with a hade slightly to the south, much jointed and cleaved and the whole criss-crossed by a net of calcite veins. On this hill stands the home of the artist, Frederick James. The sea frontage of this formation is about 630 feet, which therefore represents its visible thickness. It has yielded no fossils to anyone. The same unfossiliferous series is again exposed about two miles to the south, just beyond Cape Blanc lighthouse.

As the younger Whitehead formation may be 2,000 feet or more thick, it is probable that the Cape Canon formation is only a part of this younger series, and this appears to be proved by the fossils of the Limekiln zone next to be discussed.

The *Limekiln conglomerate* thought by Clarke to be a part of the Cape Canon formation is the rock in Logan Park

in the village of Percé on which the Logan medallion was placed in 1913 by members of the Thirteenth International Geological Congress when they were studying the geology of the region under Clarke's guidance. The conglomerate is all of small pieces, greatly brecciated and sheered, with the beds apparently standing on edge and having a visible thickness of 200 feet. "A single bed of a similar conglomerate was observed infolded in the schists [these strata are not at all metamorphosed into a schist] of Cape Canon" (Clarke 1904:27), and similar zones may be seen on the roadside west of Cape Blanc lighthouse and on the Irishtown road. In the

Fig. 2. Cape Canon and South Cove (extreme left), Mt. Joli (center), Percé village and the Murailles (extreme right), as seen from Percé Rock at low tide, looking west. Mt. Ste. Anne in background. Photograph by Cooper.

Limekiln conglomerate Clarke collected in loose pieces *Plectambonites sericeus, Rafinesquina* (geniculate sp.), *Leptaena rhomboidalis, Protozyga exigua, Ambonychia* sp., and *Ceraurus pleurexanthemus.* These fossils, he says, indicate an age "equivalent to middle or upper Trenton" (1908:58). The writer in 1927 also found here a fossiliferous pebble with young brachiopods and fragments of the trilobites *Illaenus?* and *Tretaspis?*. So far as can be seen from present knowledge, these fossils are not sufficiently unlike those of the other Ordovician localities to be regarded as belonging to anything but the Whitehead formation.

The following Ordovician formations are clearly all of one series, namely, Upper Ordovician, as will be demonstrated in the following pages.

Whitehead or Cape Blanc Formation.—To the south of

Cape Canon is the Robin fishing beach, which soon exposes the red Bonaventure conglomerate in slightly undulating attitude, extending for less than two miles and lapping against the headland known as Cape Blanc or Whitehead. The headland, Clarke's Cape Blanc or Whitehead massive, consists of limestones in vertical attitude, and of the same age as those of the south flank of Mt. Joli. On the south of these is the same unfossiliferous limestone and black shale series as at Cape Canon.

The Whitehead upended limestones dip 80° S.E. To the north along the seashore these beds are covered unconformably by the nearly horizontal red conglomerates of the very thick Bonaventure series (Carboniferous). The vertical thickness of these rocks measuring from the point of the cape southward is estimated at 700 to 1,000 feet. At sea-level the most northerly exposed limestones, here colored red by the overlying Bonaventure (our locality F_{4a}, see Fig. 1), appear to have yielded Clarke the following fossils (in these lists all names in parentheses are the corrected ones of the faunal table of this paper): *Favosites* cf. *hisingeri* (*Paleofavosites prolificus*), *Halysites catenularia* (*H. gracilis*), *Zaphrentis* cf. *stokesi*, *Lyellia affinis*, *Whitfieldella* (probably *Protozyga* or *Cyclospira?*). Our fossils from this locality were collected by Cecil H. Kindle in 1929.

Clarke is certain that his fossils indicate "late Siluric, clearly older than the fauna of the Percé rock, probably older than beds of Cape Barré but not necessarily older than the north flank of the Mt. Joli massive" (1908:72). In this conclusion he is certainly in error, since the horizon is Upper Ordovician and of the same time as the strata of the south flank of Mt. Joli.

In the farmed fields to the west and south of the lighthouse of Cape Blanc, "in thin clinking limestone plates," Clarke got the following species (our locality F_4; E. M. Kindle also collected here in 1929): *Climacograptus*, *Bolboporites americanus?*, *Orthis? merope* (the writer has seen these minute shells but as they may be the young of some species they can not be identified accurately), *Zygospira recurvirostris* (var. *aequivalvis*), *Camarospira bisulcata* (*Cyclospira? minuscula*), *Ceraurus pleurexanthemus* (*C.* sp.), *Asaphus* or *Ptychopyge*, *Bumastus*, *Calymene senaria* (*C. consimilis*), *Phacops primaeva* (*Portlockia primaeva*).

"This association," according to Clarke (1908:72),

"presents species of early Trenton age; a quite different congeries than that we have reported from the lower rocks of Mt. Joli but indicative of about the same geologic age." In 1904 Clarke thought the trilobite *Phacops primaeva* to be near *P. logani* of the Devonian (Helderbergian), but in the book of 1908 he is convinced that the Cape Blanc beds are of Trenton age and "represent essentially the same time interval

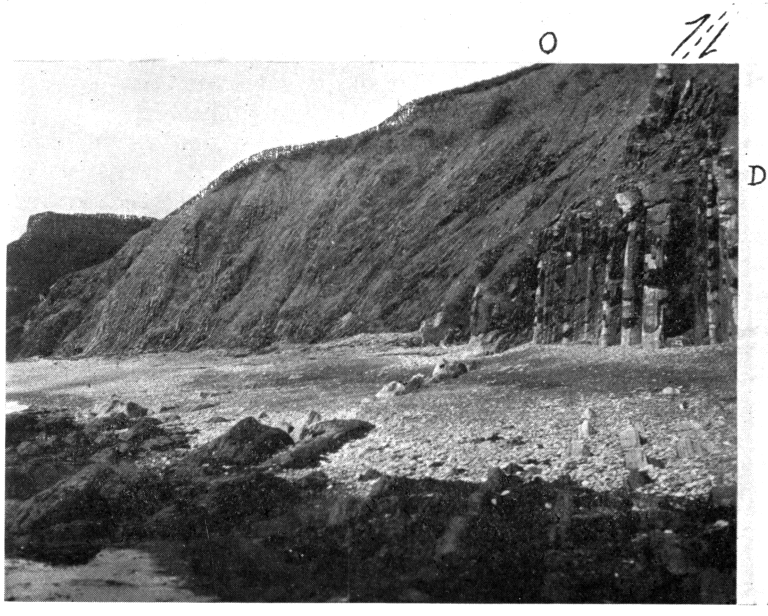

Fig. 3. North part of South Cove, showing fault contact between Upper Ordovician (left) and oldest beds of Lower Devonian of Mt. Joli formation. Photograph by Cooper.

as the Siluric series displayed on the shore from Cape Canon to the head of Mt. Joli" (73). On page 74 he shows that he is using the term Siluric in its old Murchisonian sense and accordingly is including what we now call Silurian and Ordovician.

East of Cape Canon is South Cove, and the part having no strata in place has a width of 350 feet (see Fig. 2). Still farther east follows the rest of South Cove, exposing nearly vertical light-blue thin-bedded calcareous shales and earthy

limestones with a thickness of about 250 feet. These Clarke calls the "south flank of the Mt. Joli massive"; the strata strike N. 30° W. and dip steeply to the southwest, lying unconformably and in faulted relation beneath the Mt. Joli massive proper (see Fig. 3). The upper series Clarke calls Silurian, but it is clearly Lower Helderbergian in age, as will be shown later. From the beds of the south flank of Mt. Joli, Clarke identifies the following fossils: *Hindia fibrosa?, Subretepora* sp. (*Chasmatopora* cf. *granistriata*), *Dalmanella testudinaria, Rafinesquina* sp., *Strophomena* strongly geniculate sp., *Parastrophia hemiplicata* (*Oxoplecia costata*), *Zygospira* cf. *uphami* (*Catazyga* aff. *anticostiensis*), *Ampyx hastatus* (*Lonchodomas longirostris*), *Tretaspis reticulatus* (*T. clarkei*), *Calymene callicephala* (*C. consimilis*), *Pterygometopus* cf. *intermedius* (*Calyptaulax*), *Ptychopyge ulrichi, Illaenus americanus* (*I. percéensis*). The age of these, Clarke says, is Trenton, but he "can not escape the inference that it is early Trenton with suggestions of Pretrenton age" (1908:60). It is not the interior Trenton, however, "but the invading fauna from the Atlantic province whose closer affiliations are with European species" (61).

Clarke's "south flank of Mt. Joli" is our locality F_3. The stratigraphic horizon appears to be the highest Ordovician about Percé. The character of the beds is very much like that of locality F_2, Grande Coupe, and the thickness exposed is about 250 feet. The rich trilobite beds, located by Cooper, begin 112 feet (measured horizontally) south of the overthrust fault and *Tretaspis* is most plentiful in the upper 5 feet and less common in the next lower 20 feet. *Lonchodomas* is not common and was found only where *Tretaspis* is abundant. The bulk of the fossils from this locality now in the Yale collection were found by Cooper. Clarke and Schuchert made small collections here earlier.

The Whitehead formation strikes west from Mt. Joli to the north of Mt. Ste. Anne, and fossils were gathered at localities F_1 and F_2. The Priest's road leaves Percé and goes northwest, ascending the flank of the Murailles, past the Grande Coupe to the Corner of the Beach on Malbay. About 2.5 miles northwest, where the road descends to the forks and the schoolhouse, we found in 1927 a number of large loose blocks of a pinkish crystalline limestone and many thin slabs of a grey limestone thrown out to the north side of the road by the road repairers. This is locality F_1. These blocks are

of a single layer or a local lens, from 6 to 8 inches thick, that has weathered out of the steep hillside to the south, and appear not to have drifted far out of place. The strata here stand nearly on end and strike N. 70° W. The same general horizon can be traced east on the Priest's road to near the Grande Coupe, where the beds strike N. 80° W. A day was spent collecting along this road by Northrop and Schuchert.

Locality F_2, Grande Coupe, is most easily approached from the sea, and the strata are best exposed near the mouth of the small brook in a deep gash on the side of Mt. Ste. Anne about one mile from Percé village. They are mostly interbedded argillaceous light-blue limestones and shale, striking N. 70° W., and dipping steeply to the southwest. The same beds are exposed along the shore to the northwest of Grande Coupe, for about 400 yards. This horizon and that of the Priest's road are not far apart stratigraphically. Collectors here: Northrop, Cooper, Schuchert, Gordon.

A striking North European trilobite, *Holotrachelus inexpectans,* was found loose by Cecil Kindle in Murphy's Creek two miles west of Corner of the Beach, and may be of the same horizon as localities F_{1-3}, which strikes west all along the south shore of Malbay.

The Whitehead formation, but seemingly in older beds, is exposed in White Mountain to the south of Mt. Ste. Anne. These exposures are as follows: The Mountain road runs on the south side of Mt. Ste. Anne to Corner of the Beach, and locality F_5 is at the top of this road about three miles southwest of Percé village, at a place known as the Long Cut, just beyond the last of the Bonaventure conglomerate. Locality F_{5a} is a few hundred yards farther west on the turn of the road down into the Amphitheater and the farmhouse; the beds of both places dip steeply to the southwest and strike N. 60° W.

Locality F_6 is in a great gulch on the eastern side of White Mountain, one-fourth mile southwest of the Long Cut. Collectors: Schuchert and Cooper 1929, in thick-bedded blue limestones; Cecil Kindle directed us to this place.

Locality F_7 is on the road to Irishtown, on both sides of the second brook and bridge to the west of Cape Blanc or about a mile and a quarter southwest of Percé village, in thin-bedded limestones. The strata are nearly vertical, striking N. 40° W., and the horizon the same as locality F_5. Collectors: Schuchert and Cooper 1929.

Ordovician Correlations.—The table following records the localities for at least 60 species, of which 42 are specifically

FAUNAL LIST OF THE UPPER ORDOVICIAN ABOUT PERCÉ

C, very common; c, common; R, rare; *, new species (Cooper); G, genus only

	1	2	3	4	4a	5	5a	6	7	English Head	Vauréal	Ellis Bay
										Anticosti		
Hindia cf. fibrosa	—	—	c	—	—	—	—	—	—	x	x	x
Astylospongia	—	—	R	—	—	—	—	—	—			
Paleofavosites prolificus	x	c	—	—	—	—	—	c	—	x	x	x
" capax	x	R	—	—	—	R	—	—	—	x	x	x
Halysites catenularia	—	c	—	—	—	—	—	c	—			
" gracilis	—	c	—	—	—	—	—	c	—	x	—	x
Lyellia affinis	—	c	—	—	—	?	—	—	—		—	G
Calapoecia anticostiensis	—	C	—	—	—	—	—	c	—	x	x	x
" with small corallites	—	c	—	—	—	—	—	c	—			
Streptelasma sp.	—	—	—	—	—	—	—	c	—	G	G	G
Trepostomata Bryozoa	c	c	—	—	—	c	—	—	c			
Rhinidictya sp.	C	c	—	—	—	—	—	—	R	G		
Helopora sp.	C	c	c	c	—	c	—	—	c	G	G	G
Sceptropora facula	R	R	—	—	—	—	—	—	—	x	x	
Chasmatopora cf. granistriata	R	c	c	—	—	—	—	—	—		x	
Crania laelia	R	—	—	—	—	—	—	—	—	G	—	G
*Platystrophia inferaplica	C	—	—	—	c	—	—	R	—		—	G
*Glyptorthis sublamellosa	c	c	—	—	—	—	—	—	—		—	G
*Ptychoglyptus bellarugosus	R	—	—	—	—	—	—	—	—			
Dalmanella sp.	R	—	—	—	—	—	c	—	—	G	G	G
*Bilobites indentus	R	—	—	—	—	—	—	—	—			
*Sowerbyella gigantea	c	c	—	—	—	—	—	C	—			
" sericea	—	—	—	—	—	C	C	—	C	x	x	x
" sp.	—	—	R	—	c	—	—	—	—			
*Leptelloidea septata	c	R	—	—	—	—	—	—	—			
*Christiania dubia	R	R	—	—	—	—	—	—	—			
Leptaena rhomboidalis	R	R	—	—	—	—	c	—	R		—	x
*Holtedahlina sulcata parva	c	c	—	—	—	—	—	—	—			
Rafinesquina alternata	—	—	—	—	—	a	c	—	c			
" (?) nitens	—	—	—	—	—	—	C	—	—	x	x	x
Schellwienella cf. gamachiana	—	—	—	c	—	—	c	—	—	x	x	
Triplecia sp.	R	—	—	—	—	—	—	—	—			
*Oxoplecia costata	c	—	—	R	—	—	—	—	—			
*" platystrophoides	R	—	—	—	—	—	c	—	—			
Rhynchotrema ? cf. janeum	R	—	—	—	—	—	R	—	—	x	x	x
*Plectatrypa gaspeensis	c	R	—	R	—	—	R	—	—			x
Zygospira recurvirostris aequivalvis	R	—	—	—	—	—	—	—	—	x	x	
*Cyclospira? minuscula	—	—	R	R	—	—	—	—	—			
Protozyga ? sp.	—	—	—	c	—	—	—	—	—			
Catazyga aff. anticostiensis	—	—	—	R	—	—	—	—	—	x	x	
" aff. headi	—	—	—	—	—	—	C	—	—			
*Cyclonema multivolve	C	—	—	—	—	—	—	—	R	G	G	G
*" quadricarinatum	—	R	—	—	—	—	—	—	—			
Hormotoma cf. gigantea	—	—	—	—	—	—	—	c	—		—	x
*Billingsites logani	—	R	—	—	—	—	—	—	—	G	G	G
*Apsidoceras depressum	—	R	—	—	—	—	—	—	—	G	G	G
*Tretaspis clarkei	c	R	C	—	c	—	—	—	—			
*Lonchodomas longirostris	R	R	c	—	—	—	—	—	—			
*Illaenus percéensis	c	c	c	R	—	—	—	—	—			
*Cyphaspis minima	R	R	—	—	—	—	—	—	—		—	G
*Cyclopyge kindlei	—	R	R	—	—	—	—	—	—			
*" insolens	R	R	—	—	—	—	—	—	—			
*Leonaspis parva	—	—	—	R	—	—	—	—	—			
Encrinurus percéensis	R	—	—	—	—	—	—	—	—	G	G	G
Cybele sp.	R	—	—	—	—	—	—	—	—			
*Ceraurinus elongatus	R	—	—	—	R	—	—	—	—	G	G	G
*Calymene consimilis	R	R	R	R	—	—	c	—	—	G	G	G
Portlockia primaeva	—	—	—	R	—	—	—	—	—			
*Calyptaulax glabella	—	R	c	—	—	—	—	—	—		G	
*" compressa	R	—	R	—	—	—	—	—	—			

determined. Of the latter number, 9 occur in the Upper Ordovician of Anticosti, but of the 47 genera, 31 are common

to the two places; the great bulk of this Percé fauna, however, has the impress of late Ordovician time. This is especially well seen in the presence of *Paleofavosites, Halysites, Lyellia, Calapoecia, Helopora, Sceptropora facula, Glyptorthis, Bilobites, Ptychoglyptus, Holtedahlina sulcata parva, Plectatrypa, Apsidoceras, Billingsites, Tretaspis, Holotrachelus, Cyclopyge, Encrinurus, Ceraurinus*, and *Portlockia.*

The absence of *Rhynchotrema perlamellosum, R. capax*, and other early Richmondian forms appears to show that the time is of the Middle and Upper Richmondian. On the other hand, the absence of *Hindella*, so common in Anticosti, appears to show that Gamachian time may not be present about Percé. Strange as it may seem, there is but little of a specific nature in common with Anticosti. This discrepancy is believed to be due to a lack of complete collecting from bed to bed in the Upper Ordovician of Anticosti and Percé. If this assumption proves not to be true, it may be that the Percé fauna is of the deeper water of the geosyncline and farther away from its north shore and shallower sea. The writer holds, further, that the Percé Upper Ordovician can not be older than the Anticosti series.

That the Upper Ordovician sea of Percé was in open communication with the Caledonian geosyncline of Northwest Europe is shown by the presence of the many similar corals, the brachiopods *Bilobites, Ptychoglyptus*, and *Plectatrypa;* and the trilobites *Tretaspis, Holotrachelus, Cyclopyge*, and *Lonchodomas.* Here the correlation is with the Ashgillian of Scotland and the Lake district of England and seemingly with the earlier part. In Norway and Sweden the correlation is with the *Leptaena* series, and in Estland with the Borkholm and perhaps also with the Lyckholm.

Devonian Strata and Fossils.

As we have seen, Clarke held the age of the Mt. Joli formation to be late Silurian. As the writer has collected from these fossiliferous beds many times, his evidence and that of Clarke are here brought together to show that the age of the Mt. Joli formation is unmistakably Helderbergian.

The greater northern and extreme eastern part of Mt. Joli is composed of Lower Devonian strata in nearly vertical attitude (dip about 70° N., strike N. 60°-80° W.), and on the south side of the high hill the strata are in unconformable and

faulted relation with the Upper Ordovician (see Figs. 2-4). The former series consists of dark blue shales, interbedded with harder, calcareous and muddy, slabby, lighter blue sandstones, 2 to 10 inches thick, which become dominant downward; below are thicker beds of grey sandstones, 4 to 18 inches thick, the total thickness being, according to Clarke, about 550-600 feet. The highest strata of the series are seen at low tide on the bar between Mt. Joli and Percé Rock, where the edges of about 300 feet of the Mt. Joli series are exposed, followed by about 225 feet of Oriskanian strata to the base of the rock. These higher strata of the Mt. Joli series are also seen in part at lowest tide just to the north of Percé wharf, and the sea throws out on the beach of North Cove slabby material of these younger beds.

Helderbergian.—At the base of the Mt. Joli formation, just above the faulted Ordovician contact of the South Cove locality (F_8), is a crumpled shaly zone about 5 feet thick that has many corals of a few species (see Fig. 3). The corals of the Helderbergian have never been carefully studied and so no worthwhile list of species for correlation can be given. These same corals, however, are also found at higher levels. They are a ramose *Favosites,* an irregularly growing, *Blothrophyllum*-like *Zaphrentis,* an *Eridophyllum*-like form but apparently never branching, a very small cup coral that Clarke has called *Duncanella, Syringopora* sp., *Delthyris perlamellosa,* and *Spirifer concinnus* (also occurs at Dalhousie and here is so identified by Clarke).

These basal strata of the Mt. Joli series are also well exposed on Malbay at the mouth of the Grande Coupe locality (F_2). Here, in addition to the above mentioned species, occur *Favosites* like *gotlandicus, Striatopora* sp., *Pholidops ovata, Stropheodonta varistriata, Camarotoechia* sp., and the Dalhousie gastropods *Melissosoa compacta?* and *Coelidium strebloceras?*. Fifty feet above these basal Devonian strata occurs a coral breccia 4 feet thick replete with *Cladopora* and scattered specimens of *Favosites* and *Zaphrentis.*

Apparently 50 feet above the base of the Mt. Joli formation at Mt. Joli (see Fig. 4), E. M. Kindle collected in 1929 the following fossils (his station 34, F_9 on our map): fragments of a seaweed or of the land plant *Psilophyton* (a superficial examination of similar material may have led to the identification of *Monograptus* cf. *clintonensis* in these strata), *Zaph-*

rentis of the same species as below, *Fenestella* and other bryozoans, *Camarotoechia, Rhipidomella* cf. *numus,* large *Spyroceras?,* and Ostracoda.

On the north face of Mt. Joli above the middle thickness

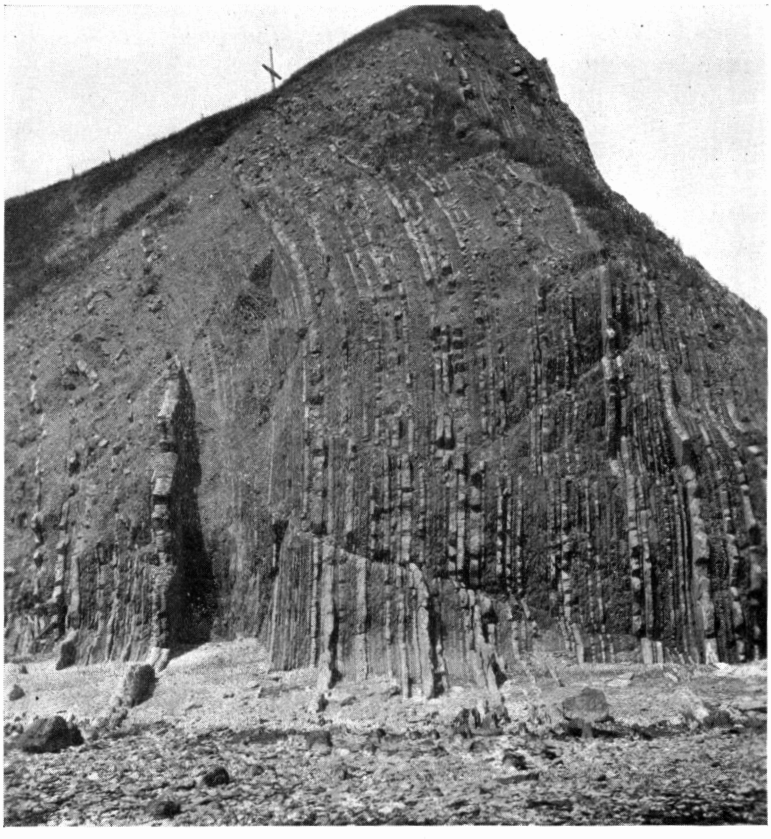

Fig. 4. East face of Mt. Joli, showing lower beds of oldest Devonian. Photograph by Cooper.

of this series (F_{10} on map) are two thin conglomerate beds separated by about 25 feet of shales. Here the dip is about 70° N. and the strike N.60°-80° W. At this locality there had been a large fall of rock in the Spring of 1929, exposing these two zones better than ever before. From them Cooper and the writer collected the following species (those with an

* are also noted by Clarke): **Hindia fibrosa*, the ramose *Favosites*, *Cladopora*, **Pleurodictyum* n. sp., *Syringopora*, **Duncanella*, **Dalmanella* cf. *perelegans*, *Rhipidomella hybridoides*, *R. numus*, **Leptaena rhomboidalis*, *Atrypa reticularis*, *Ambocoelia* n. sp., *Cyrtina*, *Spirifer concinnus*, *Delthyris perlamellosa*, large *Meristella*, *Rensselaeria stewarti*, **Phacops* tails (at Albany there is a whole one), *Dalmanites micrurus* or n. sp.

Clarke also identifies from the north side of Mt. Joli *Monograptus* cf. *clintonensis* (this genus is known very rarely in the New Scotland formation of New York, but the form *clintonensis* can not occur here), *Stropheodonta* cf. *varistriata*, *Spirifer* cf. *niagarensis* (the writer has a specimen from higher beds that can be mistaken for this species, but it is not an *Eospirifer* as the above identification calls for), *S. modestus?*. For age determination Clarke relies mostly on the *Phacops*, saying that such a species "nowhere occurs in the typical Siluric" of eastern North America, and yet he concludes that the fauna as a whole is "indicative of a very late Upper Siluric."

Professor Mignon Talbot of Mount Holyoke College collected along this north side of Mt. Joli a very fine specimen of *Eatonia medialis*, one of the most characteristic of Helderbergian fossils (New Scotland).

In strata about 50-75 feet higher than those of the north face of Mt. Joli, there is exposed at low tide after great storms a zone about 15 feet thick that Clarke (1913) called the *Dipterus beds* (F_{11} on map). No remains of this Devonian fish have been seen by the writer. The common fossils here are cup corals that Clarke has identified as *Zaphrentis corticata* and *Z. cingulosa*, which are identical with those of older strata, mentioned above. Clarke also got here a *Platyceras* of Helderbergian type. In addition, Cooper collected at this place the above mentioned ramose *Favosites*, *Syringopora*, *Rhipidomella hybridoides*, *Uncinulus*, and *Spirifer concinnus*.

From still higher strata the sea throws out slabby material on the beach of North Cove, and here the writer collected in 1927 *Phacops* cf. *logani* and a small head of *Dalmanites*.

From the above data it is clear that the Mt. Joli formation is of Helderbergian age and younger than the Coeymans of New York.

Oriskanian.—The Percé series of Clarke, best seen in Percé or Split Rock, has a marine fauna of at least 45 species (listed

by him in 1908:65). It is, he says, "clearly the Grande Grève fauna," but to what part of this thick Lower and Middle Devonian series it belongs he can not determine; he is inclined, however, to regard the time as Oriskanian rather than Onondagan of the Middle Devonian, and with this the writer agrees.

The Percé series is again seen to the north of North Cove in the high escarpment known as the Murailles (Fig. 2), which in vertical cliffs faces Malbay to the north. These beds are all of the higher Lower Devonian (Oriskanian), with the oldest ones to the east, forming the Cape Barré horizon. Clarke says the latter are thin, sandy, blue-gray limestones with intercalated shale. The strata dip northeast about 50° and strike N. 70° W., and "may attain a thickness of 75 to 100 feet." These same beds in vertical attitude are exposed at lowest tide between Percé Rock and Mt. Joli, but one can not collect fossils here. From the Cape Barré beds Clarke lists *Lingula, Spirifer* cf. *modestus, Leptostrophia oriskania, Conularia* cf. *lata,* and *Dicranurus limenarcha.* The worm burrows of *Taonurus* are common. As the trilobite *D. hamatus* is known only in the Helderbergian of the Appalachian geosyncline, Clarke refers the Cape Barré beds to the late Helderbergian, but unfortunately all the other fossils, and chiefly those in the higher strata, are regulation Oriskanian forms, and like those of Percé Rock, hence these lower beds also must be regarded as of late Lower Devonian time. Furthermore, *Dicranurus monstruosus* occurs in Etage G of Bohemia (= early Middle Devonian).

The higher beds of the Percé formation are exposed in the Pic d'Aurore and the shore of Malbay. At the top of the red Pic are 50 to 75 feet of the Percé series, dipping 65° E. and striking N. 70° W., with many fossils. In Bonaventure time these vertical beds were breaking down a steep slope in blocks up to 10 feet across and making the basal strata of the very thick Bonaventure continental deposits whose age is thought to be later Lower Carboniferous.

Late Devonian Gaspé Sandstones.—On the shores of Malbay about one-third of a mile west of the mouth of the Grande Coupe occur brilliant red beds of interbedded sandstones or fine conglomerates, sandy sun-cracked shales, and zones of conglomerates with most of the pebbles of a calcareous nature in a muddy base. They lie unconformably and probably in faulted relation against the Upper Ordovician, with the dip rising from 45° NE. to nearly vertical; the dip of the Ordo-

vician strata is steeply to the south. No fossils were seen in these beds, and as they can not be downfaulted Bonaventure, they must be of the Gaspé sandstone series as seen on the north side of Malbay, though here these strata are regarded by Clarke as of the Bonaventure series. The Bonaventure conglomerates, as seen in Mt. Ste. Anne and to the west of the Pic d'Aurore, must formerly have lain nearly horizontal across all of these upended strata of the Percé area, and been since removed through erosion.

Late Lower Carboniferous.

The top of Mt. Ste. Anne is of Bonaventure conglomerate and as it is about 1,200 feet high (see Fig. 2) with the same strata at sea-level, it follows that this formation of slightly undulating strata has even a greater thickness than this. How far below sea-level the formation goes is unknown.[1] In one place or another on Mt. Ste. Anne one can see the red Bonaventure conglomerates unconformably overlying the folded and faulted Devonian and Ordovician formations. The post-Devonian topography was a hilly one, with a relief of hundreds of feet, as may be seen to good advantage in the coulé (Trou au Chat) back of Percé village and on the western slope of the Murailles. At the falls of the little brook the water tumbles over the Bonaventure, and beneath this conglomerate is the contact with the older vertical Devonian. On the south hillside of the coulé are exposed the slabby vertical beds of the Mt. Joli series (dipping northeast and striking N. 60° W.), creeping downhill into the stream, and the same formation, in red-weathering beds, can be traced part way up the northern hillside, where the contact with the Percé series occurs. Here can be collected the guide fossil to the Percé formation, *Leptocoelia flabellites,* both in the vertical strata below and in the Bonaventure conglomerate above.

[1] While this article was in press, an article by E. M. Kindle (1930:86c) appeared in which is described the stratigraphy of Bonaventure Island, the type locality for this formation. He brings the welcome news that on the northeast side of this island the deformed Grande Grève limestones (the same as those of Percé Rock) are in contact with the younger, nearly horizontal Bonaventure, making it certain that the latter is at least 1,300 feet thick; how much has been eroded away is unknown.

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