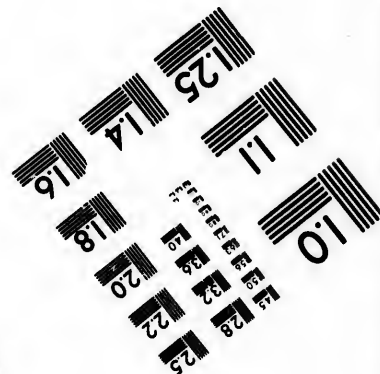
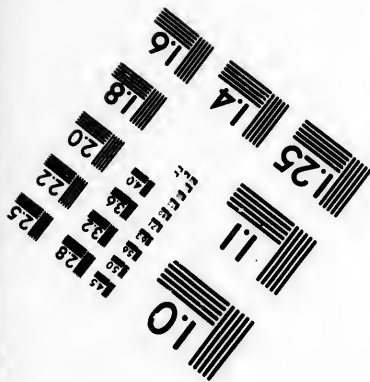
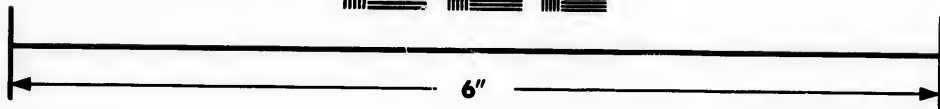
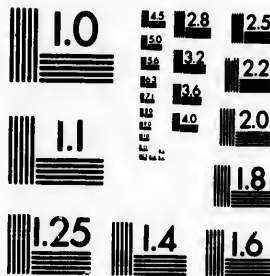


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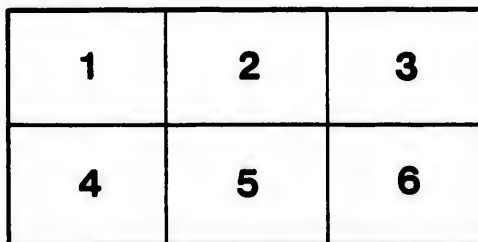
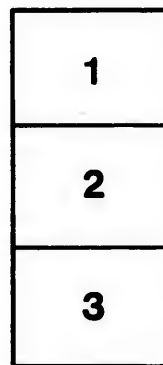
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(From *The Canadian Naturalist*, for April, 1865.)

NOTES ON
POST-PLIOCENE DEPOSITS AT RIVIERE-DU-LOUP
AND
TADOUSSAC.

By J. W. DAWSON, LL.D., F.R.S., F.G.S., Principal of McGill College.

In looking over, last winter, some of the collections made by Prof. Bell, of Kingston, when engaged in the service of the Geological Survey of Canada, I was struck with a small collection of Post-pliocene shells from Rivière-du-Loup,* as presenting a somewhat singular grouping of species; and having a few holiday weeks to spend at Cacouna, I determined to ransack thoroughly the deposits which had afforded these specimens.

The country around Cacouna and Rivière-du-Loup rests on the shales, sandstones, and conglomerates of the *Quebec group* of Sir W. E. Logan. As these rocks vary much in hardness, and are also highly inclined and much disturbed, the denudation to which they have been subjected has caused them to present a somewhat uneven surface. They form long ridges running nearly parallel to the coast, or north-east and south-west, with intervening longitudinal valleys excavated in the softer beds. One of these ridges forms the long reef off Cacouna, which is bare only at low tide; another, running close to the shore, supports the village of Cacouna; another forms the point which is terminated by the pier; a fourth rises into Mount Pilote; and a fifth stretches behind the town of Rivière-du-Loup.

* See *Geology of Canada*, p. 921, where, however, only a portion of the species collected are mentioned.

The depressions between these ridges are occupied with Post-pliocene deposits, not so regular and uniform in their arrangement as the corresponding beds in the great plains higher up the St. Lawrence, but still presenting a more or less definite order of succession. The oldest member of the deposit is a tough boulder-clay, its cement formed of gray or reddish mud derived from the waste of the shales of the Quebec group, and the stones and boulders with which it is filled partly derived from the harder members of that group, and partly from the Laurentian hills on the opposite or northern side of the river, here more than twenty miles distant. The thickness of this boulder-clay is, no doubt, very variable, and could not be ascertained in the neighborhood of Cacouna; but at Ile Verte it forms a terrace fifty feet in height.

Above the boulder-clay, where it has not been bared by denudation, there occurs a dark gray, soft, sandy clay, containing numerous boulders, and above this several feet of stratified sandy clay without boulders; while on the sides of the ridges, and at some places near the present shore, there are beds and terraces of sand and gravel, constituting old shingle beaches apparently much more recent than the other deposits.

All these deposits are more or less fossiliferous. The lower boulder-clay contains large and fine specimens of *Leda truncata* and other deep-water and mud-dwelling shells, with the valves attached. The upper boulder-clay is remarkably rich in shells of numerous species; and its stones are covered with Polyzoa and great Acorn-shells (*Balanus Hameri*), sometimes two inches in diameter and three inches high. The stratified gravel holds a few littoral and sub-littoral shells, which also occur in some places in the more recent gravel. On the surface of some of the terraces are considerable deposits of large shells of *Mya truncata*; but these are modern, and are the 'kitchen-middens' of the Indians, who in former times encamped here.

Numbers of Post-pliocene shells may be picked up along the shores of the two little bays between Cacouna and Rivière-du-Loup; but I found the most prolific locality to be on the banks of a little stream called the Petite Rivière-du-Loup, which runs between the ridge behind Cacouna and that of Mount Pilote, and empties into the bay between Rivière-du-Loup and the pier. In these localities I collected eighty-four species, about thirty-six of them not previously published as occurring in the Post-pliocene of Canada. A list of these fossils is appended to this paper; and

in connection with it I would desire to make some general remarks on the features of these interesting deposits.

We have here an indubitable instance of a marine boulder-clay. I have observed fossiliferous boulder-clays at Murray Bay, St. Nicholas, and Cape Elizabeth, but the example afforded at Cacouna and its vicinity is more clear and instructive; and there is also evidence that the surface under the boulder-clay is polished and striated, the direction of the striae being north-east and south-west, or that of the St. Lawrence valley.*

The Cacouna boulder-clay is a deep-water deposit. Its most abundant shells are *Leda truncata*, *Nucula tenuis*, and *Tellina proxima*, and these are imbedded in the clay with the valves closed, and in as perfect condition as if the animals still inhabited them. At the time when they lived, the Cacouna ridges must have been reefs in a deep sea. Even Mount Pilote has huge Laurentian boulders high up on its sides, in evidence of this. The shales of the Quebec group were being wasted by the waves and currents; and while there is evidence that much of the fine mud worn from them was drifted far to the south-west to form the clays of the Canadian plains, other portions were deposited between the ridges, along with boulders dropped from the ice which drifted from the Laurentian shore to the north. The process was slow and quiet; so much so that in its later stages many of the boulders became encrusted with the calcareous cells of marine animals before they became buried in the clay. No other explanation can, I believe, be given of this deposit; and it presents a clear and convincing illustration, applicable to wide areas in Eastern America, of the mode of deposit of the boulder-clay.

A similar process, though probably on a much smaller scale, is now going on in the Gulf. Admiral Bayfield has well illustrated the fact that the ice now raises, and drops in new places, multitudes of boulders, and I have noticed the frequent occurrence of this at present on the coast of Nova Scotia. At Cacouna itself, there is, on some parts of the shore, a band of large Laurentian boulders between half tide and low-water mark, which are moved more or less by the ice every winter, so that the tracks cleared by the people for launching their boats and building their fishing-weirs, are in a few years filled up. Wherever such boulders are dropped on banks of clay in process of accumulation, a species of

* South 55° west mag., near Cacouna.

boulder-clay, similar to that now seen on the land, must result. At present such materials are deposited under the influence of tidal currents, running alternately in opposite directions; but in the older boulder-clay period, the current was probably a steady one from the north-east, and comparatively little affected by the tides.

The boulder-clay of Cacouna and Rivière-du-Loup, being at a lower level and nearer the coast than that found higher up the St. Lawrence valley, is probably newer. It may have been deposited after the beds of boulder-clay at Montreal had emerged. That it is thus more recent, is farther shown by its shells, which are, on the whole, a more modern assemblage than those of the *Leda* clay of Montreal. In fossils, as well as in elevation, these beds more nearly resemble those on the coast of Maine. It would thus appear that the boulder-clay is not a continuous sheet or stratum, but that its different portions were formed at different times, during the submergence and elevation of the country; and it must have been during the latter process that the greater part of the deposits now under consideration were formed.

The assemblage of shells at Rivière-du-Loup is, in almost every particular, that of the modern Gulf of St. Lawrence, more especially on its northern coast. The principal difference is the prevalence of *Leda truncata* in the lower part of the deposit. This shell, still living in Arctic America, has not yet occurred in the Gulf of St. Lawrence, but is distributed throughout the lower part of the Post-pliocene deposits in the whole of Lower Canada and New England, and appears in great numbers at Rivière-du-Loup, not only in the ordinary form, but in the shortened and depauperated varieties which have been named by Reeve *L. siliqua* and *L. sulcifera*.

Of *Astarte Laurentiana*, supposed to be extinct, and which occurs so abundantly in the Post-pliocene at Montreal, only one valve was found, and its place is supplied by the allied but apparently distinct species, *A. compressa*, which is still abundant at Gaspé and Labrador, and on the coast of Nova Scotia. This exchange of *A. Laurentiana* for *A. compressa* is on these coasts an unfailling evidence of less antiquity.

A study of the varietal forms under which common species occur, also leads to the same conclusion as to the less comparative antiquity of these beds; but this is a very curious and intricate question, on which I have accumulated a great number of facts which I propose to publish at a future time.

It must be observed that though the clays at Rivière-du-Loup are more recent than those of Montreal, they are still of considerable antiquity. They must have been deposited in water perhaps fifty fathoms deep, and the bottom must have been raised from that depth to its present level; and in the meantime the high cliffs now fronting the coast must have been cut out of the rocks of the Quebec group.

The order of succession and characteristic fossils seen on the banks of the Petite Rivière-du-Loup may be stated as follows, in descending order :

1. Gravel seen on sides and tops of ridges.
2. Stratified sand and clay—*Buccinum undatum* and *Tellina Grœnlandica*.
3. Bluish sandy clay, stones, and boulders, *Balanus Humeri*, *Rhynchonella psittacea*, *Pecten Islandicus*, *Leda tenuisulcata*, *L. minuta*, *Tellina calcarea*, *Astarte compressa*, *Saxicava rugosa*, *Acmoëa cœca*, *Scalaria Grœnlandica*, *Natica clausa*, *Buccinum scalariforme*, *Bryozoa* on stones, *Foraminifera*, &c., &c.
4. Stiff reddish clay with stones and boulders—*Leda truncata*, *L. limatula*, *Nucula tenuis*, *Tellina calcarea*, &c.

At Tadoussac, opposite to Cacouna, where the underlying formation is the Laurentian gneiss, the Post-pliocene beds attain to great thickness, but are of simple structure and slightly fossiliferous. The principal part is a stratified sandy clay with few boulders, except in places near the ridges of Laurentian rocks. This forms high banks eastward of Tadoussac. It contains a few shells of *Tellina Grœnlandica* and *Leda truncata*. It resembles No. 2 of the above sectional list, and has also much of the aspect of the Leda clay, as developed in the valley of the Ottawa. On this clay there rest in places thick beds of yellow sand and gravel.

At Tadoussac these deposits have been cut into a succession of terraces which are well seen near the hotel and old church. The lowest, near the shore, is about ten feet high; the second, on which the hotel stands, is forty feet; the third is 120 to 150 feet in height, and is uneven at top. The highest, which consists of sand and gravel, is about 250 feet in height. Above this the country inland consists of bare Laurentian rocks. These terraces have been cut out of deposits, once more extensive, in the process of elevation of the land; and the present flats off the mouth of the Saguenay, would form a similar terrace as wide as any of the

others, if the country were to experience another elevatory movement. On the third terrace I observed a few large Laurentian boulders, and some pieces of red and gray shale of the Quebec group, indicating the action of coast-ice when this terrace was cut. On the higher terrace there were also a few boulders; and both terraces are capped with pebbly sand and well rounded gravel, indicating the long-continued action of the waves at the levels which they represent.

LIST OF POST-PLIOCENE FOSSILS FOUND AT RIVIERE-DU-LOUP
AND CACOUNA.

*Those marked thus * have not previously been noticed as occurring in the
Canadian Post-pliocene.*

FORAMINIFERA.

- Polymorphina lactea, Adams.
- Nonionina Scapha, F. and M., and var. Labradorica, Dawson.
- Polystomella striatopunctata, F. and M.
- Biloculina ringens? Lam.
- Entosolenia costata, Williamson.
- * Truncatulina lobulata, W. and T.
- * Rotalina? turgida, Williamson.

NOTE.—Since the publication of my former list of Foraminifera from the Post-pliocene of Canada (Can. Nat., vol. iv, 1859), I have found at Montreal, *Nonionina scapha* F. and M., *Dentalina pyrula* D'Orbigny, and *Orbulina universa* D'Orbigny. Messrs. Parker and Jones have also kindly revised my former list, and concur in all the determinations, with the exception of *Polystomella umbilicatulula*, which they refer to *P. striatopunctata*, and *Bulimina auriculata* Bailey, which they refer to *B. pyrula* D'Orbigny.

PORIFERA.

- * Halichondria—Silicious spicules.

ECHINODERMATA.

- Echinus granularis, Say.

POLYZOA.

- Lepralia Belli, Dawson.
- L. pertusa, Thompson.
- * L. producta, Packard.
- * L. trispinosa, Johnston.
- L. hyalina, Fabr.
- * L. ventricosa, Hassel.
- * Diastopora obelia, Johnston.
- Tubulipora fiabellaris? Johnston.
- Hippothoa expansa, Dawson.
- H. catenularia? Johnston.

- *Eschara elegantula*, D'Orbigny.
- *Celleporaria surcularis*, Packard.
- *Myrizoum subgracile*, D'Orbigny.
- *Heteroporella radiata* ?
- *Alecto*.
- *Membranipora Lacroixii*, Busk.

BRACHIOPODA.

- Rhynchonella psittacea*, Gm.
- *Terebratella Labradorensis*, Sow.

LAMELLIBRANCHIATA.

- Pecten Islandicus*, Chemn.
- Leda truncata*, Brown, and vars. *siliqua* and *sulcifera*.
- *L. tenuisulcata*, Couthouy, (*pernula*, Wood).
- L. minuta*, Mull, (*caudata*, Don.).
- *L. limatula*, Say.
- Nucula tenuis*, Mont., (*var. expansa*).
- *Modiolaria discors*, Linn.
- M. nigra*, Gray.
- Mytilus edulis*, Linn.
- *Cardium Dawsoni*, Stimpson.
- *Astarte compressa*, Mont. (*A. Banksii*, Leach).
- A. Laurentiana*, Lyell.
- Tellina Grœnlandica*, Beck.
- T. proxima*, Brown.
- T. (Macoma) inflata*, Stimpson.
- Mya arenaria*, Linn.
- M. truncata*, Linn., *var. Uddevallensis*.
- *Panopœa Arctica*, Gould. (*P. Norvegica* ?).
- Saxicava rugosa*, Linn., and *var. Arctica*.
- *Lyonsia arenosa*, Moll.

NOTE.—Large suites of specimens from Rivière-du-Loup enable me to determine with certainty that *Leda tenuisulcata* Couthouy, *L. pernula* Muller, (& Wood, English Crag,) and *L. Jacksoni* Gould, are varieties of one species; that *Saxicava Arctica* is merely a variety of *S. rugosa*; and that *Leda siliqua* and *L. sulcifera* of Reeve are varieties of *L. truncata*, which is identical with *L. Portlandica* Gould.

GASTEROPODA.

- *Cylichna nucleola*, Reeve.
- Acmea (Lepeta) cœca*, Mull.
- Cemoria Noachina*, Linn.
- *Adeorbis costulata* ?
- Margarita helicina*, Fabr., (*Arctica*).
- *M. cinerea*, Couth.
- Littorina palliata*, Say.
- *L. rudis*, Mont.
- Scalaria Grœnlandica*, Perry.

- Menestho albula, Moll.
 • Turritella erosa, Couth.
 Natica clausa, Sow.
 N. Grønlandica, Mull.
 • N. catenoides? Wood.
 Bela harpularia, Gould, (Woodiana, Moll.).
 • B. violacea, Migh.
 • B. decussata, Couth.
 • B. turricula, Mont.
 B. rufa, Gould, (pyramidalis).
 Buccinum undatum, Linn., and var. Labradorense, Reeve.
 • B. glaciale, Linn.
 • B. scalariforme, Moll.
 • B. cretaceum, Reeve.
 Fusus tornatus, Gould, and var. despectus, Linn.
 • Trophon clathratum, Linn.
 T. scalariforme, Gould.
 Trichotropis borealis, B. and S.

NOTE.—I regard *B. Labradorense* as merely a variety of *B. undatum* peculiar, like the oval or almond-shaped variety of *Mytilus edulis*, to the mouths of rivers. The species which I have named *B. cretaceum* is certainly distinct, but I am by no means sure that it is really *B. cretaceum* of Reeve. *B. glaciale* is common at Montreal and at St. Nicholas; but the specimens from Rivière-du-Loup enabled me for the first time to recognize it.

ANNULATA.

- Spirorbis nautiloides, Lam.
 S. vitrea, Stimp.
- *S. sinistrorsa*, Mont.
- *S. quadrangularis*, Stimpson.

CRUSTACEA.

- Balanus Hameri*, Asc., var. *Uddevallensis*.
- B. porcatus*, Da Costa.
- B. crenatus*, Brug.
- Cytheridea Mulleri*, Mun.
- *Hyas coarctata*, Lench.

Of the above species, *Panopaea Norvegica*, *Fusus tornatus*, *Leda truncata*, *L. tenuisulcata*, *Astarte compressa*, *Mytilus edulis*, *Mya arenaria* and *Littorina palliata*, had been collected at Rivière-du-Loup, by the officers of the Survey, previous to my visit. *Mesodesma Jaurcsii* had also been collected from littoral gravels east of Cacouna, but was not met with by me.

