set of specimens illustrating the character of sands used for making of bricks, and for moulding in brass and iron: of one of these (Mr. Pellow's from Windsor) a cargo of 250 tons was lately shipped to Boston for brass tube casting. Then we have a set of specimens from Springville, East River, Pictou, showing the character of the rich specular and brown iron ores found there, the latter I found to contain nearly sixty per cent. metallic iron, and there is a specimen of the East River limestone from which lime is largely made and exported: very much esteemed in the neighbourhood of New Glasgow.

I am afraid my remarks are somewhat crude and imperfect, but I must plead want of time to produce any thing more complete, and I hope such as they are they will be of service in marking the most important features in a collection of minerals which I think will be found very useful in illustrating the mineralogy of the Province, and of great interest to all who have devoted any attention to the subject.

Art. IV. On the Tides of the Bay of Fundy. By P. S. Hamilton.

(Read Feb. 4, 1867.)

The general outlines of the Bay of Fundy are well known. Its width, by a direct line from Brier island, the most western point of Nova Scotia, skirting the south-western point of Grand Manan island, to the coast of Maine, a short distance west of Quoddy Head, may be called in round numbers, fifty statute miles. From its mouth, it extends in a course as nearly as possible, due north-east, with nearly straight shores but a gradually decreasing width, for about one hundred and ten miles, when its waters separate into two arms known as the Minas channel and Chiegnecto channel. A line drawn directly from the northern to the southern shore in the immediate vicinity of cape Chiegnecto, the point of bifurcation, will show its breadth to be there about thirty miles. Following the more northern or Chiegnecto channel a further distance of about thirty miles, we find its waters again nearly equally divided. One—Shepody bay—extends in a northerly direction into New Brunswick, and

at its head receives the waters of the Petitcodiac and Memramcook: the other continues the original north-east course, and eventually forms *Beau basin*, or Cumberland basin. The distance from the mouth of Chiegnecto channel to the head of Cumberland basin may be called in round numbers fifty miles. Returning to the southern or Minas channel, we find that its general course from the mouth is nearly due east, a distance of about eighty miles, to the head of navigation at Truro. A glance at the chart will show that the contrasts in the conformation and position of these two arms of the Bay are very great, and I shall presently shew that the character of their respective tides is materially affected by these differences.

The northern shore of the Bay is a rugged "iron-bound" one, composed of a hard metamorphic rock, from its mouth nearly up to Shepody bay. The margin of this northern shore is more indented, and the outline of the hills which compose it is more uneven, than on the south side of the Bay. Towards the west these hills are of moderate elevation, but as a rule, they increase in altitude as we proceed eastward, until in Shepody mountain, near the bay of the same name, they attain a height of 1050 feet. The south shore exhibits a wall-like ridge of trap rock, associated with new red sandstone, from three to five miles in width, and from four hundred to seven hundred feet in height, stretching from Brier island to Cape Blomidon, and broken only by the deep narrow gorges of Grand passage, Petite passage, and Digby gut. The lofty isolated, or semi-isolated masses of rock known as Cape d'Or, Spencer's island, Cape Sharp, Partridge island, the Two islands, Five islands, Gerrish mountain, and some others of less note on the north side of Minas channel, belong to the same formation. As these latter headlands are within the range of parallel of three submarine ledges running parallel with the present south shore, and at the respective distances of three, five, and nine miles therefrom, it is probable that all were once parts of the same trappean range. Cape Chiegnecto, the western termination of the metamorphic Cobequid hills, rises almost perpendicularly from the water for eight hundred and fifty feet; and a short distance back attains a height of nine hundred feet. The remaining shores of Cumberland basin

consist of broad expanses of marine alluvium and low cliffs of carboniferous sandstones and shales; those of Minas basin, of marine alluvium and low cliffs of new red sandstone.

The tides of the Bay of Fundy have attained an almost world wide celebrity. This is no matter for surprise, for some of the phenomena pertaining to them are of a very striking and impressive character, and yet no more striking than singular. Without pausing to discuss the theory of the tides generally, I will proceed at once to describe some of the more noteworthy of these phenomena.

The great volume of water which sets into the Bay with the flood, comes from the south. The tidal current on entering the mouth of the Bay, is much accelerated, owing to the gradual narrowing of the bed which confines it, and rushes over the basalt ledges of Brier island, and through the Grand passage and Petite passage, with great velocity. Were this tide an ordinary ocean current, produced—say by a trade wind, on entering the Bay of Fundy from the direction from which it does come, it would strike almost directly across the Bay, and would spend its greatest force on the New Brunswick shore between Point LePreau and the mouth of the St. John. Being broken on that shore, the main portion of the current, now much weakened, would set to the eastward, but close along the north shore of the Bay, whilst a slender stream from it would be directed to the westward and eddy about Passamaquoddy bay. We find the very reverse to be the case in fact. The tide, being in its original and simplest manifestation, a vertical uprising of the surface of the ocean, has a tendency to seek *in every direction* its original level. Consequently, when the flood begins to "make" off Brier island, in the mouth of the Bay, the current sets alike in every direction, northwardly and eastwardly. But this being the case, by the time it has reached the New Brunswick shore, it will already have extended up along the south shore, far above the point directly opposite to which it first became perceptible on the north side of the Bay. Thus the tide, both flood and ebb, on the south shore of the Bay of Fundy is always in advance of that along the north shore. It is high water at the entrance to Digby gut twenty-one minutes before it

is high water at the mouth of the St. John, directly opposite. This simple fact explains several curious phenomena of the Bay of Fundy tides.

From the essential nature of a tidal current, it is obvious that the volume of water composing it is cumulative. It is not like a single huge ocean wave which rolls in upon the shore and then retreats. Rather it is like a rapid succession of such waves piling one upon another. In fact it is a cumulation of such waves, following so close upon each other that the intervals between are indiscernible. We have seen that the head of the flood—or ebb—on the south shore is always in advance of that on the north. Owing, then, to this cumulative property, it must always happen that at any given point on the south shore, there must pass over any given breadth, a greater volume of water than will, within the same time, pass over a like space along the north shore of the Bay. This greater cumulation in the volume of water in motion must, other things being equal, cause an increase in its velocity. Accordingly, we find that the velocity of the current on the south side of the Bay of Fundy is always greater than on the north side. On the north side of the bay, from the mouth of the St. John, eastward, the tide runs at the rate of from one and a quarter to one and a half knots. At the same time, along the opposite shore, it runs at the rate of from two to two and a half knots.

This difference in the force of the tidal current between the north and south longitudinal sections of the Bay, continues, but is still more marked in the prolongations of those sections—that is, in the Chiegnecto and Minas arms of the Bay. The increase in the velocity of the Chiegnecto current is very gradual. Just off of Apple river the flood has attained one and three-fourth knots. By the time it has reached cape Enrage, owing to the narrowing of the channel, this has increased to two. Above this, as already mentioned, the Chiegnecto channel is again divided into Cumberland bay and Shepody bay, the channels of both of which gradually contract above cape Merangouin, the point of bifurcation. Consequently, above this point the current in both these smaller bays soon increases to three and eventually to four knots.

We find a very different state of affairs in the Minas arm of the Bay. At the very entrance of the Minas channel the flood has attained a rate of three knots. Its velocity now rapidly increases. It passes cape D'Or and hence on to the much contracted Minas strait, at the rate of six knots. This portion of the Minas channel about corresponds with that part of the Chiegnecto arm where there is a one and three-fourth knot current. Here, about cape D'Or, is the place where a stranger, floating up with the flood, first begins to appreciate the tides of the Bay of Fundy. This six knot current, roaring and foaming in what are called "tide rips" over a submarine ledge extending directly out towards the middle of the Bay, from the base of a magnificent, perpendicular trap cliff five hundred feet in height, forms a picture which, once seen in any kind of weather, is not likely soon to be forgotten. As already stated, this six knot current continues to about the entrance of the extraordinary gorge known as Minas strait. Here, owing to the great and sudden contraction of the channel, its velocity receives another great *impetus*. About mid-channel and between that and the mural cliffs of the Blomidon shore, the tide runs at the extraordinary rate of eight knots, and, under specially favouring circumstances, has attained even ten knots. In the calmest of weather, the waters here seethe, and boil, and whirl along, as if they were in a gigantic cauldron. From the top of Partridge Island, a headland two hundred and forty feet in height, at its eastern termination, I have on a perfectly calm summer morning, seen a number of vessels drifting up the strait with all sails set, performing most singular gyrations, as if the vessels themselves had either become bereft of their senses, or, seeing that there was no wind to enable them to "move on" about their business, had determined to put in the time by indulging in a solemn waltz. But the expanse of waters to be seen from this same point of view often presents a much wilder scene. The name Blomidon is an attempted modern refinement for Blow-me-down, by which this cape was always known in former times, and by which it is still called by old baymen, owing to the prevalence of squalls in its vicinity. For the same reason the water around its base is locally known as "white waters." Off

cape Split there is another fine exhibition of "tide rips" caused by a submarine ledge of trap extending far out into the channel. When there is a high wind and the waves are in motion every where, these "tide rips" are not so discernible as at other times. Their appearance in calm weather bears a striking resemblance to that of some of the most impetuous of the rapids on the St. Lawrence and Ottawa.

There are few visitors to Minas strait who, in order to gaze upon its beauties, would not willingly make their passage through it more lingeringly than the velocity of its tide will permit. On the one hand stretches for ten miles in length, the unbroken range of lofty, wood-crowned, frowning cliffs collectively called Blomidon. At its north-western termination it becomes thinned to a narrow promontory—a bold rock four hundred feet high, cleft from its summit to its base. This split, from which the cape derives its name, being clearly defined, is discernible from as great a distance in either direction as the rock itself can be seen, however faintly. Beyond this a succession of shattered basaltic pillars and lofty pinnacles extend far out into the—here ever-foaming—tide, and terminate in the submarine ledge already mentioned. At the eastern termination of this vast wall, cape Blomidon frowns down from a height of five hundred and seventy feet, with its basaltic parapet wall and its scarp of red sandstone, like an immense bastion placed for the defence of this watery pass. On the other hand there is the bold, semi-circular sweep of Greville Bay, with its warm-tinted, sandstone cliffs, terminating away to the westward, in the hemispherical shaped Spencer's island, and the lofty table of cape D'Or. Carrying the eye eastwardly, it next falls upon cape Sharp, a wedge of trap some three hundred and fifty to four hundred feet high, jutting far out into the strait. Then comes the semi-isolated headland, called Partridge island, already mentioned, and its two cozy, placid little harbours, one above and the other below, with their broad, clean, shelving beach, and the pretty village of Parrsboro' clustering on its further margin. If from this point we complete the circle of vision, it will be to look upon as beautiful a sheet of water as ever tide flowed in, fading away, on the right, into the rich

alluvium of Cornwallis and the Grand Pre, embellished on the left with the exceedingly picturesque group of the Five Islands, and having the distant blue hills of Hants and Colchester for a background directly in front. Tastes differ in such matters; but I doubt if any bit of scenery about the Atlantic coast of North America can be found, which combines so much of the grand with such a charming diversity, as this Minas strait and its vicinity.

A glance at the map will show that the flood tide is poured into the basin of Minas at its north-western corner; and that a prolongation of the northern shore of Minas strait would be almost identical with the actual northern shore of that basin and of Cobequid bay. Hence a perfect repetition of the phenomenon which took place when the flood entered the main bay at Brier Island. But here it is, of course, the *north* shore along which the current takes the lead. Immediately on its entering the basin, there is a diminution in the velocity of the tide in every direction. Its greatest rapidity drops from eight to four knots. All along the north side of the basin it keeps up this latter rate; whilst further south the current setting in the same direction only attains a rate of from two and a-half to three knots. This continues up into Cobequid bay until the channel becomes too narrow for the difference to be observable. It must be observed, however, that on getting up into Cobequid bay, where the bed of the tide is already much contracted and is constantly narrowing as we proceed farther east, we shall find the velocity of the current gradually, but very materially, increased, and exhibiting too, in calm weather, that seething, whirling commotion in the water, already mentioned in speaking of the Minas strait. My own impression from frequent personal observation, although I have no definite proof of the fact, is that, until retarded by the great breadths of sand and mud flats which it encounters near the head of the Bay, the velocity of the tidal current is as great in Cobequid bay as in Minas strait, or very nearly so. On the other hand, in the estuaries of the rivers of East Hants and King's counties, which empty into the southern bight of the Basin of Minas, the tide flows and ebbs in a very leisurely kind

of way, and for reasons which will be obvious from what has been already stated.

I have endeavoured to point out the principal causes which direct the courses and regulate the velocity of tidal currents in the Bay of Fundy, and have briefly described some of their effects. The comparative height to which the tides rise in various parts of the Bay and its inlets, may, in a great measure, be accounted for by the same causes, but not wholly so. A vast deal depends upon the conformation of the channel in which the tide runs. Where the retaining shores converge in such a way as to form a prolonged, straight, and funnel-shaped channel, the flood, rushing up such a channel, acquires an enormous momentum, which *piles up* its waters, we may say, towards the termination of the funnel, to an extent that could not be possible under other circumstances. We find this formation in a marked degree in Cobequid bay. Again in Shepody bay with its prolongation of Petitcodiac river; and again, but in a much less degree, at the head of Cumberland basin. These localities, but more especially the first named, are noted for the extraordinary height of their tides in comparison with other parts of the Bay of Fundy and its branches.

As to what really is the maximum rise of tide at any one point in this Bay, that is a matter upon which authorities differ. Indeed scarcely any two of the Admiralty hydographers agree upon it. The results of all my enquiries and examinations amount to about this: In St. John harbour and Digby gut, ordinary spring tides do not exceed from twenty-seven to thirty feet. As a rule, the vertical rise and fall of the tide increases as we proceed from the mouth of the Bay eastward, towards its head; but the ratio according to which it increases is irregular, being much affected by the width and formation of the channel. From what has been already said, it will appear obvious that in the Bay of Fundy proper, from the mouth up to the point of its bifurcation at cape Chiegnecto, the height of the tide will increase in a more regular, but much less rapid ratio, than we shall find it to do as we proceed up Cobequid, Cumberland, or Shepody bay. It is admitted on every hand that the point where the greatest rise of tide takes place in the whole Bay of Fundy, is at the mouth

of Shubenacadie river, near the head of Cobequid bay. An impression has gone abroad and is popularly taken for granted, that here the tide attains the extraordinary maximum rise of seventy-five feet, a greater vertical rise of tide than is known anywhere else in the world. All the old shipmasters and pilots about the Bay—many of them men of great experience and keen and acute observation—used formerly to declare that this was the case. I do not know what those of their class say now. I find that, taking as a basis of calculation the vertical rise of spring tides at various other points about the bay and basin, as recorded on the latest Admiralty chart, and applying the rule which seems to apply to the tides of Cobequid bay, we are led to the conclusion that the rise of ordinary springs must, at the mouth of Shubenacadie river, considerably exceed sixty feet. I see no reason to doubt that during those exceptionally high spring tides, which take place occasionally under the combined influence of more than one of the heavenly bodies, the maximum rise, at the junction of the Shubenacadie and Truro channels, justifies the popular belief, and does attain to seventy-five feet.

I furthermore think it not improbable that the vertical distance between high water and low water mark was formerly much greater than it is now; and that formerly, at ordinary springs, there was *always* a rise and fall of seventy-five feet at the mouth of the Shubenacadie. The low water level is being gradually raised owing to the fact that the channel is filling up. This applies to all the channels of the head waters of the Bay of Fundy. For instance, not more than twenty-five years since, vessels of from fifty to one hundred and fifty tons used, almost daily, to sail up this Cobequid bay to receive and discharge cargo at the place where it is now bridged, a short distance below the village of Truro. Now nobody ever attempts to take any sort of a craft above the class of an open boat, further up the bay than Yuill's island, which is about six miles below the bridge. The channel is obviously narrowing and becoming more shallow every year. The rapidity with which this is possible, may be imagined from the fact that during springs, one tide flowing over a level space, will deposit a layer of mud a quarter of an inch thick. On the other hand, the

volume of clean river water which used in former times to wash the marine alluvium out of these channels, is every year becoming less, owing to the removal of the forest and the consequent desiccation of the country generally. Upwards of eighty thousand acres of fertile marine alluvium have already been made up by the tides of the Bay of Fundy.

Minas strait, of which mention has already been so frequently made, is about ten miles in length, by from four to six in width. In the very narrowest part, just at cape Sharp, it is less than four miles wide. It seems almost incredible that, in six hours time, a quantity of water can be poured through this narrow gorge equal to a depth of fifty feet over an area of four hundred square miles. Yet this is a not immoderate estimate of what actually does take place four times in every twenty-four hours, during spring tides. It can only be explained by the great comparative depth of this strait. It is a chasm much deeper than the basin above, or the channel below it. The low water soundings, even in the middle of the basin of Minas, only show a depth of from fifteen to twenty fathoms. A series of like soundings through the strait, near mid-channel, show a depth of from forty to fifty-seven fathoms. I can find no record of any such depth elsewhere in the Bay, until we get down to about the longitude of Digby. Whether then we are to attribute it to the eroding action of the water itself, or to that great convenience in cases of difficult explanation, a "convulsion of nature," certain it is that the bed of this strait is a great chasm from three hundred to three hundred and fifty feet deep below low water tide level, or more than double the depth of the basin of Minas; and that, were it not for this fact, the tides in this basin, instead of being greater, would be less than they are in Cumberland basin.

Everybody who has heard of the tides of the Bay of Fundy, has doubtless heard something of that tidal phenomenon locally known as "the Bore." In the Cobequid and Cumberland bays, and in the estuaries of the streams emptying into them, the tide at its ebb leaves exposed immense "flats" of sand and mud, amounting in the aggregate to many thousands of acres in each of these inlets. The more extensive of these flats are composed

almost exclusively of sand; and when they are not separated from the firm land by a channel, or gully, of open water, always have instead thereof a margin of soft, unctuous mud. These sands are always shifting and changing their position, to some extent with every tide; but within a very short time after they are left bare, they become dry and firm—so much so that in walking over them one's boots scarcely leave a discernible track. As they are often miles in extent and as smooth and level as a floor, they would serve admirably for race-courses and for grounds on which to play bass ball, golf, and cricket, were it not for their comparative inaccessibility. There are indeed quicksands in some places; but these are easily discerned and avoided by the initiated. A quicksand is never dangerous if the pedestrian walks smartly over it. I never knew of but one serious accident caused by quicksands. Some years since, a schooner loaded with stone was going down Maccan river, but, being late in the tide, grounded upon Amherst point flat, just opposite the village of Minudie. It happened that the vessel grounded in a quicksand, and sank deeply into it as the tide ran out; but it was taken for granted that she would float again with the flood tide. She did not, however, but remained stationary, filled, and became hopelessly immovable. That doomed schooner continued to sink deeper and deeper, until she totally disappeared, spars and all, and "left not a rack behind."

When the very first of the flood, running with such great velocity as it does, meets with an obstruction in the shape of these flats and the shallowness of the water in the neighbouring channel, an instantaneous ripple is produced. The still advancing and ever accumulating waters in the rear, whose velocity is always greater than that of the first of the flood, having as yet no obstruction, are hurled vehemently forward upon this ripple, which, in a second or two of time, becomes a moving wall of foaming, hissing water. This is called "the bore." The perpendicular height of this advancing tidal wave depends upon the volume of the driving force behind, and the extent and nature of the obstructions in front of it. To the spectator facing the moving mass at right angles, the slope of the surface of the water, from the brow of the wave, upwards and backwards, is plainly per-

ceptible. To ascertain with accuracy the height of what I may call the face of "the bore" seems next to impossible. I have never seen it exceed, according to my own estimation, five or six feet, but it may have been greater; during neap tides it is very much less.

A few minutes after "the bore" has passed, there may be witnessed another phenomenon of the rising tide scarcely less startling and grand than "the bore" itself. I allude to the "tide rips;" for there are tide rips upon these sands as well as upon the ledges farther down the Bay. They result from the same cause as "the bore" does. The advancing tide has acquired greater volume and greater velocity; but yet meets with shallows which impede its progress. The surface breaks into tumultuous waves which continue until, partly from tearing up the sands in the bottom and partly from the rising of the tide, the shallow is overcome. Suppose a spectator, unaccustomed to such scenes, to be on a calm day watching the coming tide from a good position. "The bore," has just roared and foamed past him, and its noise is now thrown off in another direction. There is silence except for the slight gurgling sound of the after current pressing on with tremendous rapidity. Suddenly he is startled with a roaring of waters as loud as that of "the bore" itself was a few minutes since. Looking for the cause of it, he perceives that where only two or three seconds ago the surface of the water was as smooth as glass, it is now, to an extent of many acres, a mass of tawney foam, tossing in the wildest commotion, as if a submarine volcano was about to emerge from the spot. Then it breaks into regular, but terribly energetic waves, the crests of which almost touch each other. Whilst he is admiring, or wondering at this strange phenomenon, his attention is attracted to a similar commotion in another direction; then another, and another. In each instance, after a lapse of from five to fifteen minutes, the turbulence of the waters subsides just as suddenly as it arose, and the flood sweeps on as smoothly as a torrent of oil.

Tourists cross the Atlantic to see the Falls of Niagara and the Rapids of the St. Lawrence. I cannot but think that the tides of the Bay of Fundy are scarcely less worthy of their attention.

But to see these tides in their true grandeur and beauty, the spectator must be in their midst. About the full or change of the moon he must get on board a vessel, drop down with the ebb, and get aground upon some of the broad flats about the middle, or lower part of Cobequid bay, and wait there for the coming flood. I have endeavoured to describe the scene as it would appear to him in daylight. Perhaps the occasion is even more impressive in a still summer's night. In the dead silence of the night you hear a low, prolonged whisper. What can it be? You listen intently. It grows louder. It is the "solemn roar" of the tide, miles and miles away. Every minute you are conscious of the tumult away out in the darkness yonder, growing louder and approaching nearer. It is difficult to prevent the imagination getting excited and the mind being deeply impressed with awe. On it comes like a Fate, and still you know of its approach only through the organ of hearing. At length, in the dim light you see a white streak, reaching from shore to shore, or from the gloom on the one hand to the gloom on the other. It is "the bore." It rushes and roars on, striking the as yet firmly embedded vessel in which you are luckily safe from its embraces, with a thud which makes its timbers quiver; and is past. Then, after a breathing space, the tide rips begin to make. Here, perhaps, near at hand, you can see their foam leaping up under the starlight, but you can certainly hear their fitful roaring out in the darkness in every direction. Where not many minutes since the silence was, it may be, so intense that you could hear yourself breathing, you now find yourself in the midst of a chaos of angry waters.

The momentum of this "bore" is no doubt enormous, but many stories that are told of its achievements, and indeed of the Bay of Fundy tides generally, are quite apocryphal. So many strange reports have gone abroad about this Bay, that to many strangers it is a name of terror. Yet to those acquainted with the place its navigation is comparatively safe and easy, and these very tides are what conduce so much to the facilities of its navigation. Many of nature's moods and changes there are known, can be calculated upon before hand, and taken advantage of. I have myself gone all around and over the basin of Minas

and Cobequid bay in a little open sail boat. I have seen men from twenty miles up the Shubenacadie river, away down the bay nearly to Economy point, in log canoes, fishing. And I have seen Indian bark canoes crossing the bay near cape D'Or. Still it must be admitted that the Bay of Fundy is no place for a stranger to be without a good pilot. Finally—as to the dangers of navigation there—I will hazard the assertion that the number of marine disasters in the Bay of Fundy is less than on the same extent of coast in any other part of Nova Scotia.

Art. V. On Trichina Spiralis. By George Lawson, Ph. D., LL.D., *Professor of Chemistry and Mineralogy, Dalhousie College.*

(*Read Feb.* 4, 1867.)

In this paper the author described the structure and developement of *Trichina Spiralis*, drawings of which, and specimens under the microscope from the human subject were exhibited. It was stated that although careful search had been made, no trichinæ had been found in pork exposed for sale in the Halifax markets.

Several other *Entozoa* were referred to, and a description given of *Tænia pectinata*, which occurs in the intestines of the porcupine in great quantity, both in Canada and Nova Scotia. Specimens were shown.

Art. VI. A Fortnight in the Backwoods of Shelburne and Weymouth. By J. Matthew Jones, F. L. S.

(*Read Feb.* 4, 1867.)

A FORTNIGHT seems but a brief space, yet much may be done and seen in that time. Some few years ago, on my first arrival from England, I had the good fortune to join an expedition sent to report upon the state of the timber on the admiralty reserves in the western part of this Province, and I was introduced for the first time to the pleasures of a forest life in a snug little camp, pitched in a charming nook beside the limpid waters of the ever winding Roseway, a short distance to the northward of Shelburne. It would be useless for me to dilate upon the feel-