rate of a fork caused by changes in temperature, in the amplitude of vibration, and by the pressure of the style against the paper on which the vibrations are recorded.

LETTERS TO THE EDITOR.

**** Correspondents are requested to be as brief as possible. The writer's name is in all cases required as proof of good faith.*

An early prediction of the decay of the obelisk.

I GIVE below a translation of a portion of a letter from Dr. Alfred Stelzner of St. Petersburg.

"At first I wanted to add to my remarks a comparison between the New York Needle and the Alexander column in St. Petersburg; for the rock of both is very much alike: it agrees even down to the occurrence of handsome little zircon crystals. This comparison would have been made but that it would have been a mournful and unpleasant croak in the triumphant report of Mr. Gorringe, and therefore it had to be abandoned; but privately let it at least be put on record. You know, perhaps, that the Alexander column in St. Petersburg was transported from Finland to St. Petersburg in the thirties of this century at a senseless cost, and, with the assistance of thousands of men, was erected, — a monument for eternal ages, which should remind the beholder of a Russian monarch. But even in a few years the granite did sad honor to its Finnish name of 'Rappakivi,' i.e., the lazy-stone. The granite commenced to weather, and weathered merrily on in spite of all technical and scientific commissions; and one can well say that the years of the proud monument are numbered. It is possible that they chose unsound stone, and that they shook it about too much; so that, in quarrying and transporting it, it became filled with little clefts, and thus gave free play to its disintegration. But General Helmersen explains the affair differently. The granite, he says, contains many large felspar crystals. But the felspar is triclinic, and therefore expands, under the great differences of temperature between the St. Petersburg summer and winter, differently in the directions of its three axes: hence comes the crumbling, owing to the unequal molecular movement throughout the entire mass of the monolith. If this explanation is correct, then from the similarity of the rocks from Finland and Syene, and the great differences between the summer and winter temperature which exist also in New York, an unsuspected danger threatens the old Egyptian monolith, which has always hitherto stood in a mild and equable climate. Perhaps, also, it will succumb to the weakness of old age, for the London Needle of Cleopatra is said to be beginning already to crumble in its new home. You may regard this statement as pessimistic, but a knowledge of the experiences made elsewhere will not injure the New-Yorkers. Perhaps it will lead them to cover up the Needle there with bad conductors of heat during the winter, and thus preserve the venerable old stone monument. In any case, you will agree with me that this comparison should be taken into consideration; but it will not do to insert it into Mr. Gorringe's book, where it would produce a discordant tone. But it is worthy of consideration. . . . Thus I wrote in 1882, and I regret that I was not mistaken. But the children of the tropics, be they palms or granite columns, will not stand a northern winter in the open air. For the rest, one will interest himself now more than formerly in the observations which have been made in other places. I take the liberty, therefore, of calling your attention to the memoir by Struve: 'The Alexander monument and the Rappakivi. A contribution to the better knowledge of the Finnish granites. St. Petersburg, 1863–64.'"

F. R.

Sea-level and ocean-currents.

The recent important determination of the coast and geodetic survey, by levelling up the Mississippi valley and across to the Atlantic coast, that the mean level of the Gulf of Mexico at the mouth of the Mississippi is about one metre higher than that of New York harbor; and the similar result obtained by Bourdalone, by levelling across France, namely, that the mean level of the harbor of Brest is 1.02 metres higher than that of the Mediterranean at Marseilles, — furnish an interesting subject for study, and important facts for explanation by physical geographers. If, as it seems, the surface of the ocean is not level and at rest, what are the forces which cause it to deviate from a perfect level, and to have ascending and descending gradients in different parts, and currents running in various directions?

There are two principal causes for this disturbance of sea-level, — the one, the difference of level between the equatorial and polar regions, arising from a difference of temperature of the sea in the two regions; and the other, the deflecting force depending upon the earth's rotation. The first is the real cause of disturbance, the latter being simply a modifying influence of the effects of the former, which changes, or tends to change, the directions of motion, but does not give any addition of real force.

According to Mr. Croll (*Climate and time*), as deduced from the soundings of the Challenger expedition, if the water of the upper strata were prevented from flowing away toward the poles, the level of the ocean at the equator, on account of its greater temperature, would be 4.5 feet higher than the level at the parallel of greatest diversity of sea-water, a little beyond the polar circle. This greater upward expansion in the equatorial region, however, does not change the pressure at the bottom of the sea; and its initial effect is to give rise in the upper strata to gradients of pressure decreasing from the equator toward the poles. This causes a flow of the water of these strata from the equatorial to the polar regions, and this decreases a little the pressure at sea-bottom in the former, and increases it in the latter, and consequently gives rise to a gradient of decreasing pressure, and an under-current, from the polar regions toward the equator. Hence there is now an interchanging circulation, a motion of the water of the upper strata from the equatorial region toward the poles, a very gradual settling-down of the water in the higher latitudes, a return toward the equator in the lower strata, and a very gradual rising-up again in the lower latitudes.

If the earth had no motion of rotation on its axis, this would be simply a vertical circulation without any motion either east or west. But, in consequence of the deflecting force of the earth's rotation, the water of the upper strata, in flowing from the lower latitudes toward the poles, is deflected eastward; and it retains this eastward motion until it has settled down in the higher latitudes into the lower strata, and has returned, perhaps, to the parallel of 35° or 30°, by which time the deflecting force due to the earth's rotation — always to the right in the northern hemisphere, and the contrary in the southern — has overcome the eastward motion, and it now begins to assume a westerly component of motion. Hence, where there is an interchanging motion between the equator and the poles, the effect of the earth's rotation is torsionary, tending to give rise to an eastward motion in the higher latitudes, and a westerly one in the lower latitudes; extending, where there are no interruptions from continents, all around the globe. The relation between these must be such that the action of the former, by means of friction on the sea-bottom, shall not have any greater tendency to turn the earth eastward on its axis than that of the latter to turn it the other way: for no change in the velocity of the earth's rotation can arise from the action of forces simply in the plane of the meridian, which are the only real forces here, those arising from the earth's rotation being simply modifying influences. Since the action by means of friction upon the sea-bottom in the higher latitudes, which tends to turn the earth from west to east, is much nearer the axis of rotation than that in the lower latitudes, which tends to turn it the other way, the eastward motion in the former is more rapid than the westward one in the latter.

In the real case of nature, in which a continuous motion either east or west all around the globe is interfered with by the continents, the tendency to such motions gives rise to various deflections by the continents. For instance: in the North Atlantic the tendency to flow eastward in the middle and higher latitudes causes a slight heaping-up of the water, and a rise of surface level adjacent to the coast of Europe, and a drawing-away of the water and a depression of sea-level along the north-east coast of the United States. As the water of the upper strata, however, is thus pressed over against the coast of Europe, its surface does not assume a gradient of static equilibrium; for the water, in consequence of the raising of the sea-level on the coast of Europe, and especially of France, is disposed of in three ways: one part is deflected around to the left along the coast of Norway, around by Spitzbergen and the east coast of Greenland; another to the right, down by the Canary and Cape Verde islands in the region adjacent to the north-west coast of Africa; and a small part flows back westward under the upper strata as their water is forced eastward. The latter is small on account of the great pressure and friction on the sea-bottom, which does not have its counterpart in the upper strata.

It is important to inquire here what amount of motion of the water of the upper strata toward the pole, arising from difference of temperature between the equator and the pole, is required to cause, by means of the deflecting force of the earth's rotation, the necessary pressure toward the coast of Europe, and raising of sea-level adjacent to it, to account for the observed difference of sea-level between Brest and Marseilles, and the observed resulting currents. The gradient of the ocean's surface corresponding to any given velocity of the water in any direction, in the case of static equilibrium, may be obtained from the following little table, in which the gradients are given in feet per 100 miles, for a velocity of one mile in twenty-four hours, the ascending gradient in the northern hemisphere being always at right angles to the right of the direction of motion: —

Latitude.	Gradient.	Latitude.	Gradient.
	Feet.		Feet.
0°	0.000	50°	0.101
10	.023	60	.114
20	.045	70	.123
30	.066	80	.129
40	.085	90	.131

From this table, it is seen that a velocity of four miles per day of the water of the upper strata toward the pole, on the latitude of 45°, would cause a gradient of about 0.36 of a foot in 100 miles, or about 10 feet between New York and Brest, in case of a static equilibrium. But of course, for reasons already given, there would not be really this difference, — perhaps only about half of it; but this would be sufficient to account for the observed differences of sea-level between Brest and Marseilles, and the Gulf of Mexico and New York harbor; the surface of the ocean adjacent to the coast of France being about 25 feel above mean level, and that adjacent to New York as much below. The velocity above, of 4 miles in 24 hours, would give a very gentle and almost imperceptible current, and would not be at all greater than, as we have reason to think, it is.

We have, then, an ascending gradient from the north-east coast of the United States across to the coast of Europe, over which the water of the upper strata is impelled, until it arrives on the east side of the Atlantic, by the deflecting force arising from the earth's rotation and the poleward motion of the water of the upper strata. From the raised sea-level here there is down-grade on the one hand, around by the north-west coast of Africa, across the Atlantic in the lower latitudes to the Caribbean Sea and Gulf of Mexico, and thence to the low surface-level on the west side of the Atlantic: and, on the other hand, around along the coast of Norway, and by Spitzbergen and the east coast of Greenland, to the same region of depressed sea-level; both tending to fill up the partial vacuum, as it is being continually maintained by the drawing-away of the waters, as explained above. The general descending gradient from the equator toward the pole, due to a difference of temperature, tends to decrease the gradient from the coast of France down by the north-west coast of Africa, and consequently the strength of the current; but the same increases the gradient and the strength of the current on the opposite side from the Caribbean Sea and the Gulf of Mexico. Hence the latter is greater than the former.

As a wide and gently flowing river, when it is contracted into a narrow pass, becomes a rapid stream, so the flow of the warm water from the Caribbean Sea and the Gulf to the region of depressed ocean surface adjacent to New York, being forced to pass mostly through the Strait of Florida, becomes, instead of a wide area of very gentle flow, as it would be if it were not for the West India Islands, and especially Cuba, a comparatively very narrow and rapid stream, 'a river in the midst of the ocean.' As this river of warm water flows northward, it tends, by the effect of the earth's rotation toward the right, and as the current from the east coast of Greenland flows southward it is likewise deflected to the right, toward the American coast. Hence, having very different temperatures, and being deflected to contrary sides, there is no tendency to mix together; but the division between the two, called the 'cold wall,' is nearly a vertical plane. This is the whole mystery of the Gulf Stream and of the cold wall.

The level of the Mediterranean Sea at Marseilles is undoubtedly a little lower than that of the Strait of Gibraltar and of the ocean generally adjacent to the north-western coast of Africa; so that the latter is about on a level with the western extreme of the Gulf of Mexico, there being a little down-grade across to the West Indies, and then a little ascending grade to the coast of Mexico to check the westward motion, and to deflect the current around toward the north. The difference, therefore, between the ocean-level at New York and Brest is probably about five feet.

There is another theory, the wind-theory, which is thought by some to explain satisfactorily all the currents of the ocean. It may be well to examine a little here the claims of this theory, and especially to consider whether it is adequate to explain the recently observed differences of sea-level. The westward component of the trade-winds, by this theory, raises the level of the Gulf of Mexico, and depresses the sea-level on the north-west coast of Africa as much; and the eastward and north-eastward motion of the air in the middle latitudes drives the water toward the coast of Europe, and so causes a depression of the sea-level on the American coast, and a raising of it on the coast of Europe. It is readily seen that this would give precisely the same system of circulation, and tend to cause the same differences of level between the Gulf of Mexico and New York harbor, and between the harbors of Brest and Marseilles, as the other theory. But it is well known that ordinary winds have very little effect in changing sea-level, except in very shallow water.

According to the Report of the chief of engineers (1876, part iii. p. 76), by the mean of all observations, the difference of mean level of Lake Ontario, at either end, with north-east, east, and south-east winds, and with south-west, west, and north-west winds, is only 0.05 of a foot, and hence the average effect of either class of winds on the surface level is less than one-third of an inch.

Again, if the trade-winds cause a raising of the sea-level in the Gulf of Mexico by a half-metre, they must depress the sea-level on the Pacific coast of Mexico about the same amount, and so there would be a difference of level of about one metre on the two sides. But by the levellings for the Nicaragua ship-canal, the elevation of the surface of Lake Nicaragua was found to be exactly 107 feet above mean tide of either ocean. Hence the trade-winds have no sensible effect in changing sea-level.

Furthermore, if the trade-winds can have so great an effect as is claimed for them, then the still stronger westerly winds, which usually prevail in the middle latitudes of the North Atlantic, should change the difference of sea-level between New York and Brest at least as much; and if so, there would have to be a considerable annual inequality in the height of sea-level; for the westerly winds are much more prevalent, and blow very much more strongly during the winter than during the summer season. There ought, therefore, to be a change of the height of sea level of more than one foot, higher in winter and lower in summer, on the east side of the Atlantic, and the reverse on the other. But no such inequality is observed on either side. Mean sea-level is two or more inches higher, on both sides, in summer than in winter, which is evidently due to the difference of temperature of the sea-water in the two seasons, and there is no apparent effect whatever arising from an increase of the strength of the winds. The only inference from this is that the strongest winds have no sensible effect.

A continuous wind, for some time in any direction, evidently causes mere surface currents of considerable velocity; but if they could even explain the strong and deep flowing currents, such as the Gulf Stream, it is evident, from what is shown above, that they cannot account for the great differences of sea-level which have been shown to exist by recent levellings.

WM. FERREL.

Washington, Jan. 18.

Oil on troubled waters.

I do not know much about the sea, and so perhaps you will wonder the less at my expressing incredulity with reference to the reports of the extraordinary effect of 'oil on troubled waters,' to which you seem to give unqualified assent in your notes and comments of Jan. 15.

It is indeed remarkable that seamen should have overlooked this important aid to navigation, if, as you declare, its efficiency in calming the waves is as obvious as the use of the rudder in shaping a new course; for sailors are not usually slow to adopt notions favorable to the existence of prodigies and marvels.

But, if the newspaper accounts of the matter are to be believed, it strikes me that the hydrographic office has quite outdone every other politico-scientific bureau in the propagation of startling generalizations from very flimsy details. For example: one of its witnesses testifies that in 1863, when off Sydney Head, he encountered a terrific gale, followed by a tremendous sea, in which his ship was making water, and was in danger of wreck, and that he at first tried oil upon the waves by 'jerking it out' over the side of the vessel, through a hole in the cork of a bottle; but finding that when employed in this way it blew about the stem of the ship, and not into the sea, he made use of 'the oil-bag,' into which he put about half a gallon, tying the neck tight, and towing it astern. After a short time, he says, "the effect was wonderful; for what was a very heavy-running and dangerous sea was reduced, by the use of the oil, into what a seaman would call 'blind rollers,' quite harmless to a ship." He asserts that in this manner he ran his half-sinking vessel from Sydney Head to Port Stephens, a distance of sixty-eight miles, in eight hours and a half, on a consumption of two gallons and a half of oil, although he considers that his way of using it was wasteful. His subsequent experiences convinced him that a ship could run in any sea with safety for twenty-four hours on a consumption of five gallons of oil.

It is hardly surprising, that, as soon as the hydrographic office began spreading such sailors' yarns as this, other captains should have felt the necessity of keeping abreast of the times in nautical science by publishing their similar experiences. Accordingly the skipper of the schooner J. B. Atkinson announces, that, on the 25th and 26th of December, his vessel was saved from utter destruction off Cape Hatteras by bags of oil, which he also towed astern; and still later, the captain of the steamer Lucy P. Miller, running between Philadelphia and Nassau, writes to