stitution of the matter absorbed being different from what it was before its solution, leaves no doubt that that process is molecular also: the oxygen and nitrogen molecules, whose intermixture, through diffusion, constitute the atmosphere, are disassociated, the water taking into solution a much larger proportion of the oxygen. This could not possibly occur if the process of solution were not molecular. If the air is composed of the molecules of oxygen and molecules of nitrogen so intermixed as to constitute a continuous substance, a process which takes more of the oxygen than it does of the nitrogen is necessarily molecular.

It seems, therefore, that we are authorized to conclude not only that the waves themselves are the result of motion of the molecules constituting the water, and not of masses of such molecules, but that when wind causes the waves, its friction, in part if not entirely, is due to the passage of molecules from one fluid into the other.

DANIEL S. TROY.

Montgomery, Ala., Oct. 23.

Rain-Making.

AS Professor Hazen, in his letter published in *Science* of Oct. 16, garbles the quotation from Plutarch which is relied on to prove that the ancients had the same notion in regard to rains following battles that prevails at the present time, I beg leave to give the passage entire, for it is only by a consideration of the whole that his meaning can be arrived at. Plutarch says, in his life of Marius, speaking of the defeat of the Ambrones by the Romans:

'The Romans pursuing, either killed or took prisoners above a hundred thousand. Other historians give a different account of the number of the slain. From these writers we learn that the Massilians walled in their vineyards with the bones they found in the field, and that the rain which fell the winter following, soaking in the moisture of the putrefied bodies, the ground was so enriched by it that it produced the next season a prodigious crop. It is to be observed, indeed, that extraordinary rains generally follow after great battles; whether it be that some deity chooses to wash and purify the earth with water from above, or whether the blood and corruption, by the moist and heavy vapors they emit, thicken the air, which is liable to be altered by the smallest cause."

Now, if we take by itself the statement that "extraordinary rains generally follow after great battles," it would appear, indeed, that the ancient ideas on this subject were identical with those prevailing in modern times. But if we ask the question, "How long after the battles did the rains occur to which Plutarch alluded?" and look for our answer in the context, we shall see, as I said in my letter in *Science* of Oct. 7, that the notions of the former on the subject appear to have been wholly different from those of the latter. When did the rains follow the battle between the Ambrones and the Romans? In the winter following. When did rains follow any other battles that Plutarch had in mind, or when did he think they followed? After the bodies of the dead had putrefied. How soon could the "blood and corruption" — especially the corruption — emit "moist and heavy vapors?" Not under a week. How soon could "some deity wash and purify the earth with water from above?" Not under several months.

It matters not how erroneous Plutarch's ideas were as to why rains followed after battles. It is not his conclusions with which we have to deal, but we are trying to find out what he supposed the facts to be on which he based them. In doing this we have no right to assume as facts anything that is inconsistent with his view of the case.

Professor Hazen quotes the opinion of another rain-maker in opposition to my own. He might also have quoted me against myself. In an article written by me and published in the *Golden Age* of May 11, 1872, and which is also copied into the appendix to the revised edition of "War and the Weather," occurs the following passage:

"If great noises cause rain, some other less expensive way may be devised to produce them. It was noticed, even in ancient times, that great rains followed battles, and it is not impossible that the shouts of a great multitude, with the clashing of metal on metal, may produce the same effect upon the air as the firing of cannon. Should all the inhabitants of a city at a given hour unite in creating an uproar with hands and voices, it would seem to one in our day as though the world were returning to barbarism; but in the higher civilization of some age to come, this may perhaps be a common occurrence."

The other rain-maker referred to has evidently adopted this idea without having made any more critical examination of the passage quoted from Plutarch than I had done when the above was written. But though I have changed my mind in regard to the meaning of this passage, it would be going too far to say that ancient battles did not immediately produce rain, and that the above does not furnish the true explanation of the phenomenon. I only affirm that Plutarch did not say that rains immediately followed great battles, and that the inference that he thought they did cannot be drawn from what he does say. I contend further that, even if the ancients thought that battles produced rain, they may have been wrong, while the moderns may be right in that opinion. Coincidences sometimes occur in thought as well as in action and events.

In speaking of the battles of the late war, and their supposed effect upon the atmosphere, Professor Hazen says, "Mr. Powers thinks that the currents of the atmosphere do not travel at the rate of twenty to fifty miles per hour, or, at least, during these battles they did not do so." This is hardly a fair statement of my position. I think it very probable that portions of two currents moving in nearly opposite directions, in mingling together, lose to a great extent their original motion, and take on a circular motion, moving for a time neither very far east nor very far west. I think that in this way the influence of the concussions may remain in the vicinity of the firing until enough air of different temperatures has mixed together to develop a rain-storm, and that then the storm will move eastward along with the current that supplies the greater portion of the moisture that forms the rain.

Professor Hazen repeats his statement that "one thing seems very certain, that absolutely no rain can be obtained out of a dry atmosphere," and eliminates from it the word "seems." It is not apparent how this helps it as an argument against the artificial-rain theory. According to my understanding of his first article, he did not state this as an abstract idea, but in order to show how unreasonable it was, in his view, to expect to produce rain by concussion in certain states of the atmosphere; and by "atmosphere" I naturally understood him to mean the same thing that he would mean if he were speaking of measuring the humidity of the atmosphere with his instruments. My contention is that there is nothing unreasonable in expecting to produce rain, however dry such air may be, for we are constantly receiving, by the vehicle of air-currents, supplies of aqueous vapor from the tropical portion of the Pacific Ocean; and these currents and the vapor they bring occupy a high altitude, and there the clouds and rain are formed.

Professor Hazen says, "It certainly is not a fact that two currents pass in opposite directions near the point of formation of our storms." How does he know this? He must admit that there is a current moving constantly from west to east or from south-west to north-east. How does he know what there is above this current? Professor Maury gives very strong reasons for believing that there is a polar current there flowing in nearly the opposite direction. Has any one ever given as good reasons for believing to the contrary? Professor Maury's theory was not evolved from a few isolated facts, but from a comprehensive knowledge of the winds throughout the whole world, or so much of it as could be reached by navigators. Has his theory of the circulation of the atmosphere ever been overturned, or even seriously attacked? When I speak of air-currents, one bringing tropical moisture and the other polar cold, I am not drawing upon my own imagination for props to support the theory of artificial rain production, but I am availing myself of the result of investigations and deductions by one who, as a man of science, was a peer to any whom this country has ever produced.

Delavan, Wis., Oct. 19. EDWARD POWERS.