the autograph of St. Luke. The details of the investigation will be found, with many other points of interest to New-Testament students, in the article above referred to.

INFLUENCE OF MAGNETISM ON CHEMICAL ACTION.[1]

MORE than a year ago I gave an account[2] of some experiments which I had performed with the object of determining whether magnetism exerts any influence on chemical action. I succeeded in getting what appears to me to be strong evidence in favor of the view that magnetism does, at least in one case, exert a marked influence on chemical action. The principal experiment upon which this conclusion is based may be briefly described here. A vessel made of thin iron (ferrotype-plates were used) was placed on the poles of a magnet, and a solution of sulphate of copper poured into it. Instead of getting a uniform deposit of copper on the bottom of the vessel, the metal was deposited in distinctly marked lines, the direction of which was at right angles to the lines of magnetic force. Further, directly over the poles, the deposit was uniform; and this uniform deposit was bounded by a band of no deposit, from one-sixteenth to one-eighth of an inch in width.

Since the first paper on this subject was published, I have spent a great deal of time in endeavoring to discover other cases of similar action, and to extend the observations in various directions, in the hope of reaching a satisfactory explanation of the phenomenon described. I shall soon give a full account of the work in the American chemical journal. In the mean time a condensed account is here given.

I should say at the outset, that the subject of this paper has frequently been discussed and experimented upon in past years. In 1847 Wartmann[3] summed up what had been done previous to that time, and also described some new experiments of his own. According to him, magnetism does not influence chemical action. His proof was furnished by two experiments. In the first, the electrolysis of water was carried on in a magnetic field, and the results compared with those obtained with the same apparatus without the magnet. The results were the same in both cases. In the second experiment, iron cylinders were placed in a solution of copper sulphate. Some of the cylinders were magnetized, and others were not. No difference was observed between the deposits formed. The author calls attention to the fact that his conclusion, that magnetism does not influence chemical action, differs from that of a number of earlier writers, among whom may be mentioned Schweigger, Döbereiner, Fresnel, Ampère, and Robert Hunt; but that, on the other hand, it agrees with that of Otto-Linné Erdmann, Berzelius, and the Chevalier Nobili.

Among the experiments referred to by Wartmann, those of Robert Hunt[1] are perhaps the most striking; and to these I turned my attention. Hunt states, that, when a concentrated solution of silver nitrate or of mercurous nitrate is placed on glass over the poles of a magnet, the salts crystallize out in curious lines, of which an illustration is given. While these experiments have no direct bearing on the question whether magnetism influences chemical action or not, I nevertheless repeated them. To my surprise, the effects described by Hunt were not obtained. The conditions were repeatedly changed, — the strength of the solutions, the strength and form of the magnets, the thickness of the glass plates, being varied; but under no conditions were the expected effects obtained. Some of the other experiments of Hunt were also repeated, but only with negative results. So that even the most positive statements of Hunt will require verification before they can be accepted in favor of his conclusion that magnetism influences chemical action and crystallization.

Among the experiments which I have performed since the publication of the first paper already referred to, may be mentioned the following: 1. The action of copper on zinc. In this case the magnet evidently exerted some influence on the action; causing apparently an accumulation of copper on the lines bounding the space directly above the poles. No lines between the poles like those obtained when copper acts on iron were observed. I am unable to say positively whether the faint figure observed in the zinc was due to an increased deposit of copper or to a lack of deposit. 2. Action of silver on zinc. Indistinct lines were observed, which appeared to be at right angles to the lines of force. These were obtained only when the solution of silver nitrate was quite dilute. 3. Action of copper on tin. The action was evidently modified by the presence of the magnet. 4. Action of silver on lead. No action was

[1] Abstract of a paper read before the National academy of sciences, at its semi-annual meeting in New York, Nov. 14–17, 1882.

[2] American chemical journal, iii. 157.

[3] Philosophical magazine, 1847 [3], 30.

[1] Philosophical magazine, 1846 [3], 281.

observed. 5. Action of silver on iron. A slight effect was produced.

It will thus be seen, that the first experiment described is the one which best exhibits the influence of the magnet. The question still remains, whether the striking effect observed is due to the influence of magnetism on the chemical action, or to some indirect influence of the magnet. An examination of the liquid while the action is going on shows clearly that there are currents in it. Small particles of dust, or any light material, on the surface of the liquid, are drawn towards the poles, and then move in circles above the poles, to the right above one, to the left above the other. We have hence electric currents in the liquid; and these revolve under the influence of the magnet, as we would expect them to. This action gives rise to a streaky condition of the liquid, and this may possibly account for the deposition of copper in the peculiar lines which have been described. I am unable to say whether this satisfactorily accounts for the fact, that the lines of deposit are at right angles to the lines of force; but, as far as I have been able to determine, it does not. Further, if the presence of the currents is the cause of the peculiar deposit of copper on iron, it would appear that the same kind of action should be observed whenever one metal is deposited upon another under the influence of a magnet. This, however, is not the case, as was pointed out above. The fact that the action takes place markedly in the case of iron, and only very slightly, if at all, with other metals, suggests, though it does not prove, that the action is in some way connected with the magnetized condition of the iron. Up to the present I have been unable to experiment with cobalt and nickel. Using nickel-plated brass, I did not succeed in getting any displacement of other metals from solutions by nickel in this condition. Experiments with these metals will of course be of special interest. If it can be shown that with them the same kind of action takes place as with iron, and that with non-magnetic metals it does not take place, the influence of magnetism directly on the chemical action would be practically demonstrated. The slight effects observed with other metals already described may possibly be attributed to the presence of small quantities of iron in the metals experimented upon.

Turning from the ridges of copper deposited on the iron, what is the cause of the space around the outline of each pole upon which no copper is deposited? It is sharply defined; and at the end of the operation it is bright, having remained entirely unaffected by the solution of copper sulphate. Here is evidently a region, not by any means inconsiderable, in which no chemical action has taken place. This can hardly be ascribed to the presence of currents in the liquid. The cause must, I think, be looked for in the magnetized condition of the iron; and I venture, though with misgivings, to suggest, that, the influence of the magnetism being most strongly felt in the iron at the outlines of the poles, these parts of the iron resist the action of the copper sulphate. We may imagine, that the molecules of iron in the regions immediately surrounding the poles are held more firmly than those which are less directly under the influence of the magnet, and that the interference with their motion protects them. Just as, in general, any cause which facilitates the motion of molecules facilitates chemical action, so, also, any cause which interferes with the motion of molecules would probably prevent chemical action either completely or partially. I recognize the crudeness of this suggestion. If there are any objections which can be raised against it, I shall be glad to be informed of them. In the mean time it may at least serve as a working hypothesis, and may lead eventually to a more satisfactory view. I intend to continue experiments on the subject under consideration. Unfortunately, the phenomena which can aid in the solution of the problem appear to be but few, and these do not readily lend themselves to quantitative treatment. The work will necessarily advance slowly, but I shall continue it as long as there appears to be any hope of getting results of value. IRA REMSEN.

ROTIFERA WITHOUT ROTARY ORGANS.

PROFESSOR JOSEPH LEIDY, in a paper recently published in the Proceedings of the Academy of natural sciences of Philadelphia, observes that the Rotifera, or wheel-animalcules, form a small class, abundant in kind, and found almost everywhere in association with algae and with infusorians to which they were formerly considered to belong. Later they were regarded as crustaceans, but now are looked upon as belonging to the group of worms. Their usual striking characteristic, the rotary disks, is not possessed by any well-marked crustacean. Among the Rotifera, however, there appear to be some which do not possess the rotary organs, and yet in all other respects conform in structure to ordinary forms.

Dujardin, Gosse, and Claparede have described rotifers which they regarded as destitute of rotary organs: but Cohn described one with these organs, otherwise resembling the form of Dujardin, and suspects that the latter made a mistake; and remarks that the existence of a rotifer without vibratile cilia would be an abnormal condition in the class. While the forms described by the three authors above named are open to the suspicion that they may possess rotary organs which were withdrawn at the time of