with its temperature. The resistance of the north-western and south-eastern districts of the plate will therefore be greater, and that of the north-eastern and south-western districts smaller, than before it was subjected to the stress; and an equipotential line through the centre of the plate, which would originally have been parallel to the west and east sides, will now be inclined to them, being apparently rotated in a counter-clockwise direction.

If the plate were of iron instead of copper, the Peltier effects would clearly be reversed, and the equipotential line would be rotated in the opposite direction.

The peculiar thermo-electric effects of copper and iron, discovered by Thomson, are thus seen to be sufficient to account for Hall's phenomenon in the case of those metals. It became exceedingly interesting to ascertain whether the above explanation admitted of general application; and the author therefore proceeded to repeat Thomson's experiments upon all the metals mentioned by Hall. The results are given in the following table, where those metals which in Hall's experiments behave like gold are distinguished as negative, and those which behave like iron as positive.

Metals.	Forms used.	Direction of current.	Hall's effect.
Copper	Wire and foil, pure.	S. to U.	Negative.
Iron	Wire and sheet, annealed.	U. to S.	Positive.
Brass	Wire, commercial.	S. to U.	Negative.
Zinc	Wire and foil.	U. to S.	Positive.
Nickel	Wire.	S. to U.	Negative.
Platinum	Wire and foil.	S. to U.	Negative.
Gold	Foil, purity 99.9 %.	S. to U.	Negative.
	Wire, commerc. pure.	U. to S.	
	Jeweller's 18-ct. wire and sheet.	S. to U.	
	Jeweller's 15-ct. sheet.	S. to U.	
Silver	Wire and foil.	S. to U.	Negative.
Aluminium	Wire and foil, pure.	U. to S.	Negative?
Cobalt	Rod, 8 mm. diameter.	U. to S.	Positive.
Magnesium	Ribbon.	S. to U.	Negative.
Tin	Foil.	S. to U.	Negative.
Lead	Foil (assay).	No current.	Nil.

S. means stretched. U. means unstretched.

It will be seen that in every case excepting that of aluminium, and one out of five specimens of gold, there is perfect correspondence between the direction of the thermo-electric current and the sign of Hall's effect. With regard to the aluminium, a piece of the foil was mounted on glass, and Hall's experiment performed with it. As was anticipated, the sign of the 'rotational coefficient' was found to be positive, like that of iron, zinc, and cobalt. Either, therefore, Mr. Hall fell into some error, or the aluminium with which he worked differed in some respect from that used by the author. The anomalous specimen of gold, being in the form of wire, could not be submitted to the same test: it probably contained some disturbing impurity.

[To the foregoing article, Dr. Hall has favored the editor of *Science* with the following reply.]

Mr. Bidwell's table is certainly very suggestive, but his 'explanation of the Hall phenomenon' cannot stand.

He makes this phenomenon to be an incidental result of the manner in which the metal strip is attached to the plate of glass. It is, he says, like a beam rigidly fastened at both ends, and weighted in the middle. Without discussing the closeness of this analogy, one can see, that if we fasten the strip by its middle, and leave it free at both ends, the conditions upon which Mr. Bidwell supposes the phenomenon to depend are quite changed.

After reading Mr. Bidwell's paper, I took a strip of soft steel, about one-tenth of a millimetre thick, and made the usual connections, but, instead of fastening the strip to glass with cement, so arranged it that it could at will be clamped across its middle or across the ends to a sheet of hard rubber. The end-clamps were about three centimetres apart, and the width of the magnetic poles between which the strip was placed was considerably greater than three centimetres. Now, when the strip was clamped across its middle and left free at the ends, and was made to conduct a current of electricity across the magnetic field, it was like a beam supported at the middle, and with a load distributed from end to end; but when the strip was clamped at its ends and left free in the middle, it was like a beam supported at both ends, and with a load distributed from end to end. Experiment shows that the effect is positive, as I have always found it in iron and steel, whether the strip be clamped in the middle, or at the ends.

There is one other consideration to be urged. Mr. Bidwell would, I suppose, account for the fact that the observed effect is proportional to the magnetic force by saying that the strain would be proportional to this force. But how will he explain the fact that the effect is nearly or quite proportional to the current, as was shown in my first paper upon the subject? Let us see what his theory leads to. Doubling the current, the magnetic force remaining unchanged, would double the strain. But a doubled strain, with a doubled current, would make the heating and cooling from the Peltier effect four times as great as before. This would deflect the equipotential lines four times as much as before; and, as these lines are only half as far apart as before, the transverse current would be eight times as great as before the direct current was doubled. The transverse effect, then, would be proportional, not to the current, but to the cube of the current. EDWIN H. HALL.

Cambridge.

THE CREVAUX EXPEDITION.

E. MILHÔME writes from Corumba, Sept. 24, 1883, to the Société de géographie in regard to the possible survivors of the Crevaux expedition. He believes that several survived for a time, but were afterward put to death by the savages. Information of any sort could hardly be obtained; as the Tobas had made ready for war, and retired to the interior, holding no further communication with the neutral tribes from whom the previous vague news had been derived by the whites. The Indian survivors, from their terror and sufferings, can afford little help. It is known that Branco, one of the party, in his capacity of soldier, was preserved alive by the natives to instruct them in the use of the fire-arms which they captured; and it is possible he may be still living, but, if so, has

probably been carried far into the interior. It is certain that the Tobas who massacred Crevaux's party are now provided with hatchets, knives, and Remington guns, which they have captured, partly from Crevaux, and partly from the Bolivian expedition of Col. Rivas. They are not, however, so formidable as might be supposed; since it seems their captive instructed them to aim in such a way as to render it almost impossible that any thing of a man's height should be hit by the ball; so that the guns are more terrifying than dangerous to their enemies. The second expedition sent under orders of Col. Fontana accomplished nothing. The third, organized by Col. Sola, and since commanded by Col. Hazetta, is at present penetrating the Chaco region, toward the banks of the Pilcomayo. Another better prepared Bolivian expedition was in contemplation under Col. Campu; but the writer, broken down by fever, was obliged to return to Corumba on his way to Buenos Ayres. He fears that all traces of the expedition of Crevaux are lost; that even their remains cannot be recovered, since the Tobas are in the habit of utilizing the bones as trophies or for religious purposes, so that they would be widely separated and unrecognizable. The vertebrae of the hated Christians are in special demand among the Toba women for use as rattles or rattling pendants worn during their dances. Altogether, the savagery of these Tobas seems to be more energetic than that of any other American aborigines. Milhôme has sent to Paris a complete collection of their arms, tools, instruments, and clothing, with an explanatory catalogue.

On the other hand, M. Paul Armand, in the Bulletin of the Marseilles society for December, without mentioning any date (but published before Milhôme's letter), says that the Argentine expedition to the Pilcomayo arrived safely in the early part of August, at the Bolivian town of Caiza, without the loss of a man, although having fought three battles with the Tobas. They ascended the Pilcomayo sixty leagues beyond the place where the Crevaux party was assassinated. The Bolivian congress has resolved that a colony named after Crevaux shall be established at that point, and that it shall be marked by a monument to the sufferers. Thouar arrived at Caiza on the 12th of July; having heard from some neutral Indians that two survivors, Haurat and Branco, were prisoners with the Choroti Indians of the Rio Abajo. He had had some communication with the Tobas, and obtained some relics, among other things a barometer which had belonged to Crevaux. He intended to leave Teyo about Aug. 10, and pass completely round the north Chaco, on the left bank of the Pilcomayo. In January it was stated to the Société de géographie that Thouar had arrived safely at Assuncion, and was about to embark for France, where he was expected before this time. Nothing further is said in regard to his search for Crevaux; but it is stated that the most important result of his voyage will be the opening of a practicable commercial route between Bolivia and Paraguay, giving opportunities for a reciprocal commerce now valued at twenty million dollars.

A NEW THEORY OF HEREDITY.

The law of heredity: a study of the cause of variation, and the origin of living organisms. By W. K. BROOKS. Baltimore, *Murphy*, 1883. 12+336 p., illustr. 16°.

JAEGER is quoted by Semper as saying that there has been enough Darwinist philosophizing, and that it is now time to subject the numerous hypotheses to the test of investigation. While this is undoubtedly true, some hypotheses are necessary; and even incomplete and erroneous ones may be of great service by offering a series of definite problems for solution, instead of a chaos of facts. "An honest attempt to reason from the phenomena of nature can hardly fail to result in the discovery of some little truth." This is the keynote of the book before us, which is therefore worthy of very careful consideration, however unsatisfactory it may prove to be as an explanation of the great problem of heredity.

The theory proposed in this book is a modification of Darwin's hypothesis of pangenesis, reconstructed with a view of avoiding the many difficulties in the way of that hypothesis. Brooks's theory, very briefly stated, is as follows. 1. The union of two sexual elements gives variability. 2. In all multicellular organisms the ovum and the male cell have gradually become specialized in different directions. 3. The ovum has acquired a very complex organization, and contains material particles of some kind corresponding to each of the hereditary species characteristics. 4. The ovarian ova of the offspring are the direct and unmodified descendants of the parent ovum. 5. Each cell in the body has the power of throwing off minute germs. During the evolution of the species, these cells have acquired distinctive functions adapted to the conditions under which they are placed. When the function of a cell is disturbed through a change in its environment, it throws off small particles, which are the germs or 'gemmules' of this particular cell. 6. These germs may be carried to all parts of the body, and penetrate to an ovum or to a bud; but the male cell has acquired a peculiar power to gather and store up germs. 7. When impregnation occurs, each gemmule impregnates that particle of the ovum which will give rise in the offspring to the cell corresponding to the one which produced the gemmule; or else it unites with a closely related particle, destined to produce a closely related cell. 8. In the body of the offspring this cell will be a hybrid, and tend to vary. 9. The ovarian ova of the offspring inherit the properties of the fertilized