librium. *Rest* is the opposite of motion; it is the state of matter in which the physical forces acting on it are in equilibrium; that is when the force impelling motion in a given direction is counteracted by an equivalent force impelling motion in the opposite direction; or is resisted by a superior force. A stone *rests* on the surface of the earth because the force of gravity acting on the stone is resisted by the force of cohesion in solid matter; but the force continues although there is no motion resulting from it. The stone *sinks* in water, that is, it moves from the force of gravitation because the force of cohesion in the molecules of water is insufficient to counteract the force impelling motion; but when the force of cohesion in the molecules is sufficiently increased by congellation, the stone *rests* on the surface of the ice. So a top spun rapidly *rests* on its peg, because the force giving it horizontal motion counteracts the pull of gravity which causes it to fall when the rotation ceases.

Dr. Mayer defines force as "Something which is expended in producing motion; and this something which is expended is to be looked upon as a cause equivalent to the effect, namely to the motion produced."[1]

This is obviously too narrow to include even dynamic energy. Two horses pulling a vehicle in opposite directions with the same force would produce no motion; divide the force by unhitching one of the horses, and the vehicle moves. Then, according to this definition, we have the absurdity that the whole force is nothing, but half of it is something.

A correct definition of phpsical force is that it is something producing the state of ponderable matter in which it is subject to human observation. Whether the state be one of motion or rest, hot or cold, solid, liquid, gaseous, colored, etc., it is the result of force. We only know physical force from its effects on ponderable matter, and we only know ponderable matter as affected by force.

The supposed difficulty in the concept of an element in nature entirely distinct from, but inseparably connected with, ponderable matter, is entirely factitious. Time and space are such elements, entirely distinct from, and inseparably related to, ponderable matter; and the concept of force as above defined is as absolute and imperative as the concept of time, the concept of space, or the concept of matter itself. The progress of science in tracing a force through its various manifestations, as has been done to some extent with gravity, confirms the primal concept of force which comes with the very dawn of intelligence.

The still more abstract concept of law by which any force is what it is, is also primal, absolute, and inevitable in every human intelligence.

Whether all ponderable matter is one as claimed by some philosophers, or whether all force is one as claimed by other philosophers, are speculations which, with our present knowledge of these elements, are idle if not mischievous.

It is undoubtedly from phenomena resulting from the apparent differences in ponderable matter, and the apparent differences in the forces acting on it, that real progress in unravelling nature has been made.

We need a specific name for this force of which molar motion, molecular motion, heat, and light, are manifestations. There seems to be no doubt that positive electricity is also one of its forms. Electricity, like heat, is developed by friction and by chemical reaction; and its mechanical equivalent, or, more accurately, the electric equivalent of molar motion, doubtless is the same as the heat equivalent of molar motion, or differs from it by some law which will prove the identity of the force. Dr. Mayer suggested that whether friction, which of course is resisted molar motion, developed heat or electricity, depended on the character of the substances used in the friction, homogeneous substances developing heat and heterogeneous substances electricity. There appears to be no essential difference in the chemical reactions which develop heat and those which develop electricity; the difference apparently being in the mode of applying the force or energy and the substances to which it is applied.

Electricity passes from dynamic to potential under not precisely the same conditions as heat, but not more essentially different than the conditions under which motion passes from dynamic to potential, and its dynamic power is exhausted in doing work. This feature of electrical energy has been utilized by Mr. Hodges in his new lightning-rod, constructed of copper ribbon, so arranged that the copper will be dissipated by the electric current.

But I must leave this branch of the subject to those better informed as to the phenomena.

There may be still other forces, or rather forms of force, which may be found to have equivalence and mutual convertibility with heat. It is equivalence and mutual convertibility which warrants the assumption that motion and heat are phenomena resulting from, or, more accurately, are manifestations of, the same force.

In speaking of the force itself, I have used the expression "force or energy" because these words have several meanings, and the sense in which they are synonymous comes nearer the expression of the concept sought to be presented than any other phrase that has occurred to me. But it would facilitate induction if we could call it "Ergic Force," or "Ergism," or give it some other specific designation to distinguish it from other forces, or force generally, including under the term "Ergism" every manifestation of force for which a heat equivalent may be found. This name seems appropriate because it suggests the element in nature which is the basis of work It enables us to grasp a concept of the force distinct from its manifestation in any one of its forms; and if the delimitation itself is correct we can class as "Antergic" the forces, like cohesion, which have no heat equivalent, but which, under certain conditions, render dynamic "Ergism" potential. DANIEL S. TROY.

[1] "Correlation and Conservation of Forces," D. Appleton & Co., 1890, p, 335.

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.*

On request in advance, one hundred copies of the number containing his communication will be furnished free to any correspondent.

The editor will be glad to publish any queries consonant with the character of the journal.

Further Notes on the Loup and Platte Rivers.

SEVERAL years since it was my privilege to spend several weeks studying the peculiar drainage of central Nebraska. I have therefore been much interested in the papers of Professors Hicks and Davis in recent numbers of *Science*. I trust I shall not be intruding if I call attention, at this time, to a few additional facts which seem to have a bearing on the discussion.

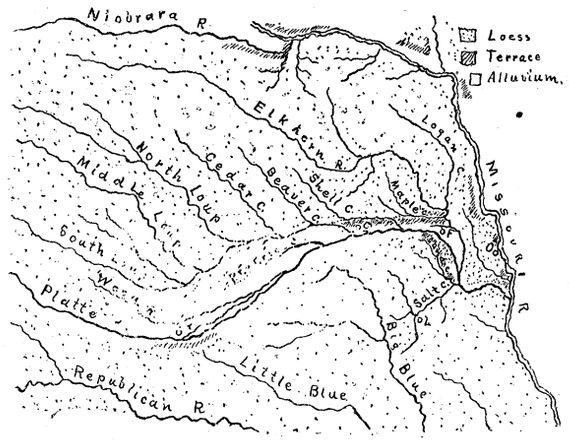
1. The streams north of the Platte, from Kearney to Fremont, have their courses first quite regularly south-east, then, as they near the Platte, they turn to the east-north-east, adopting the direction of that stream. Not only is this true of the Loup system, as Professor Hicks has well shown, but also of Shell Creek and Maple Creek further east.

2. There are dry channels, but little above the streams, connecting the Loup with Shell Creek, and Shell Creek with the Maple, which are known as Lost Creek and Dry Creek. These lie in the

same east-north-east direction, and are clearly analogous with the lower course of the Loup, where it connects its various branches. It seems not very improbable that the channel mentioned by Professor Hicks as connecting the South Loup with Wood River may be of the same sort.

3. The hills north of this compound channel, as it might be called, running parallel with the Platte, are of similar height and structure to those south of the Platte, but the hills south of the same channel are more than 100 feet lower, and of different structure. Both are capped with yellow loam of almost the same texture, but underneath the former have a well defined stratum of northern drift east of the meridian of Columbus, while the latter have but a faint trace of it mixed with deep stratified sand. These lower hills, moreover, are less eroded, and are evidently an alluvian terrace formed since the deposition of the older drift and the Loess. This terrace is seventy to ninety feet above the Platte, east of Columbus, and is more sandy and lower further west. The ancient north bank approaches the present Platte again, near Josselyn.

4. Corresponding in level to this high terrace, is an old channel crossing Saunders County along the valley of Sand Creek and in direct line with the upper course of the Maple. East of this is an area of higher land between it and the Platte, which has been recognized as an "ancient island." It may be added, also, that this high terrace seems to be easily correlated with a terrace of



Drainage Map of Eastern Nebraska.

similar height and structure, found at several points along the Missouri, which may be referred either to the "Second Glacial Epoch" or to the time of the second cluster of moraines of that epoch.

The subjoined map exhibits most of the points mentioned above, as well as some knowledge of the drainage, and indirectly of the topography of the surrounding region.

These facts point strongly to the efficiency of the second influence mentioned by Professor Hicks, viz., "Pliocene channel filling," as the principal and sufficient reason for the peculiar arrangement of the Loup channels, rather than a secondary influence. This has been already pointed out by Professor Davis. The Loups did formerly flow through to the Platte, but at a time when it or a portion of it occupied the north channel already described, and when it was flowing on a level seventy-five to a hundred feet higher, relatively, than at present, somewhat as it now occupies the channel north of Grand Island, and probably not long ago occupied a portion of Prairie Creek. The superabundant sediment, the shifting of the Platte to the south in obedience to Ferrel's law,— possibly reinforced by a tipping to the south, — and a deepening of its channel, which may have been partly due to a cutting through of a divide north of the "ancient island" into the lower channel of the Elkhorn, which, again, may have been accelerated by the recent eastward tipping of the region, are sufficient causes to explain the changes of the Platte, Loup, and associated streams since the disappearance of the waters which deposited the loess. The exceptional course of the Platte, however, from Kearney to Fremont, which we conceive was first taken about that time, remains unexplained. The causes which may be surmised are the following: 1. The position of a depression in the bottom of the Pliocene or Pleistocene lake, which may in some way have been produced by unequal deposition of its sediment, or the earlier unequal erosion or deposition of the subjacent formations whose strike here is approximately north-east. 2. A slight fold in the plains a little south of this course of the Platte. Of such no distinct trace has yet been found. There is a slight anticlinal axis crossing the Big Blue near Milford, but it is probably quite limited in extent. 3. This course may perhaps be a survival of a time when this region was tipped toward the north-east, because of the burden of ice which then rested upon Iowa, Minnesota, and eastern Dakota. This is but a conjecture, against which several objections arise, which it is needless to express.

In this connection, it may be helpful to call attention to a similar bend in the Arkansas in central Kansas, and to note that in each case the exceptional direction is upon more recent beds near, and parallel to their junction with, the upper Carboniferous. This may be a straw which would indicate that our first surmise may have some truth in it.

Concerning the efficiency of abstraction to change lines of superficial drainage, we may find considerable light from the study of this region. The remark of Professor Davis, that this rarely occurs where formations are nearly horizontal, seems well supported. Such is the slope of the country, and the porosity of the deposits, that the headwaters of the Big Blue rise a little below the level of the Platte adjacent, and the tributaries of Salt Creek rise below the level of the Big Blue near by, so that it is possible that water may leave the Platte between Kearney and Columbus, pass into the Blue, be drawn off into Salt Creek, and return to the Platte through the latter stream. And yet I know of no clear case of change of channel by abstraction in the whole region. The abundant sand, through the water flows underground, renders an open channel unnecessary. In fact, it may be argued that abundant sand tends to prevent the formation of superficial streams, unless there be first a velocity of flow sufficient to carry the sand easily, which cannot occur unless the flow is concentrated in some way. This is frequently noted in the sunken rivers of deserts. Possibly this may have had something to do with the exceptional course of the Platte before considered. Dunes form an important part of the divide between the Platte and the Little Blue south of Kearney.

One word further, regarding the comparative slopes of the Loup and Platte, to which Professor Hicks has called attention. Do we not find here examples of the law that declivity varies inversely as the quantity of water, as pointed out by Gilbert in his masterly paper on "Land Sculpture," in his report on the Henry Mountains? Although the Platte is much the more important river, by the time it has reached Kearney it is much reduced by evaporation and abstraction; then, because of its shutting off its tributaries by its abundant sediment, as before noticed, it is so reduced that it is often smaller than the Loup at their junction, even sometimes ceasing to flow above the surface, as I have been informed, while the Loup flows with a good current. On the other hand, the Loup is not so much exposed to evaporation, and has numerous tributaries, which having more frequently cut through the sand stratum, and on the lower side of its sloping basin, are more apt to be fed by springs than lose water by seepage.

J. E. TODD.

Tabor, Iowa, Feb. 29.

Estimates of Distance.

BESIDES the very interesting inferences drawn by Mr. Bostwick from his experiment (*Science*, Feb. 26, p. 118), one or two others should be suggested, in the hope that they may lead to some further investigation.

1. Is not an effect of fatigue shown in the eight or ten per cent by which the average observer's "mean deviation" from his own "average" is increased when the last ten of his thirty estimates are compared with the first ten? Should not this effect be greatest,— perhaps both appearing earliest and increasing most rapidly