cloud above, almost as soon as formed, the conditions necessary to its full development not existing.

In his excellent article on tornadoes, in the current number of the *Kansas City review of science*, Mr. John D. Parker speaks of the four characteristic motions of these meteors. These motions might be classified as horizontal and vertical. The horizontal motions are the linear, caused by the forward motion of the air-current governing the direction of the storm-cloud; second, the gyratory motion, caused, as above stated, by the mutual resistance of air-currents moving in different directions; third, the swaying motion, due partly to the varying pressure on different sides of the tunnel, and partly to the vertical or bounding motion of the tunnel. This latter motion would not have a very marked effect in producing the 'dentated edges' of the storm's path, if the tunnel-cloud were vertical instead of slanting. What causes the bounding motion it is difficult to say, but it certainly resembles electrical attraction and repulsion. This bounding movement was very marked in the tornado of April 18, 1869, which passed near this locality; but occurring, as it did, in the daytime, I could not distinguish the illumination of the lower part of the tunnel, which may sometimes be seen when these storms occur after dark, and which some think is due to electricity.

It is interesting to produce in miniature the horizontal motions of the tornado by the following simple experiment. When there is a good fire, let a small quantity of light, flaky ashes, or other light material, be sprinkled over the whole top of the cooking-stove. The heat forms quite a strong current, ascending mainly from the central parts toward the pipe. Cool currents flow in from all sides. Now, with the hand or a fan, produce local or opposing currents over the heated surface, and at once little tornadoes are developed, whirling the ashes several inches in the air. I have often produced them on both sides of the stove at the same time; those on the left moving as tornadoes in our latitude, and those on the right in the opposite direction. Now, are not the causes of the gyratory motion of the little whirlwinds on the stove, tiny as they are, the same in kind as those which produced the storms which devastated Marshfield, Grinnell, or Camanche? If this be answered in the affirmative, the rotation of the earth plays no direct part in causing the gyratory movement of this class of storms. Of course, the rotation of the earth causes the higher currents of air to move toward the north-east, instead of due north, as they pass from the equatorial to the arctic zone, and these currents determine the general linear movement of storms in our latitude; but this makes it proper to consider the gyratory motion an indirect result rather than a direct consequence.

S. A. MAXWELL.

Morrison, Ill., Oct. 9, 1883.

The chinch-bug in New York.

Why should Mr. Lintner conclude that the chinch-bug was brought to St. Lawrence county, N.Y., in a freight-car from the west? Harris corrects the erroneous idea that it is confined to the states south of 40° of latitude by demonstrating its occurrence in Illinois and Wisconsin, while Fitch's record of finding it in northern New York would justify us in assuming that it has always existed there, especially when we know that its range is much farther north. Packard found it on the top of the White Mountains; and it is to-day the most serious enemy that threatens the vast wheat-fields of Dakota. It seems to me more rational to consider this injurious manifestation in New York a result of undue increase of a species always there than to call it an invasion. Though we rarely hear of its injury in the Atlantic states, yet it is commonly met with where collecting is done near or in the ground, and in dry years is by far the most common Heteropter in grain and grass fields and dunes. This I know from personal experience, and have found it as far north as Boscawen, N.H.

Should it prove less susceptible to heavy and continued rains in New York than elsewhere, the fact will be remarkable. Such rains affect it most, however, in spring and early summer. My own interpretation of the interesting facts recorded by Mr. Lintner would be, that the species multiplied exceedingly during the very dry seasons of 1880 and 1881, and that the wet season, which it has so far braved (as it often does for a while in the west), will nevertheless tell on the hibernating bugs. In this view there is cause for encouragement rather than alarm. A careful survey would undoubtedly show, as Mr. Lintner suggests, that it exists in many places in the state where it has not yet been detected.

C. V. RILEY.

Washington, D.C., Oct. 24, 1883.

Unusual reversal of lines in the summit of a solar prominence.

On Oct. 17, between 3.45 and 4.30, local time (about 8.45 and 9.30 Greenwich time), a rather unusual phenomenon was observed at Princeton, in a prominence connected with the large and active group of spots which at that time was just passing off from the sun's disk.

The prominence had the very common form of a number of overlapping arches, with a sort of cap above them, or of a cloud connected by several curved stems to the chromosphere below. Its elevation was about 2′, and its extent along the sun's circumference a little less.

The peculiar features were the extreme brilliance of the cloud-cap at the summit of the prominence, and the perfect delineation of the form of this cloud in certain spectrum-lines, which ordinarily are reversed only at the base of the chromosphere; while, at the same time, certain other lines, which not unfrequently are reversed at considerable elevations, showed its form only very faintly, or not at all.

When I first came upon the prominence, in running around the sun's limb with the spectroscope, the brightness of the cloud-cap, as seen through the C line, was simply dazzling. I do not remember ever to have seen a prominence, or any part of one, quite so brilliant. At the same time, the line λ 6676.9 (which is in the same field of view with C, and is No. 2 of my catalogue of chromosphere-lines, — a line attributed to iron) also showed the top of the cloud quite as well and as brightly as is usual in C under ordinary circumstances. The chromosphere, also, was faintly visible in the same line; but the stems and lower portion of the cloud could not be seen at all in it. On turning to line λ 7055 (No. 1 of the catalogue), I was surprised and gratified to find the same appearances conspicuous in this line also. A careful search failed to show any other lines reversed below C.

Running up the spectrum from C to D, I could not find any lines showing the *top* of the prominence, though a considerable number were reversed in the chromosphere at its base. D_3, of course, showed the cloud-cap magnificently, but D_1 and D_2 only very faintly, though *distinctly* enough.

Between D and b the same remarks apply as between C and D. The corona-line, λ 5315.9, was reversed at the base of the prominence a little more brightly than in adjacent parts of the chromosphere, but not at all in the cloud-cap. The magnesium members of the *b* group showed the cloud faintly in the same way as the sodium-lines; but in b_3 the form was a little more conspicuous.

Between *b* and *F*, *two* lines (λ 5017.6 and 4923.1, both attributed to iron) showed the cloud-cap as beautifully as either of the two below *C*. Numerous other lines were reversed in the chromosphere, but none of them showed the upper parts of the prominence. *F* appeared much the same as D_3.

Between *F* and *G*, *five* lines were noted as showing the cap. The most refrangible of them was Lorenzoni's *f* (λ 4471.2): the other four I did not identify at the moment, being in haste to reach the violet portion of the spectrum, and intending to examine them later, — an intention I was not able to carry out, on account of the intervention of clouds.

The lines $H\gamma$ (λ 4340) and *h* were, of course, conspicuous, each showing the whole of the prominence. I expected that *H* and *K* would do the same, but was disappointed. They both exhibited the cloud-cap finely, but I could not make out in them either the stems of the prominence, or the spikes and knots of the chromosphere; and yet both the lines were well reversed, not only in the chromosphere, but also on the face of the sun itself, over all the faculous region surrounding the spots. The ultra-violet line above *K*, first observed here a few weeks ago, was not visible.

There was no considerable motion-displacement exhibited by any of the lines, — something rather singular in so brilliant a prominence, — nor did its shape change much during the forty-five minutes of observation.

It is perhaps possible that this cloud was indentical with a remarkably brilliant facular *bridge*, which was observed two days before, spanning the largest of the spots which composed the group: still this is by no means certain. The instrument employed was the nine and one-half inch equatorial, with the Clark spectroscope carrying a Rutherfurd grating, of about 17,000 lines to the inch; first-order spectrum.

C. A. YOUNG.

Princeton, N.J., Oct. 22, 1883.

Sternal processes in Gallinae.

Having several times been asked the function of the long processes of the sternum as found in the Gallinae, I would make the following suggestions: —

If the sternum be examined *in situ*, the outer processes will be seen to extend far back, and well up the sides of the body, while the inner pair extend over the abdomen. The notches between the processes are closed by very tense, fibrous membranes. By this means a large area is afforded for the insertion of muscles with a minimum of bone. This must contribute slightly to diminish the weight of the posterior end of the body. Passing now to the muscles, we find that the great pectoral arises from the entire posterior border of the sternum, while the subclavius fills up the angle between the keel and body of the bone.

So much for the anatomy. What are the physiological results, and why could they not be attained in other ways? The results are an increased amount of pectoral muscle, and an increase in the length of the fibres, as compared with many other birds. Both of these are very desirable results for heavy birds of short, rapid flight, — the first, because with the increase in muscle comes a corresponding increase of force in the stroke of the wing; the second, because, by virtue of the long fibres, rapidity of contraction and a long stroke of the wing are secured. The rapidity is gained by all parts of the fibres contracting at once, whence the longer the fibre, the more quickly will a given amount of motion result. Both the first and the second are also aided by the fact that the first part of a muscular contraction is more powerful than the last part.

There is but one other way in which the same results, so far as the insertion of the muscles goes, could be attained; that is, by their origin from the ribs which lie under the sternum, as in the mammals, instead of from the overlapping sternum. To this, however, there is an all-powerful objection. If a man be watched while violently using his arms, it will be noticed that the upper part of the chest is held stationary. The pectoral muscles must have a firm point to pull from, in order to move the arms. As a result, respiration in the upper part of the chest is impeded, or, better, respiration is impeded by the diminished amount of tidal air. This principle is illustrated in the long, slow stroke, about twenty to the minute, of men trained to row great distances. The breathing is done, while the pectoral muscles are relaxed, at the normal rates. The same, only in a much greater degree, would hold good for birds. Were the muscles inserted into the ribs, respiration would be interrupted several times each second during flight: hence it is evident that the muscles could not be inserted into the ribs.

But again: why should the Gallinae require rapid powerful motions of the wings? Why should they not have long wings, and a comparatively slow stroke? This is forbidden by their habits. Long wings would be very cumbersome when the bird was on the ground, and absolutely worthless in much of the brush through which a grouse will fly with wonderful rapidity.

Therefore we may say that the processes are developed to give, with the greatest economy of material, a large area for the insertion of the pectoral muscles in such way as not to interfere with respiration, and that such area is required for the flight of the bird.

J. AMORY JEFFRIES.

A bifurcate tentacle in Ilyanassa obsoleta.

Some years ago, when collecting for my marine aquarium, in Raritan Bay, at Keyport, N.J., I obtained an Ilyanassa obsoleta of such a strange form, that I made a pencil-sketch and notes of it at the time. The left tentacle was bifurcated at the shoulder, or place where the normal tentacle abruptly narrows. The two sub-tentacles thus caused, seemed to be equally sensitive, as each was capable of separate and independent movement. Several instances have been long known to me of bifurcation of the caudal spine of Limulus; but the additional prong in every instance was functionless, and, in fact, an inconvenience. I have also seen malformed antennae in microscopic insects. As I have not heard of a similar instance in the mollusca, it seemed to me that the case should go on record.

SAMUEL LOCKWOOD.

Freehold, N.J.

The mechanism of direction.

Shortly after reading Professor Newcomb's paper in SCIENCE for Oct. 26, 1883, I had the pleasure of meeting him, and of discussing some matters of mutual interest in regard to subjective states of consciousness. It seems to me that the professor does not give sufficient weight to habit, and to unconscious cerebral action. In the strict sense of the word, one is not always *conscious* of the way he is going; for although he may avoid obstacles of any kind, yet he may pass