thirteen tubers planted May 4, nine furnished plants, which bloomed July 12, and in September ripened a crop of tubers no larger than the seed planted, or of the size of small hazel-nuts. The leaves were small, deep grayish-green above, not hairy; the stems, much branched, deep purple at the nodes; the flowers, white and numerous. The tubers were very diffusely spread in the soil.

An analysis of the tubers harvested by the station chemist, Dr. S. M. Babcock, is as below: —

Water	64.44
Ash	1.17
Albuminoid (N. × 6.25)	4.86
Crude fibre	.78
Nitrogen (free extract)	28.62
Fat (ether extract)	.13
	100.00

E. LEWIS STURTEVANT, *Director*.

N. Y. agricultural experiment-station,
Geneva, N.Y., Nov. 14, 1883.

Musical sand.

In September (no. 31) you published a brief abstract of our preliminary paper on the singing-beach of Manchester, Mass. Since then we have continued our investigations, and collected additional data and material. One of us has just returned from a visit to the singing-beach on the west shore of Lake Champlain, four miles and a half south of Plattsburg, Clinton county, N.Y. This beach is about seven hundred feet long, crescent-shaped, and terminates at the south end in low cliffs of limestone, and at the north end in shelving rocks of the same material. About a hundred feet north of the beach the limestone is quarried for building-purposes.

The acoustic phenomena previously described in connection with Manchester and Eigg are reproduced at Lake Champlain quite perfectly. On the occasion of our visit, however, the sand retained traces of moisture, and the noise, indicated by the syllable *groosh*, was less strong than it would otherwise have been. Two tests, however, showed that the sound made by rubbing the sand with the hand, and pressing it on the strata below, could be heard distinctly at a distance of more than a hundred feet. The tingling sensation in the toes, produced by striking the sand with the feet, was also perceived. We failed, however, to obtain sounds by rubbing the sand between the palms of the hands, — a method which yielded remarkable results at Manchester and at Eigg; but this failure is doubtless due to the imperfect dryness of the sand. Having learned, by experience with samples from the aforesaid localities, that they lose their acoustic properties after repeated friction, we tested this question directly on the beach. We found, that, by rubbing a definite quantity of sand continuously, its power of emitting sounds gradually diminished, and finally ceased.

The sand is unusually fine, and its grains of remarkably uniform size, averaging about 0.2 millimetre in diameter. Even to the naked eye their tendency to a spherical shape is apparent; and, when examined under the microscope, they are found to consist, to the amount of about thirty per cent, of round and polished grains of colorless quartz, usually of spherical, ellipsoidal, and reniform shapes; about the same quantity of angular to subangular grains of the same mineral, colorless, reddish, and yellowish, sometimes enclosing scales of hematite, grains of magnetite, and fluid cavities; a considerable number of fragments of a triclinic felspar, angular to subangular, colorless, and sometimes exhibiting cleavage-planes, and lines of striation; many short fibres and fragments of hornblende, and apparently augite, of a deep green color, often irregularly colored reddish brown by decomposition, and possessing strong dichroism; and a few minute particles of menaccanite and magnetite.

In conclusion, we will be greatly obliged to any reader of SCIENCE for information of additional localities of sonorous sand, and especially for samples for microscopical study.

H. C. BOLTON and A. A. JULIEN.

Nov. 19, 1883.

November shower of meteors.

Watch was kept here for the November shower of meteors by myself and a number of students on the mornings of the 13th and 14th, — on the 13th from 2 to 4, on the 14th from 2 to 6. The observers were in a room having southern and eastern exposures, and meteoroids were looked for only in those directions. It was quite cloudy on the 13th, and only one meteoroid was seen; nearly clear on the 14th; and considering the fact that the moon was nearly full, and stars of the fourth magnitude could not be seen without attention, more meteoroids were seen than were expected, nearly all coming from the radiant in Leo. Owing to the fact that their appearance was not frequent enough to maintain constant attention, it is likely that most of those which were near the limits of visibility escaped observation. The maximum seemed to be at about 4.30. At 3.20 a very brilliant one, much exceeding Sirius in brilliancy, was seen.

Michigan agricultural college. L. G. CARPENTER.

SOME RECENT STUDIES ON IDEAS OF MOTION.

Studien über die bewegungs vorstellungen. Von Dr. S. STRICKER, professor in Wien. Wien, *Braumüller*, 1882. 6+72 p. 8°.

THESE studies are efforts in experimental psychology, with accompanying speculations, by a physiologist who has already written upon like subjects in his 'Studien über das bewusstsein.' The style is fragmentary, and not always very clear; and there are some confusing efforts to frame a new terminology. Above all, the author's training in general philosophy is very imperfect; and therefore what he says in the latter half of this essay, 'Ueber die quellen unserer vorstellungen von der causalität,' is almost wholly antiquated and insignificant, having been superseded ever since Hume, whom, in fact, our author seems in one respect to have wholly misapprehended. But in his direct observations of mental facts, Professor Stricker attracts one's attention as having given some independent contribution to the discussions about the relation of the muscular sense to our ideas of motion. Even here, it must be remarked, he pays little attention to the fact that others have been at work before him, and seems to think his ideas quite new. Yet what he has done is to observe, and record his observations; and in so far forth he has done what we want done in the psychological field.

Professor Stricker asserts that practice in the use of his muscles, and especially in the training of the muscular sense for mechanical purposes, has rendered him uncommonly well qualified to note the presence of muscular sensations as elements in any complex state of mind. Some of his colleagues have like skill. He has thus been led to pay attention to facts such as, that, when he perceives the movements of another person, or remembers these movements clearly afterwards, or deliberately imagines a movement of a man or even of an animal, he always is aware of a slight feeling of effort in those muscles of his own body that would be concerned in the same or in some analogous movement. The appreciation or conception of a bodily movement is thus accompanied by a more or less well-marked dramatic imitation of the movement. Again: if he perceives or conceives the visible motion of a body in space, he is conscious of a motion, or of a tendency to motion, in the muscles of the eye. These personal observations he finds confirmed by others in proportion to their training in introspection, and in the special observation of the muscular sensations. In watching the motions of many small objects at once in the field of vision, as in case of a snow-storm, the author is not quite so fortunate. "I find difficulty," he says, "in discovering any trace of motions of the eyes; yet, after long exercise, I have now no longer the least doubt that I follow the single flakes with small and quick motions or nascent motions of the eyes" (p. 23). In case, however, of an effort to picture in memory just how a snow-storm looks, the author either finds himself picturing a stationary mass of flakes, or else following in mind the motions of single flakes. In the latter case he discovers that the muscles of the eyes are perceptibly innervated. The result, therefore, notwithstanding the difficulty, is in the end the same.

In the case of the illusions of motion in the 'wheel of life,' the author asserts that the illusion is always accompanied by motions of the eyes, and that it is impossible without such motions.

His conclusion from all this is, that "motion is conceivable only in connection with, and by means of, the muscular sense," — a result that, in this extreme form, probably very few investigators will accept. Certainly Professor Stricker has not proved it; since he has, on the one hand, left very numerous facts wholly unnoticed, and, on the other hand, has adduced facts that are of doubtful force for his purpose. As for the omitted facts, a reviewer of this book in the *Philosophische monatshefte* has challenged Professor Stricker to show what part the muscular sense plays in the perception of the motion of an object seen double in indirect vision, when the eyes are fixed on some chosen point. Thus, if one's gaze is fixed directly in front on some bright point, or on one of the eyes of the observer's own face as seen in a mirror, so that the eyes are surely at rest, then the finger, or a pencil, held up so as to appear double, will yet in both its shadowy images be seen to move when the real finger is moved, or when the pencil is moved by an assistant without the observer's previous knowledge. Yet here, says the reviewer, the double images show that the eye does not follow the motion at all, else they would coalesce. And if the mirror is used, the observer, looking at his own eye in the mirror, can be doubly sure that his eyes are motionless. This objection, however, is not so near at hand as another, mentioned by the same reviewer, — the one that must at once occur to any reader of Professor Stricker's book; viz., the case of the motion of some small object over the skin, say a crawling insect. Here the motion is felt as motion, and not as mere tickling, as soon as the requisite speed and amplitude are attained. What has the muscular sense to do here?

But, obvious as these objections are, they are not final. Professor Stricker might reply, that, according to Lotze's own suggestion, the now well-recognized *localzeichen* themselves may be of the nature of muscular impulses. In the retinal field the tendency to bring any point of attention into the point of sight may exist universally; and the motion of the indirectly seen finger over the resting retinal field may be known by reason of the change in the magnitude and direction of the effort that during the experiment constantly exists, to bring the finger, as the object most attended to, into the point of sight. Something analogous may make possible the perception of the motion of a point on the skin. But these are hypotheses. They are doubtful; and they require of Professor Stricker supplementary investigations, whereof he seems to have had no thought.

There remain, however, the cases of what a late writer in the *Wiener sitzungsberichte* (Fleischl, *Optisch-physiol. notizen*, no. vi., in bd. lxxxvi., i., for 1882) has called *bewegungsnachbilder*, which have long been observed and discussed. These are the subjective appearances of motion in the visual field, after the continued observation of swiftly-moving real objects; as when one has been looking at a waterfall or at a rotating-disk. Helmholtz, indeed, explains all these appearances together as visual vertigo; putting them with the phenomena of apparent motion in dizziness, and regarding them as all alike caused by motions of the eyes, unconsciously continuing after the cessation of the observation of the objective motions. Yet Helmholtz has trouble to apply this explanation, whose validity in its own class of cases is undoubted, to the case where contrary motions appear in the field of vision at the same time; and Hering, in Hermann's 'Handbuch der physiologie' (iii., i., 562), insists for these cases on the rival explanation, "Die scheinbewegung beruht auf einer localen reaction des sehorganes gegen die vorangegangene erregung." Thus we should have true spectra of motion.

One may add, that the recent article by Drs. H. P. Bowditch and G. Stanley Hall in the *Journal of physiology*, vol. iii., p. 297 sqq., leaves no room to doubt that optical illusions of motion of this class do exist, that cannot be explained as resulting from visual vertigo, and that can properly be called *bewegungsnachbilder*, at least until we know more about them.

If, now, the explanation of Helmholtz is not sufficient for all cases, if there are any cases of true *bewegungsnachbilder*, then surely they cannot be brought in any wise under Professor Stricker's extreme theory without a simply appalling mass of hypotheses. Such cases are insisted upon by Fleischl in the note above cited; and he even notes the curiously contradictory character of the spectra of motion, — the presence in them of a motion, without any actual transferrence from place to place that the eye *can* follow. They excite him to the rather petulant outburst with which his note closes; viz., that *empfindungen* are fundamentally illogical, and that the principle of contradiction does not hold good for them, but only for their more developed relatives, the *vorstellungen*. Perhaps, however, our author will insist that it was of *vorstellungen* only that his studies treat, and that with such wicked and illogical *empfindungen* as Fleischl's *bewegungsnachbilder* he has nothing to do. Yet, if his theory is to be complete, he must not be allowed to shrink from its applications. What can he do with the own cousins of these illogical phenomena, namely, the chaotic sensations of the darkened visual field? Here is for some eyes, such as the present reviewer's, little more than motion or change, without any power of distinguishing what it is that moves. So it is with Mr. Galton ('Human faculty,' p. 159). Helmholtz himself describes, in his own case, motions of 'two systems of circular waves advancing towards their centres;' and so, of course, there must be for him, in the darkened field, motions at the same time in contrary directions, that cannot well be explained as the result of muscular efforts. A similar experience is described by Professor LeConte (in his book on 'Sight,' p. 72); and Purkinje's observations, as Helmholtz gives them, are also to this effect. In all these cases, then, we have motions — whether manifold and confused, or definite and regular — which, it would surely seem, cannot be explained as resulting from, or in any way implying, muscular sensations. These cases, then, lie wholly out of Professor Stricker's range.

Yet possibly it may not seem to most readers worth while to spend time in refuting the hasty generalization of our author. But the object here is to suggest both the necessary limitation and the possible scope of this theory of the ideas of motion. Its limited scope seems clear, but its very one-sidedness is instructive if we look a little closer. It is one-sided, for instance, in the inductive methods used. In case of the mental picture of the snow-storm, Professor Stricker found his theory in danger of failing: so he followed the single snow-flakes with the mind's eye; and lo! the theory is verified, and so throughout. The influence of attention upon the result is so plain, that the reader must have noticed the fact in reading our previous summary of the book; and yet this formal error in the reasoning does not make the result wholly erroneous. If one takes note in himself of the facts upon which such stress is laid by our author, one will very readily find that there is at least this in them; viz., every clearly conceived or perceived objective motion tends, just in proportion to the *clearness and definiteness* of perception or of conception, to become associated with a certain kind, degree, and direction, of muscular effort. That muscular efforts are involved in mapping out the visual field; that we follow every point in whose motion we take special interest, and are partially conscious of what we do in following it; and that analogous facts exist for the sense of touch, — are truths now generally recognized. Professor Stricker is interesting as having given us an independent, and, in so far forth, unprejudiced, contribution to the theory. That it has charmed him over-much is itself a fact of interest for the theory: for it shows how much clearer and better Professor Stricker seemed to himself to have conceived motions, when he had brought their conception into immediate connection with the facts of the muscular sense; that is, we see hereby how the muscular sense, used as the *measure of the amount of our activity*, is for that reason the especial means of helping us to build up definite ideas of complex facts. Motions we could know, it would seem, apart from the muscular sense; but we should have no such clear ideas as we have of the differences among motions. Even so it probably is with space. We should know of space if we were motionless; but we should not know of what Mr. Shadworth Hodgson calls figured space, — space mapped out as the mathematician needs to map it out. In fact, the connection of the muscular sense with the simple perception of movement, to form the complex perception of the definite character of the manifold differences between one movement and another, gives us an excellent illustration of that general law of mind according to which as many originally separate mental facts as possible are constantly being brought together, in order that, from their blending, a new and more definite unity may come. Increased complexity of data running side by side with increased simplicity of form, — this is the law of mental progress; and so the motions perceived by the pure sense of touch become definitely comparable with one another, and with the motions of the pure sense of sight, by means of the union of both with the data of the muscular sense, the whole thus forming the basis for higher rational mental processes.

Professor Stricker's facts are also useful as independent illustrations of certain other allied laws that have been elsewhere recognized. For instance: the tendency to join the conception of a motion with an imitation or nascent imitation of this motion has been before illustrated by the phenomena of hypnotism, by the gestures of sensitive and vivacious people, by the facts of so-called 'mind-reading,' and by many similar and very common experiences. Professor Stricker has attended more to these imitative tendencies than most people are accustomed to do, and has verified them subjectively for himself. Mr. Galton's 'histrionic associations' ('Human faculty,' p. 198) belong to the same group of facts.

Another law, however, is indirectly verified by Professor Stricker, as far as his observations go; and it may be well to mention this law here, because, so far as the present writer knows, little attention has been devoted to it by psychologists. It is the law formulated as an aesthetic principle in Lessing's 'Laocoön,' that moving objects, actions, events, can be properly described by the poet in language; while things that have to be spoken of as resting, and, in general, things that are coexistent, cannot successfully be represented by language. Still more generally stated as a practical principle of the rhetorician, the law is, that, to describe vividly, one must seize upon every element in the object that can be spoken of in terms of motion or action, and must either neglect or very briefly indicate whatever elements cannot so be interpreted. This principle explains one use of personifications, whether total or partial. The mountains rise into the sky, or lift their heads; the lake stretches out before one's sight; the tower looms up, or hangs over the spectator, — such are some of the more familiar devices of description. An exception that illustrates the rule is found in the case of very bright colors, whose interest and comparative brilliancy in the mental pictures of even very unimaginative persons may make it possible for the descriptive poet to name them as coexistent, without suggesting motion, particularly if he render them otherwise especially interesting. So in the well-known description, in Keats's 'St. Agnes' eve,' of the light from the stained-glass casement, as it falls on the praying Madeline. Even here, however, the light *falls*. And color-images, however brilliant, are increased in vividness by the addition of the suggestion of motion; as in Shelley's 'Ode to the west wind,' where

> "The leaves dead
> Are driven like ghosts from an enchanter fleeing,
> Yellow, and black, and pale, and hectic red,
> Pestilence stricken multitudes."

Much less effective would be the mention of the most brilliant autumn hues apart from motion.

Lessing gave as basis for this theory the somewhat abstract statement that language, being spoken or read successively, is best fitted to portray the successive. But this is hardly the whole story. The modern generalization that men and animals alike observe moving more easily than quiet objects, in case the motion is not too fast or too slow, seems to come nearer to offering an explanation. But this account is still incomplete; for it will be found that we do not always picture mentally the motion of an object, even when we try to do so. To see a man walk in the mind's eye is not always so easy as to picture a man in some attitude. Professor Stricker notes that his dreams seldom picture to him actual motions. In many dreams we must all have noticed that the rapid transitions that take place are rather known as motions or alterations that have happened, than as changes in process of taking place. The present writer's own image with Shelley's lines above quoted is not so much of dead leaves actually moving, as of the leaves rustling, with the sense or *feeling* that they are driven by the wind. The words descriptive of motion give, rather, the feeling of action connected with the leaves, than a picture of movement itself. So, to say that the mountains *rise* is to direct the mental eye upwards, rather than to introduce any picture of objective motion into the mental landscape. So, then, it seems probable, that, while we notice moving rather than resting things, our mental pictures tend to be representations of resting attitudes, rather than pictures of motion. And the greater vividness which descriptions of motion nevertheless possess would seem to be due to the sense of activity that they introduce into our ideas of the objects; and that this sense is connected with the muscular sensations that we are accustomed to associate with all clearly perceived motions seems both probable in itself, and in some wise confirmed by Professor Stricker's observations. The whole leads us, in fact, to another probable law of mental life; viz., that, since an animal's consciousness is especially useful as a means of directing his actions, the ideas of actions, however they are formed, will naturally be among the most prominent elements of the developed and definite consciousness. We need not make any assertion about the direct source of these ideas. Whether the active muscular sense is a direct consciousness of the outgoing current, or a true sense through the mediation of sensory nerves, the result will not affect either Professor Stricker's argument or our own suggestions.

In conclusion it may be well to say, that, if psychology were already a developed experimental science, such independent and hasty observations and generalizations as our author's would hardly be worth discussion. But as things are, even very imperfectly conducted observations, if they are direct and sincere, must be thankfully accepted. Something of the same sort may possibly hold good of the similarly hasty suggestions that have here been thrown together.

JOSIAH ROYCE.

WEEKLY SUMMARY OF THE PROGRESS OF SCIENCE.

MATHEMATICS.

Algebraical equations. — M. Walecki, in a note presented to the Académie des sciences by M. Hermite, gives a proof of a fundamental theorem in the theory of algebraical equations; viz., that every algebraical equation has a root. The theorem being evident for real coefficients, M. Walecki assumes the coefficients as imaginary, and writes the first member of the equation in the form $P + iQ$, and also makes $F(x) = P^2 + Q^2$. He considers first the case of an equation of odd degree, say p; then it is only necessary to prove that the equation $F(x) = 0$, of degree $2p$, has a root. To do this, he writes $x = y + z$, and distinguishes the odd part in z from the even part in the development of $F(y + z)$, writing thus: $F(x) = \phi(z^2) + z\psi(z^2)$. The resultant of ϕ and ψ is shown to be a real polynomial of odd degree in y, and vanishing for a real value of y. Two cases present themselves: viz., one of the functions ϕ or ψ may vanish identically; and this can only be ψ, for the coefficient of the term of highest degree in ϕ is not zero. Then, ϕ being of odd order, $F(x)$ has a real divisor of the second degree. The second case is when ψ is not identically zero, and when ϕ and ψ have a common divisor, $F(x)$ being then decomposed into the product of two factors. The author shows, then, that in either case a divisor of $F(x)$ is obtained of either the first or second degree, and with real coefficients; thus proving the proposition for an equation of odd order. A similar investigation is given for equations of even order. — (*Comptes rendus*, March 19.) T. C. [409

A differential equation. — M. l'abbé Aoust has here given a method for obtaining the formula giving the general integral of the differential equation —

$$x^n \frac{d^n y}{d x^n} + A_1 x^{n-1} \frac{d^{n-1} y}{d x^{n-1}} + \ldots + A_n y = F(x),$$

by aid of a certain multiple definite integral. The quantities $A_1, A_2 \ldots A_n$ are constants. He proposes first to solve the problem of finding a function, ϕ, in terms of another function, ψ; the two functions being connected by the relation —

$$\psi(x) = \int_0^1 d\,a_n \int_0^1 d\,a_{n-1} \ldots \int_0^1 d\,a_1 \phi\left(a_n^{\frac{1}{a_n}} \ldots a_1^{\frac{1}{a_1}} x\right).$$

The process for the reduction of this is by substituting successively z_1 for $a_1^{\frac{1}{a_1}} x$, z_2 for $a_2^{\frac{}{a_2}} z$, etc.; and finally the expression of ϕ in terms of ψ is obtained. The transition from the solution of this problem to the solution of the problem of finding the general integral of the given differential equation is then indicated, and the integral given in the form —

$$y = \Sigma_1^n M_i x^{a^i} + \frac{1}{a_1, a_2 \ldots a_n} \int_0^1 d\,a_n \int d\,a_{n-1} \ldots \int_0^1 F(a_n a_{n-1} \ldots a_1 x)\, d\,a_1.$$

The quantities $M_1, M_2 \ldots M_n$ are arbitrary constants, and a_1, etc., roots of a certain algebraical equation. — (*Comptes rendus*, March 19.) T. C. [410