The probability of an event is the value of the expectation of its occurrence existing in the mind of the thinker: "We must again warn the reader that probabilities are in his mind, not in the urn from which he draws" (De Morgan, "Enc. Met.," 414); but in the solution of these problems this subjective value is converted with startling ease into a much more objective and concrete expression. As Forbes puts it, "The doubt existing whether an event still future, which may happen in many different ways, shall occur in one particular way is not equivalent to an inherent improbability of its happening, or having happened, in that way"

We do not assume that a friend is speaking untruly when he tells us that, out of 10001 seats, the number of his ticket is 453, yet the antecedent probability is 1/10000 against the truth of his statement. The chances are greatly against ten stars out of 230 appearing as binary combinations; but, according to one view of the meaning of "random distribution," that arrangement is no more unlikely than any other, and we should be no more surprised to hear that one rather than another is the actual one. Forbes objects that "to assume that 'every star is as likely to be in one position as another,' is not the expression of the idea of random or lawless distribution." The expression seems to me to be true, but its interpretation into mathematical symbols has been far too closely restricted both by Michell and Forbes.

"Michell assumes that, with random distribution, the chance of finding a star in a space is proportional to the space, or that a perfectly uniform distribution would be that alone which would afford no evidence of causation."

Suppose the whole surface of the sphere cut up into minute equilateral triangles, and a star placed at each collection of angular points. Each star is the middle point of a regular hexagon, and at a distance, a, from six other stars. If we imagine the six stars to be fixed, and the central star shot out from the centre of the sphere so as to fall within the hexagon, that it may not fall within a distance, r, of any other star it must fall in a regular hexagon, the side of which is $(a - r)$ situated symmetrically within the larger hexagon. The probability of the star falling within this smaller hexagon is expressed by $\frac{(a-r)^2}{a^2}$, which becomes less and less the more nearly r equals a; that is, the more nearly the distribution is truly uniform. When $r = a$, the expression becomes 0, or the probability of exactly uniform distribution is *nil*, and apparently uniform distribution is due solely to the imperfections of our instruments. Michell, however, seems to assume this probability to be 1, or certainty. Struve's method is open to the grave objection that he assumes that the total possible number of binary combinations really occur. Applying his formula to calculate a value for n which makes the chance a certainty, we find that, if 2917 stars are scattered over the sphere, it is a certainty that each will be within 3′ 20″ of another! Of the three methods, that of Forbes seems to be the least open to objection.

Besides these fundamental difficulties in principle, there are several very doubtful points in the calculation which may be worthy of a brief notice.

Michell considered the whole surface of the sphere, though in his time the examination of the southern hemisphere was hardly complete enough to furnish the requisite data The stars do not lie on the surface of a sphere, but scattered through infinite space, so that two stars, the angular distance between which is apparently small, may in reality be very far apart. Suppose that the nearer star lies on the surface of our imaginary sphere, the probability that the direction of the other star is within 15° of the surface is only about one-fourth. Hence the number of apparently double stars must be reduced to a considerable but unknown extent.

Forbes throws considerable doubt on the correctness of raising a second time to the power n. Struve's multiplication by n's seems to prove very curious conclusions. Mr. Venn's reasons for dissenting from Michell's solution will be found well worthy of perusal ("Logic of Chance," p. 260).

SYDNEY LUPTON.

VEGETABLE RENNET.

THE idea that the protoplasm or living substance of both animals and plants is essentially similar, if not quite identical, has long been accepted by both physiologists and botanists. This similarity is most easily seen in the very lowest members of both kingdoms; in fact, for a very long time doubt existed in the case of many organisms—*e.g.* Volvox—as to which kingdom they should properly be included in. Even now it is hardly possible to formulate a definition of "plant" or "animal" which shall put all into their proper positions. When we go higher up the scale in both the animal and the vegetable world, this difficulty of course disappears, on account of the differences of organization and development. It is not difficult even here to trace a remarkable similarity of properties in the living substance, which leads to the conception that not only is protoplasm practically the same in animal and vegetable, but that its activities in the two cases that is, the metabolic processes which accompany, and are in a way the expression of, its life—are fundamentally the same. In both kingdoms we have as the sign of its life the continual building up of the living substance at the expense of the materials brought to it as food, and the constant breaking down of its substance with the consequent appearance of different organic bodies, which are strictly comparable in the two cases. The vegetable protoplasm produces starch, the animal glycogen—both carbohydrate bodies of similar composition and behaviour. In both organisms we meet with sugars of precisely similar character. The proteid bodies long known to exist in animals, and classed into albumins, globulins, albumoses, peptones, &c., have been found to be represented in vegetables by members of the same groups, differing but in minor points from themselves. We have fats of complex nature in the animal represented by oils of equal complexity in the vegetable, their fundamental composition being identical; even the curious body lecithin, so long known as a constituent of nervous tissue in the animal, having been procured from the simple yeast plant.

Further, the changes which give rise to these bodies, or which bring about various transformations of them, have been in very many cases demonstrated to be due to similar agencies at work in both the animal and vegetable organism In many cases, no doubt, they are produced by the actual splitting up of the protoplasm itself; but apart from this we have their formation in large quantities by the agency of bodies which are known as unorganized ferments, and which are secreted by the protoplasm for the purpose of such formation. Perhaps no line of research in vegetable physiology in recent years has been so productive of good results as the investigations that have been made into the occurrence of such bodies, and the comparison of them with those that are met with in the animal organism. Diastase in vegetables, and the ferments of saliva and of pancreatic juice in animals, possess the same power of converting starch into sugar. The peptic and tryptic ferments of the stomach and pancreas respectively have been shown to have representatives in the vegetable kingdom, and these not only in such cases as the carnivorous plants, but to be actually made use of in such truly vegetable metabolism as the processes involved in the germination of the seed. The conversion of albumins and other indiffusible proteids into a further stage than that of diffusible peptone—

that of leucin in the animal, and asparagin in the vegetable—has been shown to be the work of such a ferment in the two cases. These ferments, too, are interchangeable to a certain extent, for those of the alimentary canal are capable of digesting the proteids of vegetable bodies, while those of the latter can similarly split up the animal albumins, fibrin, and other forms of proteid.

The essential similarity of the metabolism is also indicated by the appearance in the two cases of complex bodies of somewhat similar constitution which are quite comparable with each other. In the vegetable kingdom these bodies are known as alkaloids; in the animal they have for the past ten years or more been known as ptomaïnes. They are among the products of the destructive decomposition of proteids. Thus *cadaverin*, a body found in putrefying animal matter, is apparently to be looked upon as belonging to the same group of bodies as *muscarin*, the poisonous principle found in several species of mushroom.

Perhaps the latest development of the same idea has been the discovery of ferments in the vegetable kingdom which are comparable in their action with the rennet which is obtainable from the stomach of many young animals, particularly the calf. In an extract of such a stomach taken while secretion of gastric juice is proceeding, or in the gastric juice itself, is a principle which has the power of curdling milk—a property taken advantage of by the farmer in the process of manufacturing cheese. The *casein*, which is the proteid concerned in cheese-making, is, under appropriate conditions, converted by this body into an insoluble form, which, for want of a better name, may be called briefly cheese. The conversion is not to be confused with the loose curdling which takes place when milk becomes sour from putrefactive changes or from the addition of an acid, for it is a true coagulation, resembling the clotting of blood. Now, recent investigations show us that in many plants a similar ferment exists, which possesses an identical power, producing, when added to milk, a clot which is quite indistinguishable from that which is formed under the action of animal rennet. The list of such plants is continually increasing, but they do not appear to be grouped at all on the lines of the recognized natural orders. Ranunculaceæ, Solanaceæ, Cucurbitaceæ, Compositæ, Galiaceæ, and others, furnish us with conspicuous examples.

At a meeting of the Society of Natural Science of Stockholm, held about four years ago, the Secretary brought before the notice of the meeting the fact that the common butterwort (*Pinguicula vulgaris*) possessed the very curious property of causing a clotting of milk when the vessels in which the milk was contained had been first rubbed over with the plant. No explanation was offered of the phenomenon, but a suggestion was made that the power might be due to the presence of micro-organisms. Judging from analogy with other plants since discovered to possess the same property, it is far more likely to be due to a specific unorganized ferment. The occurrence of this in Pinguicula is very significant, as bearing on the similarity of the metabolism in animals and vegetables, for Pinguicula is one of the carnivorous plants, digesting, by the aid of its secretions, flies which it captures in its leaves. We have so associated in the same plant a proteolytic and a rennet ferment, a condition which at once recalls the gastric juice of animals, in which both these bodies are present.

One of the most interesting of the plants which contain this ferment, or vegetable rennet, is the so-called "Naras" of the West Coast of Africa (*Acanthosicyos horrida*), a species of Cucurbitaceæ. The plant was described in detail by Welwitsch, in 1869, when its peculiar physiological property was unknown. A more detailed description, given by Marloth, has recently appeared, which deals, among other points, with this power. The plant is to be met with in dry, sandy, and desert places in Namaqua Land, Whale Bay, and the Mozambique district. It is very singular in its habit and appearance, consisting of long, spiny, weak-looking branches running almost on the surface of the sand, and being at intervals buried therein and again emerging. The stem is very short, so that the plant looks like a system of creeping spiny branches, some of which measure 20 feet or more in length. The root system is similarly developed, long creeping roots penetrating, in some cases, for a distance of 100 feet through the sand. The long spiny branches seem destitute of leaves, for these are quickly deciduous and sometimes abortive, and while they remain upon the shoots they are closely adpressed to them, and are stiff and horny in texture. At the base of each leaf are two strong spines, which persist after the leaf has fallen. The flowers are borne in the axils of the leaves, between the spines. The male and female flowers are found on separate plants; the former are sessile, the latter shortly stalked. The ripe fruit is of considerable size, much like an orange in appearance. It has a very powerful and pleasant aroma, and its pulp is very juicy and agreeable to the taste. In the unripe condition it is bitter and uneatable. According to Marloth, the natives eat it to a very great excess, both fresh and in the form of "Naras cake," a preparation of it made by drying the expressed pulp and juice in the sun. The power to appreciate its excellence seems to be confined to the natives of the part, for strangers partaking of it for the first time are said to pass through strange and painful experiences after their banquet.

Its power of causing the clotting of milk is well known among the natives of the part, who use it freely for that purpose. The ferment is contained in considerable quantity in the juice, the pulp, and the rind of the fruit. It is absent from the branches, from the seeds, and from all parts of the unripe fruit. It is soluble, according to Marloth, in alcohol of 60 per cent. strength, an extract of the pulp made with that fluid retaining the power to coagulate the milk. It is not identical with the principle which gives the fragrance to the ripe fruit, nor to that which gives the bitter taste to it when still young. The ferment is destroyed by boiling, but will remain for an almost indefinite time in the dried rind. Marloth, in his experiments, found that an extract of pulp dried to a friable condition in the sun was quite active in causing coagulation. The writer had the opportunity recently of examining some dried rind and some old seeds.[1] An extract of these materials, made with 5 per cent. solution of common salt, showed the ferment in abundance in the rind, but absent from both the testa and the interior of the seeds.

Another plant, occurring nearer home, has the same property. This is the common yellow Galium (*G. verum*). In his "Popular Names of British Plants," Prior speaks of its peculiarity as being known in the sixteenth century, when Matthioli wrote of it, "Galium inde nomen sortitum est suum quod lac coagulet." In the West of England, particularly Somersetshire and Herefordshire, it is still the custom of dairymen to put this plant into the milk they have devoted to cheese production, to "set" it. The plant has a long straggling stem, bearing at short intervals whorls of small leaves, in the axils of which are numerous panicles of yellow flowers. The practice is to put the whole plant, or as much of it as is above ground, into the milk, but the active principle seems to be located in the flowers. The white Galium (*G. Aparine*) is said to be devoid of the property.

The common traveller's joy (*Clematis Vitalba*) is another instance of the occurrence of this ferment. It is peculiar in one respect, the property appearing to be

[1] This material was kindly furnished by Mr. W. Thiselton Dyer, F.R.S., Director of the Royal Gardens, Kew.

situated in the tissue of the stem, probably the soft bast. In most other cases it seems to be attached somehow to the reproductive parts of the plant. The quantity that can be extracted from Clematis is, however, much less than from the other plants spoken of.

The ferment has also been found in the petals of the artichoke (*Cynara Scolymus*).

An account of the occurrence of this vegetable rennet would not be complete without its including the researches of Dr. Sheridan Lea on *Withania coagulans* (Proceedings of the Royal Society, 1883). These have, besides their scientific value, a direct bearing upon the commercial aspect of the question. Many of the natives of India refuse to have anything to do with cheese prepared by means of animal rennet, and there is consequently there a large field for the employment of the plant. Some years ago Surgeon-Major Aitchison sent home an account of the peculiar property of the Withania. The shrub grows freely in Afghanistan and Northern India, and the natives there have for a long time employed an aqueous extract of the capsules to curdle their milk. Some dried material sent from thence to Kew was used by Dr. Lea in his investigations. Withania is a genus of the order Solanaceæ, and has a capsular fruit, containing a large number of small seeds. In the dried material these seeds were enveloped in a coating of a peculiar resinous matter, which was probably the dried juice of the capsules in which they had ripened. The ferment was found to exist to a very slight amount in the stalks of the fruits, and to be extremely abundant in the seeds. From the ground seeds it could be extracted easily by maceration with solution of common salt and by treatment with glycerine. So extracted, it was found to be destroyed on boiling, but to be able to withstand moderately prolonged exposure to alcohol. Its activity in a fairly strong extract was quite equal to that of most commercial samples of rennet prepared from the stomach. It could, moreover, be kept with as great security as the latter by the aid of common salt and a little alcohol. Its commercial value is somewhat interfered with by the presence in the seeds, and in their extracts, of a peculiar yellowish-brown colouring-matter, which cannot be separated without destroying the rennet.

Since the publication of Dr. Lea's researches the writer has met with the ferment in the unripe seeds of *Datura Stramonium*, a plant belonging to the same order, Solanaceæ. In this plant, though present in the unripe seeds, it appears to be absent from them when ripe. Its exact distribution is, however, not yet determined.

The occurrence of this property in so many plants, and these not at all closely connected in other ways, leads to the consideration of what must be its physiological significance. It is perhaps not difficult to see why rennet should occur in the stomachs of young animals whose food consists chiefly of milk, but its importance in the vegetable kingdom must be independent of such a function. Further researches, still in progress, may perhaps throw some light upon this point. It is significant so far to notice that its occurrence is mainly in those parts which are especially connected with the reproduction of the plant, a fact which seems to point to a possible function in connection with the storage of proteid food materials for the nutrition of the embryo during germination.

J. R. GREEN.

THE METEORIC SEASON.

WE have now arrived at a period of the year which is full of interest to meteoric observers. The number of meteors visible has greatly increased, as compared with preceding months, and apart from this, observations may be pursued without the discomfort and inconvenience so often experienced on the cold starlight nights of autumn and winter. The impending return of two rich showers is an additional incentive to those who may contemplate giving a little time to this interesting branch of astronomy.

From observations at Bristol on the nights of July 8, 11, and 12 last, it appears certain that the *Perseids* (which attain a maximum on August 10, when the radiant is at $45° + 57°$) had already commenced. On July 8 twenty-five meteors were counted between 11h. and 13h. 30m., and these included six paths which denoted a well-defined radiant at the point $3° + 49°$, a little south of Cassiopeia's Chair. The visible traits of the individual meteors traced from this radiant were identical with those exhibited by the *Perseids* which are displayed in August, and the fact that this radiant seen on July 8 is far west of the radiant usually remarked on August 10, does not negative the presumed identity of the two showers. The *Perseid* radiant which endures a considerable time, changes its position amongst the stars from night to night, and the extent and direction of this displacement will be seen by a reference to NATURE vol. xxxvi. p. 407, where I have described a number of observations secured at this station in July and August of last year.

When the moon leaves the evening sky towards the close of the present month, observers should watch for the reappearance of the *Aquarids* which are usually seen in marked abundance about July 27, 28, and 29. The radiant is near δ Aquarii, and the meteors are rather slow, usually ascending from low in the south-east, and the brighter ones throw off trains of sparks. Early *Perseids* are also numerous at the end of July, and the radiant is then closely south of the well-known star cluster χ Persei. Observers should register the paths of the meteors and determine the precise place of the radiant on each night of observation.

Bristol, July 13. W. F. DENNING.

NOTES.

THE proposal that a Professorship for the exposition of the Darwinian theory should be established in connection with the Sorbonne has received the sanction of the Sorbonne authorities. Three members of the Committee by which the matter was decided were opposed to the scheme, but they did not vote against it. They simply refrained from voting. The Sorbonne has asked that the name of the proposed chair shall be changed. One or other of the three words, "evolution," "morphology," "phylogeny," is to be substituted for "philosophy."

THE Birmingham meeting of the Photographic Convention of the United Kingdom will be held from the 23rd to the 28th of July. A programme of excursions and local arrangements has been issued. The Convention will be opened on the evening of the 23rd inst., by the Mayor of Birmingham, at a *conversazione* to be held in the Masonic Hall in connection with an exhibition of photographs and photo-apparatus.

ON Thursday, the 12th inst., the anniversary meeting of the Sanitary Institution of Great Britain was held in the theatre of the Royal Institution. The Chairman, Mr. Edwin Chadwick, in opening the proceedings, claimed credit for the Sanitary Institution of Great Britain and like institutions for a large proportion of the reduced death-rate of the metropolis, which was now 14 in 1000. London in that respect compared very favourably with other places, the death-rate in Paris being 27, Vienna 30, and St. Petersburg 40. The medals and certificates awarded to the exhibitors at the Sanitary Exhibition held at Bolton in 1887 having been distributed by Mr. Chadwick, Dr. B. W. Richardson delivered an address on "The Storage of Life as a Sanitary Study." He began by referring to instances of long life in lower animals and in man. These, he said, by