

A lecture on cell-biography and raphides in relation to systematic botany.

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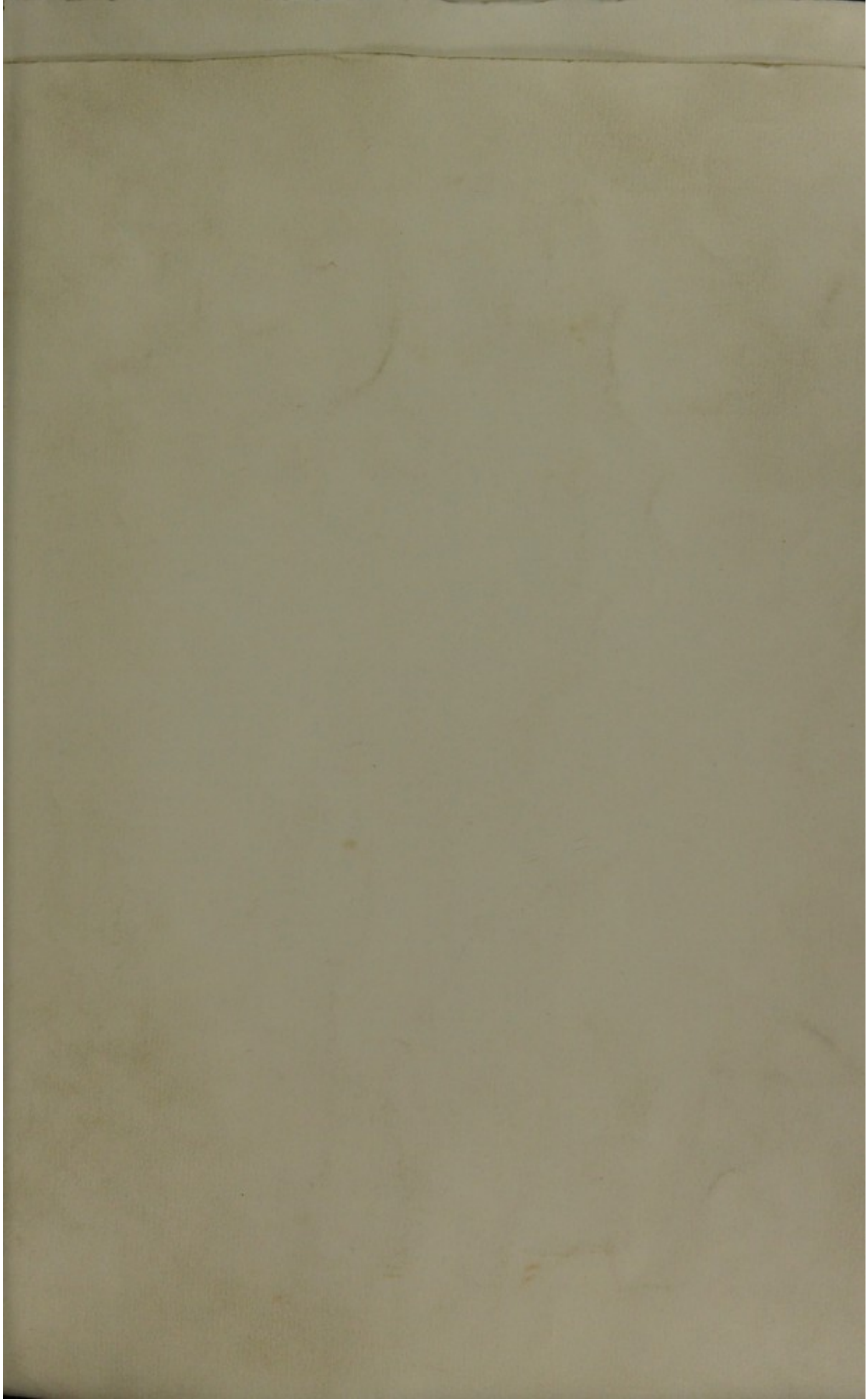
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SIXTH MEETING.

Canterbury, October 20, 1868.

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The usual monthly meeting of the above Society was held in the Library of the Working Men's Institute, Canterbury, on Tuesday evening last, when G. Gulliver, Esq., F.R.S., delivered a very interesting and instructive lecture on "Cell-biography, in relation to Systematic Botany." Colonel Horsley presided, and there were also present Colonel Cox and family, Rev. W. Blissard, J S. Lipscomb, G. Rigden, A. B. Andrews and S. Harvey, Esqrs., and many lady friends and patrons.

The CHAIRMAN congratulated the Society upon the acquisition of Dr. Gulliver as a member, and expressed the gratitude they must feel at that gentleman's kindness in coming forward to instruct them on the present occasion. He concluded by introducing to the meeting

Mr. GULLIVER, who, after the applause which greeted his appearance had subsided, said:—Ladies and gentlemen, —Responding to the request of our respected president, I proceed to offer a few observations, to be followed by some simple practical demonstrations, in order to show how

easily and pleasantly an important branch of phytology might be cultivated by many of our members, and even by ladies, whose taste may incline to this science. Indeed, it seems to me that, instead of rambling among the miscellaneous wonders of the microscope, every possessor of that instrument should endeavour to employ it in some of the many methods likely to be at once useful and instructive, and that pointing out any path to this end, how to pursue it and find the subjects, are among the legitimate objects of this society. There are, moreover, certain chains of scientific inquiry which can only be completely followed and the missing links cleared by the co-operation of a large number of independent observers, and without which we are never likely to acquire sufficient materials for an accurate and conclusive judgment. And this is eminently the case as regards the subject to which I have now to solicit your attention.

A long pursuit of minute anatomy has led me to the belief that the next great step towards a truly natural system of classification of the products of organized nature will be in this direction. In the anatomy of animals, the observations of John Quekett, Alexander Nasmyth, Mr. Tomes, and Professor Beale, are to this effect; years have rolled away since I proved the immense importance of a certain part of this branch of knowledge in systematic zoology; and my subsequent researches have shown a like value of the same line of inquiry in systematic botany.

And in this point of view we come to the Cell-biography of Plants, on which subject it is now proposed to give an account of the results of some of my own researches, and of the means by which those results were obtained; so that any botanist, even with the most slender information of phytotomy, may easily ascertain the value of the leading phenomena. To me, they appear quite sufficient to prove that, until the cell-life of plants has been more carefully studied, and the facts generally realized by botanists, we shall never arrive at a full and satisfactory knowledge

of botanical science. Those learned men will all grant that the most fundamental and universal elementary organ of vegetables is a cell; and that the entire life of a plant is the sum of the life of its constituent cells. How then can we avoid the conviction that the organs of this life must possess a correlative importance in taxonomy? And how is the investigation of this subject to be prosecuted without a careful attention to the phenomena of this life? Surely we shall never be able to comprehend and realize the mysterious plans of Nature, and those infinite details by which she has marked, for our interpretation, the true affinities and contrasts of the members of her system in the vegetable kingdom, unless we use every diligence in our attempts to read her own characters. And how are we to do this without a recognition of the phenomena of the cell-life as part and parcel of the natural history of every plant? And though we have this evening to treat of a very small fragment of this great argument, it is a portion which has been strangely overlooked; and this chiefly from a lamentable neglect by systematists, admirable as their labours have generally been, of the cell-biography of species. This neglect is the more remarkable, as the cell-characters are not only eminently natural, but in some instances, to be shown presently, afford the most fundamental and universal single diagnostic between allied orders, and even lower subdivisions.

Good use, no doubt, has long since been made of the intimate structure, including cells, of course, for the great or primary divisions of the vegetable kingdom, such as Cellulares and Vasculares, in systematic works. But let any one refer to those works for the diagnostic characters of some of our most familiar British plants, such as members of the orders Onagraceæ, Galiaceæ, and Balsaminaceæ, or the species of the genera *Ranunculus*, *Lotus*, *Juncus*, *Hymenophyllum*, and many others, when he will not find a single hint of the cell-diagnostics by which, as will be shown this evening, these orders or species may be at once distinguished from

their allies. You are left to the recognized and orthodox characters ; and as these, for ordinal purposes, are commonly founded on the flowers and fruit, to the chance of finding such parts present for your purpose ; while the fact of remarkably natural characteristics in such cases being really afforded by that inmost structure, to be noticed immediately, never seems to have been dreamt of by the author of any Flora or other systematic book, native or foreign.

Let us turn then a little from such books to the book of Nature—for she is ever true and delightful, and, as one of her own poets sings, “Never did betray the heart that loved her”—when we shall find that she has stamped a cell-character on certain orders by which they may at any season, at any period of growth, even in the seed-leaves, and in truth from the cradle to the grave of the species, be plainly distinguished from the nearest allied orders. And this simply by remarkable cells abounding in raphides ; the raphides being beautiful needle-like crystals, composed either of phosphate or oxalate of lime ; yet not mere crystals, as they form part and parcel of a delicate organism — the raphis-cell. This cell will be found so diffused throughout the frame of the plant that a mere fragment of that plant will be sufficient for the diagnosis. Again, certain closely allied species in some lower flowering plants may be distinguished in like manner ; and several high Exogens and some Endogens may be known by their pollen-grains, epidermoid and other cells, and certain Ferns by the tissue-cells of their fronds and spore-cases. Indeed, the extent, distinctness, and value of such truly natural characters are probably far greater than we suppose ; and, as the subject is new, it seems proper to specify the means by which it was investigated.

Adopting, then, Lord Bacon’s recommendation to review our knowledge and transplant it into the minds of others as it grew in our own, let us see how the importance of cell-characters as diagnostic of orders or species became evident to me. During many years I had been

making dissections under the microscope, and notes of the results, of every plant collected in my rural excursions. These researches were undertaken mainly for the purpose of comparing the intimate structure of plants and animals; and the discovery of the value of this structure in systematic botany was quite an incidental and unexpected result.

My own observations had not been long prosecuted when several examples were found that seemed to justify the truth of Schleiden's remark as to how little hope there is, without a study of the fundamental principles of development, of much further aid to systematic botany from mere anatomy. But, when a large mass of my notes has been collated, it plainly appeared that the mature structure and function of the plant-cells would be far more useful in this way than was supposed by the eminent German botanist. Thus, for example, no single instance of any species belonging to the orders Onagraceæ, Galiaceæ, and Balsaminaceæ was without a note of the presence of raphidian cells. And, conversely, a single order, *e.g.*, Hydrocharidaceæ, in which these cells were never seen at all, would be surrounded by its allied orders in which raphidian cells always appeared abundantly. The cells of the pollen, epidermis, pith, and of many tissues of various other orders of plants, were also found to give constant and diagnostic characters. Thus it was that this subject forced itself on my attention; and, afterwards, numberless experimental trials satisfied me that the raphidian form of cell-life is, in particular, an essential and intrinsic, a distinct and truly characteristic, phenomenon throughout the life of the plants exhibiting it, and withal clearly a sure and constant result of that life; while the same character is as certainly wanting in the species of allied orders. These raphidian cells were proved to be present in the ovule, in the seed-leaves, and thenceforth throughout the succeeding leaves and a large part of the intertexture of the frame of the species of several orders, some of which have been just specified.

And, independently of the interest of the subject in abstract botanical science, I have often found this cell-character useful practically. Thus, in little accidental embarrassments or disarrangements of the garden and seed-frame, I have been able very easily, and with surprising certainty and novelty, to pick out, simply by this diagnostic, all the seedlings of exotic Onagraceæ, now so generally cultivated and admired, from seedlings of other orders; and seedlings of Mesembryaceæ, which had been sown in pots, and got into perplexing confusion with other pots of seedling Crassulaceæ—both orders of succulent flowering plants—were as surely and quickly distinguished in like manner. This kind of practical diagnosis also proved equally good and convenient in plants at every period of their existence, and even shapeless fragments of their dead and rotting stems were thus plainly distinguishable. For example, a reserve bed, in which had been planted, and intended for removal when required, a Willow-herb, various Evening Primroses, Phloxes, Campions, and Rockets, had got into troublesome confusion, when nothing was easier than to pick out all the Onagraceæ solely by this raphidian character in the roots, subterranean buds, and dead and rotten leaves or stems, and at a time before growth had revived in the winter and early spring. Only there was an abundance of raphidian cells, beautifully marked in the tissue of the root and under-grown stems of another plant in that bed, and certainly neither a Willow-herb, an Evening Primrose, nor any other ‘Onagrad.’ Here then was a puzzle; some perplexing exception? Not at all. For after it had been put into a pot, and grown there for further observation, this questionable plant turned out to be a fine specimen of Woodruff, a species belonging to that very order, Galiaceæ, which I had already shown to be characterised by these raphidian cells. Thus plants may be known by their inmost structure; and for that reason by characters most eminently natural, but which use of them is yet either unknown to, or neglected by, all systematic writers; since in their works you will look in vain

for these diagnostics, or, indeed, for any other that would be available in such cases.

Other similarly instructive examples might be indefinitely multiplied, but it is better to indicate the way by which they may be easily found and realised ; to show how a fertile field, hitherto left barren, may be cultivated with such pleasure and profit as to afford a source of rational amusement and information to persons in the country ; to point out another and refined addition to rural pursuits, and one by which a reasonable hope may be entertained, even by inexperienced and unskilful observers, of enlarging the bounds of botanical science.

And this is not the only value of such pursuits. In themselves they afford a precious reward. They beguile the dull routine of professional and other employments, take us out of what Milton too truly called "the troubled sea of noises and hoarse disputes," cherish gentle thoughts and calm desires, and multiply and refine our enjoyments ; thus endearing many a rural walk with delightful associations of

. "Each lane, and every alley green,
Dingle or bushy dell,
And every bosky bourn from side to side."

Such studies, too, may soften affliction ; they must convey meek and touching lessons of the means of happiness so bountifully spread around us, and of how cheaply some of our best pleasures may be purchased. But, above all, while thus teaching us to look for the good and the beautiful in surrounding objects, and helping us to the true riches of contentment and thankfulness—those large and best possessions—incline our minds to the grateful habit of "looking through nature up to nature's God."

Another recommendation of the study of this department of cell-biography is that the subjects are ever at hand. And hence, in reply to frequent questions about collections and preparations, I have constantly referred to Nature's own collection, always at our disposal, and the very best after all ; and there, with certainty, we may find

many treasures, and employment of idle time, then not idly spent. In fact, the chief purpose of the present observations is to show how she invites us gratuitously, how the visit may be paid with little trouble and much profit, and how even this lowly study of the cell-life of plants may be made at once subservient to science and to some of our best enjoyments.

To this end we have only to compare the cells of the many plants ever greeting us in our country rambles, and for which purpose an achromatic object-glass of half an inch focal length will suffice. The form and contents of the cells may be best seen in fine sections, made in various directions, of the stems, leaves, roots, and other parts; but as such preparations require practice and skill, they may be dispensed with generally, and another way employed, rough and ready, yet likely to be rewarded with interesting and useful results, provided the pursuit be steadily continued. Thus we have simply to dissect with needles, or scrape or mash with a penknife, a fragment of the plant-tissue in a drop of water on the glass object-plate, and place it, either covered or not with a thinner bit of glass, under the microscope, when many of the vegetable cells will appear with their form and contents perfect, and more injured or broken, with their contents, yet recognizable and characteristic, escaped into the water. You will perceive that this kind of examination is far more easy than the process required for the display of the anatomy of the seed, and some other ordinal characters, while the character we are searching for is determinable at once and at all times, quite independently of the flowers or fruit. For example, if the problem be to distinguish, even if by a mere fragment of the species, whether a Rush belong to this or that division of the genus, we have only to look at the pith-cells, which form a very beautiful stellate or radiate tissue in one group of the genus, and a tissue of oval cells in the other, as may be well seen by comparing the actinenchyma of the pith of the common *Juncus*

conglomeratus, with the ovenchyma of the pith of *Juncus bufonius*. The constant difference of size in the cells is remarkable sometimes when their form and contents remain the same. If you examine them in *Hymenophyllum Wilsoni* and *H. Tunbridgense*, you will perceive this difference at once, and very likely then dissent from the views of those eminent botanists who regard these two pretty ferns as but one species. To the same effect is the uniformly smaller size of the pollen-cells in *Lotus major* than in *L. corniculatus*. By the singular largeness and roughness of the same cells in *Ranunculus arvensis*, this species is distinguished from its nearest allies, and other curious cell-differences, either of form or size, occur in different sections of this genus, and indeed of many other genera.

But still more striking examples occur as regards either the presence or absence of raphidian cells. Thus, *e.g.*, if the question be to discriminate between a Balsam, Bed-straw, or Willow-herb—species belonging to the orders Balsaminaceæ, Onagraceæ and Galiaceæ—and any of the plants in the alliances of those orders, mere shapeless fragments of the leaves or stems, or other parts, without the slightest aid from the recognized characters in systematic books, would, as already explained, be quite sufficient for the purpose.

Of the validity of this character numberless examples might be added; one more will suffice now. Having proved the facts as regards several orders in our own Flora, I extended the inquiry to all the exotic plants available, and never could find any exception to the character of Onagraceæ, *e.g.*, as a raphis-bearing order; when at length an apparent exception turned up in *Montinia*. However, on subsequent inquiry this genus, though placed by Lindley and other eminent botanists in the order Onagraceæ, proved to be no member of it, but rather to belong to the Saxifrages, with which its cell-structure better agrees; and thus a seeming exception became an excellent proof of the rule.

But in this inquiry we must take care not to confound raphides with crystal prisms, sphæraphides, and other crystals. There will be endless confusion else. Their distinctive characters are given, with far more details than can be entertained at present, in the memoirs contributed by me to the *Annals of Natural History*, the *Microscopical Journal*, and *Seemann's Journal of Botany*, from 1861 to 1866, and epitomized in the *Popular Science Review* for 1865-8. And I must beg to warn you against the very maze of errors on this and other points of the subject occurring in all the books on the Microscope with which I am acquainted; for in this department of phytotomy confusion has been led round from compiler to compiler in most admired disorder.

The question will arise of the use of raphides and other plant-crystals; it has never been answered. But we have now proved one use of them in systematic botany, including the fact that nature has regularly established in certain plants a laboratory and storehouse of these crystalline calcareous salts; while we all know how valuable they are as manure, and can now perceive how curiously and carefully the excess of them, more than has been expended in the economy of the plant, is soon and periodically restored to the parent soil, so that there may be no unnecessary loss of a fertilizing matter. Hence we see a good reason why the rotted leaves and other parts of such vegetables—*e.g.* the Willow-herbs, Fuchias, and Duckweeds—as abound in raphides, should be carefully husbanded by the gardener for his composts. These crystals are surely also useful, if not necessary, as part of the food of many animals, and sometimes as medicine for man. The commonest Duckweed abounds in raphidian cells and starch-granules; and I have found it, presenting its true cell-characters, in the stomachs of water-fowl and water-rats. Thus even this abject and despised weed is plainly useful in the economy of nature, and we could hardly imagine a better adjunct to the aliment of the young growing animal than the

phosphate of lime and starch. Besides, any physician would testify to the medical properties of sarsaparilla in certain diseases of the bones ; and this plant too, like the other Dictyogens, abounds so in raphides of phosphate of lime, in an organic form, that I have suggested a plentiful course of it in those sad cases in which this salt is morbidly deficient, as in the Rickets of children. Such facts are among the practical applications of the subject.

Finally, simple and plain evidence has now been adduced of the novelty and importance of the cell-biography plants ; and we may conclude that, without a discriminative recognition of this subject, both in its physiological bearings, and as presenting intrinsic and essential characters in systematic botany, no fair and complete history can ever be written of the Vegetable Kingdom.

Valuable microscopes were lent for the occasion by Colonel Horsley, Colonel Cox, and Mr. Harvey. The lecturer showed the method of making the preparations or dissections, of the choice of plants and suitable parts, and of the easiest means of subjecting them to microscopic examination ; and so the subjects under discussion were thus amply and practically illustrated. Colonel Horsley exhibited the crystal prisms subjected to polarized light, while the raphides, sphæraphides, and other objects were under view with the other microscopes. At the conclusion of the meeting, a vote of thanks to Mr. Gulliver, for his agreeable and instructive lecture and demonstrations, was proposed by Colonel HORSLEY, seconded by Mr. DOWKER, and cordially carried.