

the distance of the motion is less, which only amounts to the truth, that a small portion of an ellipse is ultimately undistinguishable from a circle. The truth of the Axioms of Geometry never really comes into question at all, and Helmholtz has merely pointed out circumstances in which the figures treated in plain geometry could not always be practically drawn.

It is a second question whether the dwellers in a spherical world could acquire a notion of three dimensions of space. We must remember that such beings could bear no analogy to us, who have solid bones and flesh, and live upon a solid globe, into which we can penetrate a considerable distance. These beings have no thickness at all, and live in a surface infinitely thinner than the film of a soap bubble, in fact, not thin or thick at all, but devoid of all pretensions to thickness.

There would be nothing at first sight to suggest the threefold dimensions of space, and yet I believe that they could ultimately develop all the truths of solid geometry. They could not fail to be struck with the fact that their geometry of finite figures differed from that of infinitesimals, and an analysis of this mysterious difference would certainly lead them to all the properties of tridimensional space. Indeed, if Riemann, prior to all experience, is able to point out the exact mode in which a curvature of our space would present itself to us, and can furnish us with analytical formulæ upon the subject, why might not the Riemann of the spherical world perform a similar service, and show how the existence of a third dimension was to be detected? It might well be that the inhabitants of the sphere had in the infancy of science never suspected the curvature of the world, and, like our ancestors, had considered the world to be a great plain. In the absence of any experience to that effect, it is certain that the notion of thickness could not be framed any more than we can imagine what a fourth dimension of our space would be like. We have some idea what a world of one dimension would be, because as regards *time* we are in a world of that kind. The characteristic of time is that all intervals beginning and ending at the same moments are equal. But suppose that some people discovered a mysterious way of living which enabled them to live a longer time between the same moments than other people; this could only be accounted for by supposing that they had diverged from the ordinary course of time, like travellers taking a round-about road. Though in one sense such an occurrence is utterly inconceivable, yet in another sense we can probably anticipate the character of the phenomenon, and the 47th proposition of Euclid's first book would doubtless give the most important truth concerning times thus differing in direction.

With all due deference to so eminent a man as Helmholtz, I must hold that his article includes an *ignoratio elenchi*. He has pointed out the very interesting fact that we can conceive worlds where the Axioms of our Geometry would not apply, and he appears to confuse this conclusion with the falsity of the axioms. Wherever lines are parallel the axiom concerning parallel lines will be true, but if there be no parallel lines in existence, there is nothing of which the truth or falsity of the axiom can come in question. I will not attempt to say by what process of mind we reach the certain truths of geometry, but I am convinced that all attempts to attribute geometrical

truth to experience and induction, in the ordinary sense of those words, are transparent failures. Mr. Mill is another philosopher whose views led him to make a bold attempt of the kind. But for real experience and induction he soon substituted an extraordinary process of *mental experimentation*, a handling of ideas instead of things, against which he had inveighed in other parts of his "System of Logic." And the careful reader of Mr. Mill's chapter on the subject (Book II. chapter 5) will find that it involves at the same time the assertion and the denial of the existence of perfectly straight lines. Whatever other doctrines may be true, this doctrine of the purely empirical origin of geometrical truth is certainly false.

W. STANLEY JEVONS

LEIGHTON'S LICHEN-FLORA OF GREAT BRITAIN

The Lichen-Flora of Great Britain, Ireland, and the Channel Islands. By the Rev. W. A. Leighton, F.L.S. (Published for the Author. Shrewsbury, 1871.)

IT falls so rarely to the botanical reviewer in this country to notice works on Lichenology, that we gladly avail ourselves of the present opportunity of introducing to our readers a little unpretentious volume which has the excellent object primarily—"of elevating the knowledge of our insular lichens to a level with that of other branches of our country's flora," and which, moreover, completely vindicates the title of Britain's lichens to at least equal study with the other families of her cryptogamia. Since the publication of Mudd's excellent "Manual" in 1861, the additions made to the lichen-flora of Great Britain and Ireland have been both so numerous and important, that lichenological students have felt the want of some systematic work containing a complete list of the British lichens up to the present date, along with specific diagnoses and other aids to their identification. It was generally felt, moreover, that no fitter authority could undertake so intricate a labour than Mr. Leighton, whose name is identified with lichenological progress in this country by the publication of many important papers of a monographic character, and who is justly regarded, both by home and foreign botanists, as the representative and father of lichenology and lichenologists in Britain. The present work, which we are glad to find is to be followed, in due time, by another which is even more urgently required—a *Conspectus* of all known lichens throughout the world—is a convenient 12mo volume of about 470 pages, which confines itself mainly to a systematic enumeration, with specific diagnoses, of all the lichens at present known to occur in "Great Britain, Ireland, and the Channel Islands." The nomenclature and classification followed are those of Dr. Nylander, of Paris, who is described as "the *facile princeps* of modern microscopic lichenologists." Succeeding the specific diagnoses, the author cites the leading synonyms; gives references to published plates and fasciculi of dried specimens; narrates the general geographical distribution of species throughout the world, on the one hand, and throughout the three kingdoms on the other; specifies the particular localities of growth in each of these latter kingdoms; and gives, so far as possible, the date of original discovery in Britain, with the name of the discoverer.

Besides the fruits of laborious compilation, the work obviously contains a large amount of original research. There are no less than seventy-five species, varieties, or forms, described for the first time (though not necessarily in this volume) by Mr. Leighton himself; many of these referring, however (as in the case of the *Graphideæ*), to varieties or forms that do not apparently require separate description and nomenclature. He has also given great attention to the action of certain chemical substances on the thallus and apothecia, and has to a considerable extent employed the said reaction in his minor classification. Only those who have attempted similar works can understand the immense labour involved in their preparation; and British botanists ought to feel, and doubtless do feel, themselves under great obligations to Mr. Leighton for undertaking and successfully executing so difficult a task. The present work has been published at Shrewsbury for and by the author himself—a procedure which enables a writer to escape the irksome and mischievous fetters sometimes imposed by publishers. But this circumstance—of local publication—is apt to be attended with certain counter-vailing disadvantages; so that in the present instance it does not surprise us that the typography, paper, and binding—the general up-get of the volume—do scant justice to all the author's labours in its compilation.

It is always an ungracious task to expose faults in a work that is, on the whole, excellent; that has been a labour of love; that embodies the fruit of much research; and that could have been fitly undertaken by very few individuals. But Mr. Leighton himself apparently invites co-operation, if not criticism, in order to the preparation of a fuller and more accurate second edition; and his present work contains defects of a character that seriously mar its usefulness to the student, and that no honest reviewer, if he is to be critical at all, would be warranted in passing without notice. It is then a very serious defect of the book that it contains no Index of Species and Varieties, alphabetically arranged after the manner of that in Mr. Crombie's Enumeration. For small genera, containing not more than half a dozen species, it may be comparatively easy to find *varia* or *communis*, or any other type; but in large genera such as *Lecanora*, *Verrucaria*, and *Lecidea*, each containing from 73 to 233 species, the student must carefully read that number of names, spread over 53 to 110 closely printed pages in each case, before he finds perhaps the species of which he is in search. Only the most ardent lichenologist, who has abundant leisure as well as patience at command, will care to take this amount and kind of trouble. The omission referred to is of such importance that we counsel Mr. Leighton to lose no time in issuing a full and legible Index of species and varieties as a supplement to the present work; and to avail himself of the opportunity, which we trust its rapid sale and extensive circulation will give him, of inserting such an Index in its proper place in a second edition. The form of the said Index should be that adopted by Crombie in his Catalogue of the British Lichens (1870), and not that of Mudd, in his Manual (1861), which is infinitely less easy to use.

In his present work, Mr. Leighton assumes too high a previous standard of technical knowledge on the part of the student. How many beginners in lichenology are

likely to know—without being informed—what our author means by a “glypholecine” epithecium, or “bacilliform” spores? In fact, there ought to be a Glossary, to explain the meaning of the technical terms employed throughout the work; and this is the more necessary, seeing that, unlike Mudd in his “Manual,” Mr. Leighton gives no Introduction explanatory of the general structure and morphology of lichens. Further, the student cannot be expected to know by intuition the meaning of the abbreviations used by the author, such as B.; Bohl.; Zw.; M. and N.; Arn.; Fellm.; Th.M. Fr.; Flk. D.L.; Nyl. Syn., Scand. or Pyr.; Hepp sporen; and so forth. There ought certainly to have been prefixed a full explanation of all these, and similar, contractions; which explanation would necessarily include a comparatively complete and most useful Lichen Bibliography. Again, there is no standard of form, size, or colour. We are told that certain spores are large, moderate, small, minute, or very minute; and certain spermatia long, shortish, or shortly cylindrical. But in no case are measurements given; and the student has to form his own opinion as to the signification of these unscientific, vague, relative terms. He is left, moreover, to conjecture as to what constitute the “positive” and “negative” reactions of hydrate of potash and hypochlorite of lime; and as to what is a “vinous” reaction of the hymenial gelatine with iodine!

The work professes to give a “full diagnosis” of each species. But that surely cannot be considered a full diagnosis, which systematically omits almost all reference to the important Secondary Reproductive Organs? In not a single species, so far as we have been able to discover, is there a full description of the *Spermogones*! *Pycnides* are not once mentioned in the volume! No doubt in one or two species the character of the *spermatia* is sketched by a single term, or by other inadequate means. Thus in *Opegrapha amphotera* the spermatia are said to be “different from *O. vulgata*,” but we are not told what is their character in *O. vulgata*. There are certain large and important genera in which the spermogones are not at all mentioned even in the diagnosis of the genus (e.g., *Verrucaria*, *Cladonia*, *Collema*, *Leptogium*, *Opegrapha*, and *Graphis*); while in others such a description as “Spermatia various” (e.g. in the *Ramalinæ*) conveys little or no real information! In a very few exceptional instances, among the higher Lichens, are spermogones or their contents described. Where the attempt is made, the result is singularly bald and unsatisfactory, and is obviously not the fruit of original investigation. And, further, the beginner will scarcely understand what is meant by crenated, oblong cylindrical, straight, curved, or slender spermatia, without plates, which are wholly wanting in the present volume. A student cannot be said to have acquired a “knowledge” of Lichens, who is ignorant of the characters of their *Spermogones* and *Pycnides*. To the biologist or physiologist, therefore—to him whose object is to study the whole Natural History of a given Lichen-species—such omissions in a systematic work on a national Lichen-flora is one of primary importance. The author tells us that he aims at descriptions, which will “facilitate the student (*sic*, the italics being ours) in the ready and accurate determination of his specimens;” that is to say, the naming or ticketing of them, which is something very different from imparting a knowledge of all their natural characters! The truth is

that such works as the present are calculated not to create Biologists, but to perpetuate a race of mere collectors and labellers—men whose highest aim is to gather “new” or “rare” species; who spend their holidays in accumulating *specimens*, sending those that are unfamiliar across the Channel for identification or naming. One of the results of the latter procedure is that the present work contains no less than 200 British species or varieties bearing Nylander’s name as the author of their first description!

While, however, meagre attention has been thus bestowed upon the secondary reproductive organs, undue prominence is given to the action of potash and lime on the thallus and apothecia, and the reaction of iodine with the hymenial gelatine; phenomena that are so uncertain and inconstant that they vary even in the same individual under different circumstances. We would not *exclude* chemical or *any* natural characters from the definition of species; but the present work seems to us to furnish ample illustration of the danger of making use of secondary, trivial, inconstant characters as a basis for classification (e.g. the genus *Cladonia*.)

The localities of growth are satisfactory so far as they go; but they are utterly inadequate as representing the distribution of species in either of the three kingdoms. In order to specify, with at all adequate fulness, the diversity of locality occupied in England, Scotland, and Ireland respectively by the species enumerated, Mr. Leighton must have examined for himself the contents of all the Lichen-Herbaria in these kingdoms; and, though the said herbaria are neither numerous nor large, compared with those of flowering plants, such a labour is obviously impossible for any *one* man of average leisure and opportunities.

There is no Tabular Summary showing the numerical richness of the British Lichen-Flora; an omission, it may be, of minor importance, but still of importance, inasmuch as it is always interesting to “take stock” occasionally of the rate of progress of the additions that are being made to a national Sub-Flora. Basing our calculations on the data supplied by the present work, we find a total of 73 genera and no less than 781 species; whereas only last year in his enumeration, Crombie (p. 124), gave the whole number of British Lichens then known as 658, the difference apparently representing, or consisting of, so-called *new* species. Of the host of these *new* species added of late years to our Lichen-Flora, perhaps not above one-fifth will survive in that “struggle for existence,” to which they will sooner or later have to submit at the hands of the philosophic botanist. A large proportion will doubtless be found to consist of *mere forms of common, protean, widely distributed species*—forms that neither require nor deserve separate nomenclature and rank.

We have not exhausted the list of blemishes in the book before us. But to notice *all* the errors in matters of detail; all those points on which other lichenologists are likely to take grave exception to his views; all the faults in typography or otherwise, would extend and expand this review into a Treatise on the Classification of Lichens; for it would necessarily deal with certain features of that Nylanderian system, which Mr. Leighton follows in his present work.

With all the aids the author gives the student, it will,

we fear, be impossible for the latter to identify the majority of the less common and familiar species without reference to authentic specimens named by Mr. Leighton himself. The work is so elaborate and complex, the principles and practice of classification adopted in it are so puzzling, that we candidly confess our own general impression to be one of increasing bewilderment, and of growing indisposition to attempt the identification or nomenclature of Lichens at all! We hesitate not to avow our own preference for studies on the Biology of the common economical species, such as those which at present are called *Cladonia rangiferina*, *Usnea barbata*, *Ramalina calicaris*, *Parmelia saxatilis*, *Roccella tinctoria*, or *Lecanora tartarea*.

On the whole, however, the “Lichen-Flora of Great Britain” is a work that should find a place in every public botanical library in the three kingdoms, as well as in the private libraries of all students of the extremely puzzling cryptogamic family of which it treats.

W. LAUDER LINDSAY

OUR BOOK SHELF

A Complete Course of Problems in Practical and Plane Geometry, adapted for the Use of Students preparing for the Examinations, &c. By John William Palliser, Second Master and Lecturer of the Leeds School of Art and Science. (London: Simpkin and Marshall.)

A NEW class-book on Practical Geometry commends itself to our attention. Mr. John Palliser, of the Leeds School of Art and Science, has produced one of those educational works which a demand created by Government examinations has recently brought to our aid. Reserving our opinion as to the final tendency of an epidemic for what are called practical results, we must, in justice, say that this class-book of Mr. Palliser’s is the very thing for cheapness, conciseness, comprehensiveness, to rapidly possess the student with a ready-handed ability to answer all demands of the examiner. The work is not encumbered with demonstration, for this, in view of the proposed end, would be out of place; it is a laboratory of experimental formulæ. We have a recipe for constructing all conceivable polygons within the compass of a single circle, for drawing lines to invisible points, and for trisecting the most obdurate angles by the magic of a slip of paper. Faith is all that is demanded of the student, faith in the formulæ before him, and industry to get them by heart. Not troubled with the *Why*, he has only to remember the *How*; but he must be careful, exact, and neat-handed; and this, if not mental training, is next of kin to it. The arrangement of the book is generally good, the style concise in the extreme, the letter-press wonderful at the price, and the diagrams, with their faint, dark, or dotted lines, are highly effective and intelligible, not less so from the fact of the *lettering* being (what we very seldom find it) correct.

To examine in detail the 220 problems of Mr. Palliser’s book is more than we can just now undertake; but so far as we have dipped into them there is little to complain of, considering that the work is merely practical. The style, we have said, is concise; but (if we might venture a criticism on a point where most geometers are more guilty than Mr. Palliser) it would lose nothing in intelligibility if the nominative case were less frequently preceded by a multitude of perplexing conditions which really have to be neglected by the learner till the said nominative is reached, and then returned to lastly in that natural order of thought which geometers have a fancy for inverting. Whilst taking these minor exceptions, we must not omit to call the author’s serious attention to Problem 13, which, whether we consult the diagram or the letter-press, is wholly fallacious. Such a construction will not effect the