Simple tactile papillæ occur in stigma lobes of *Golfussia anisophylla*; they are not highly sensitive, and a pressure on them sufficient to bend the lobe is required, but whether or no the deformation of the motile tissue acts as an accessory stimulus is not easily decided. In his section on irritable styles and stigmas, Haberlandt describes the curious movements of the style of *Arctotis* (Compositæ), which was discovered by D. Müller in 1853, but has, until recently, received too little attention. Like the filaments of *Helianthemum*, it has no special sense organs, and Haberlandt suspects that the reaction is called forth by the style being forcibly bent rather than irritated by touch.

In Darwin's "Fertilisation of Orchids" the mechanism by which *Catasetum* shoots out its pollen-masses was for the first time described. Haberlandt has now shown that in *C. Darwinianum* and *macrocarpum* the "antennæ" which receive the stimulus, and transmit an influence to the rostellum, are provided with sense organs. His drawings (especially Taf. iii. Fig. 7) fully confirm his remark that the tactile papillæ bear a striking resemblance to those on the filaments of *Opuntia* and *Portulaca*.

In an undetermined species of *Catasetum* a most remarkable divergence from the type occurs. Tactile papillæ are wanting, and the antenna is converted, by the development of mechanical tissues, into a vibrissa or lever; it is capable of bending near the base, and obviously functions like filaments in *Dionæa*,¹ where the movement of the stiff apical part deforms the percipient joint or hinge near the base.

Allied to the tactile papillæ are the *Fühl-tüpfeln* or tactile pits discovered by Pfeffer in certain tendrils, inasmuch as by their means the protoplasmic prolongations which fill the pits are brought close to the free surface, and in such a position that they are liable to deformation by contact. Haberlandt describes these structures in detail in a variety of genera, and gives drawings of several, including the cases where a relatively large crystal is included in the pit, an arrangement which must have the effect of a stone in a man's shoe in increasing the sensitiveness to contact.²

For the interesting account of the minute tactile pits in the tentacles of *Drosera*, the reader is referred to the original. The remaining sense organs described by Haberlandt may be placed together, although by the author they are subdivided into tactile hairs, tactile bristles, stimulators, &c. Their essential character has already been referred to in describing an unnamed species of *Catasetum*; it is the occurrence of a stiff terminal part the movement of which deforms either the base or the tissues from which it springs. A simple example occurs on the contractile stamens of *Centaurea montana*; here the sense organs consist each of a simple, strongly built hair, the movement of which acts on the thin-walled basal joint. Other organs of the same essential type have been described³ in *Aldrovanda*, but here the sensitive joint is not at the base, but in the middle of the hair.

One of the most interesting points in the book is the discovery of similar organs in *Mimosa* and *Biophytum*.

¹ Haberlandt, "Physiologische Pflanzenanatomie," Edit. ii., p. 481.

² See also Haberlandt, "Physiologische Pflanzenanatomie," Edit. ii., 1896, p. 478.

³ Haberlandt, "Physiologische Pflanzenanatomie," Edit. ii., 1896, p. 480.

The sensitive lower surface of the pulvinus of *Mimosa pudica* bears a number of obliquely lying bristles, and Haberlandt finds that the familiar reaction follows a touch applied to one of these. To convince himself of the fact the observer must, it seems, select a plant not in the highest condition of irritability; with a slightly sluggish plant it is easy to convince oneself that the bristles are the most sensitive part of the surface. The bristles are of several types, of which the most interesting is described as the "cork-squeezer" pattern.

In the angle between the bristle and the surface of the pulvinus is a projecting mass of cells, which will necessarily be squeezed when pressure is applied to the end of the bristle. The same mechanical contrivance is found among the *Oxalidæ* on the leaves of *Biophytum*, the lever being in this case a stiff hair instead of a bristle. The author points out (p. 80) that the discovery of these organs throws light on the question of the biological meaning of the irritability of *Mimosa*. Their existence does not seem compatible with Sachs' view that the response to contact is useful as a protection against sudden violent hail- or rain-storms. On the other hand, it lends support to Pfeffer's theory that the movement of the leaf stalks serves to warn off small creeping insects, &c. In Java and Singapore, where *Mimosa pudica* is an introduced weed, Haberlandt has seen the leaves react to visitors of this type.

The book concludes with a short section on the comparison of the tactile organs of plants with those of animals, in which the interesting point is brought out that in insects the lever-like or hinged hairs bear a distinct resemblance to corresponding structures described by the author in plants.

FRANCIS DARWIN.

A NEW TREATISE ON THE CALCULUS.

An Elementary Treatise on the Calculus, with Illustrations from Geometry, Mechanics and Physics. By George A. Gibson, M.A., F.R.S.E., Professor of Mathematics in the Glasgow and West of Scotland Technical College. Pp. xix + 459. (London: Macmillan and Co., Ltd., 1901.) Price 7s. 6d.

AMONG several notable characteristics possessed by this work, the most prominent appears to be the severity of its logic. In one important respect it differs also from the usual English mathematical treatise—it seems to speak to the student, warning him against too probable error and giving him advice. This is a feature which should be encouraged. The aim of the writer of a text-book should be to educate his reader, frankly recognising the imperfections of human nature, and not merely to set forth a work of unassailable art full of unimpeachable truths.

While applied mathematics is the great field for the exercise of such a method of treatment—since erroneous views on the part of students are at once more probable and more numerous in this domain than in others—the calculus is probably, in the field of pure mathematics, the subject in which a student most needs the anticipation of errors and difficulties; and the really philosophical student will find in Prof. Gibson's treatise a work which

seems to leave no difficulty unnoticed, the Scottish love of pure logic being prominent throughout.

It is not a work for the mere smatterer who aims only at learning rules and practical processes, regardless of the logical foundations; and in its various applications and illustrations it lays under contribution the sciences of electricity, magnetism and heat. The student, however, who has no knowledge of these subjects is not hindered by the introduction of them; for they can be passed over for a more convenient season, and they are used only as examples which do not belong to the essence of the treatise.

The first hundred pages (five chapters) of the book are devoted to several subjects which are generally dealt with in other treatises—such as the elements of co-ordinate geometry, the most prominent properties of the conic sections, and the discussion of the limiting value of $(1 + \frac{1}{m})^m$ when $m = \infty$. In these chapters, also, there is a good deal about the graphs of functions, algebraic, exponential and trigonometric. It is possible that Prof. Gibson need not have included the portion on conic sections, since students are certain to make a special study of this elsewhere.

The whole of chapter iv. is devoted to the exposition of rates and limits, and it is minutely logical and illuminating. We cannot imagine Prof. Gibson as accepting that truly wonderful measure or definition of a variable rate which we often find in works on dynamics when their authors treat of a variable velocity:

“the velocity, when variable, is measured by the distance that would be gone over in a unit of time if the velocity remained constant and equal to that which it is at the particular instant”!

It is in chapter vi. that the special subject of the treatise begins formally with the discussion of differentiation; and here Prof. Gibson adopts the good plan of associating in the mind of the student, from the outset, both the “derivative” and the function from which it comes; in other words, the student is learning his integral as well as his differential calculus, and he is exercised in the art of deducing the function which has a given one for its derivative. There is here a section specially devoted to the properties of hyperbolic functions. The names of these functions leave much to be desired, inasmuch as several of them suffer from the fatal defect of being unpronounceable. Thus, how are $\sinh x$ and $\tanh x$ to be pronounced? And does not $\cosh x$ suggest merriment? A very simple change would remove the first difficulty. If the prefix *hy* were put to each of the trigonometrical functions, all the names would be pronounceable and not too long. Thus *hysin* x , *hytan* x , &c., would at once be pronounceable and indicate the hyperbolic nature of the functions.

Prof. Gibson's paragraph (p. 157) on the conduction of heat, together with the accompanying page of exercises, is marked by his accustomed love of clearness, but it may not be appreciated by the student of pure calculus unless he happens to have studied previously comparatively advanced physics. It is, however, a good principle to keep the purely mathematical subject as much as

possible in touch with physics. There is a dangerous tendency visible in some writers to overload the special subject in hand with applications and technicalities in several other subjects, with the result that much of the work is unappreciated by the student. In this respect, however, Prof. Gibson is more judicious than many other authors. The work abounds in warnings to the student against possible (and probable) errors, and the author never hesitates to give a useful collateral piece of information, which it is desirable that the student should have, whenever it can be simply and shortly conveyed—as, for instance, at p. 175, when the different ways in which a battery of a number of cells may be arranged are discussed. This would be regarded by the typical English author as quite outside the bargain which he considers himself to have made with his reader—to give him the truth, the whole truth, and nothing but the truth, with no extra useful information, advice, or warning.

There is also plenty of the graphic method of illustration in the book in dealing both with the processes of differentiation and with those of integration.

In dealing with partial differentiation (chapter xi.), the author has a few pages devoted to the elements of co-ordinate geometry of three dimensions, which will, probably, be found by the student who has advanced thus far to be unnecessary. The equations of thermodynamics and also Laplace's spherical harmonic equation supply appropriate applications of the subject of the chapter.

This is followed by a very good chapter on the theory of equations, in which the methods of approximate solution are well discussed, together with the reliance to be placed on successive approximations.

The successive reductions of the binomial integral

$\int x^{m-1}(a+bx^n)^{\frac{p}{q}}dx$ are dealt with rather too shortly

at p. 295. It is strange that such an old work as Hymers's “Integral Calculus” should have treated these integrals in such a helpful, complete, and systematic manner, and that Hymers' simple rules for reduction in any specified case should have been quite neglected or overlooked by subsequent writers.

The mechanical method of integration by Amsler's planimeter, together with the allied geometrical theorems on the displacements of a line, is given in chapter xiv. Near the end of the book there is a thorough discussion of series, their convergency, divergency, &c. The last chapter, xx., is devoted to a short discussion of linear differential equations; and it is to be hoped that this chapter will be considerably lengthened in the next edition with a good discussion of the symbolical method of integration—a subject on which we should expect Prof. Gibson's acute logic to be very illuminating.

Finally, the work seems to be exceptionally free from misprints. We notice the extraordinary letter “O” in the centre of fig. 65, p. 315, which looks like a branch of the curve, but is really the *origin* of coordinates. See a similar defect in fig. 83, p. 362; and in line 6 from the end of p. 379 the term p^n should be p^n .

GEORGE M. MINCHIN.