loss how to come at the truth of the current temperature of this climate as the thermometrical observations which are now regularly published in the *Philosophical Transactions* can furnish us with a proper standard with which the solar phenomena may be compared. This leads me to remark that although I have in my first paper sufficiently noticed the want of proper criterion for ascertaining the temperature of the early periods where the sun has been recorded to have been without spots, *and have also referred to future observations for showing whether a due distribution of dry and wet weather with other circumstances which are known to favour the vegetation of corn, do or do not require a certain regular emission of the solar beams*, yet I might still have added that the actual object we have in view is perfectly independent of the result of any observations that may hereafter be made on the *favourable or defective vegetation of grain in this or in any other climate* . . . . It may be hoped that some advantage may be derived even in agricultural economy, from an improved knowledge of the nature of the sun and of the causes or symptoms of its emitting light or heat more or less copiously."

It perhaps will be news to many that the idea of a possible connecttion between sun-spots and rainfall which has been represented as a modern idea, may really be credited to a man whose chief work was done in the last century.

DARWIN'S "DIFFERENT FORMS OF FLOWERS"

The Different Forms of Flowers on Plants of the same Species. By Charles Darwin, M.A., F.R.S. (London: John Murray, 1877.)

THIS is another of the remarkable series of volumes in which Mr. Darwin has given us the extremely valuable results of his researches in the vegetable side of biology. Mr. Darwin's method of investigation would in itself be a very interesting subject for consideration. It is, however, sufficient to point out that its characteristic feature is the combined attack upon a given problem from both its morphological and physiological aspects. This method Mr. Darwin employs with consummate success, and in turning over the pages of the present book—a considerable part of which has been before the world for more than a decade without being materially impugned—one is almost distracted from the intrinsic interest of the facts and speculations by the sagacity with which the research is carried on, and the skill with which the results are marshalled for our information. It is peculiarly worthy of notice in the present volume how the reader is allowed, in studying Mr. Darwin's pages, to form his own hypotheses in explanation of the facts, only to be compelled in due course, as the narrative proceeds, to admit that such hypotheses are utterly untenable. There is no impression so curious as to find oneself so distinctly under the hands of a master, and to realise that the calm flow of the argument proceeds over the *débris* of objections and difficulties which are found to be already comminuted as soon as one attempts to give them any definite form.

It would be quite impossible to treat, in the short space at our disposal, all that calls for notice in the present volume. Commencing with a short introduction, the body of the book falls into three divisions. The first treats of heterostyled plants, and contains in a connected form the substance of Mr. Darwin's various papers communicated to the Linnean Society. The second and third divisions are much shorter, and treat respectively of the passage of hermaphrodite into dicœcious plants, and of cleistogamic flowers.

As has been already remarked, Mr. Darwin's researches on what are now termed heterostyled plants have been common scientific property for many years, and have filtered down into the current text-books. The seventh and eighth chapters are therefore the essentially new part of the book, and these we shall more particularly consider.

The vast majority of flowering plants are, as is well known, hermaphrodite, that is to say, they contain within the same floral envelopes both male and female organs. The governing principle in the morphological adaptations of flowers is apparently to escape the obvious consequences of such juxtaposition and evade self-fertilisation. This is effected either by their being dichogamic—that is the sexual organs in any one flower maturing at different times, or by their being entomophilous—that is calling in the intervention of insects to carry the pollen of one flower to the stigma of another, or by their being heterostyled—that is by the flower being modified in two or three ways, admitting of a certain number of reciprocal modes of fertilisation which are legitimate, and of others which are distinguished as illegitimate, and are more or less sterile.

Each of these modes of avoiding self-fertilisation practically sets up a functional separation of the sexes, and it might seem that the cases in which this separation is *structurally* accomplished are its natural sequence. Mr. Darwin points out, however, very conclusively that this is by no means the case.

"There is much difficulty in understanding why hermaphrodite plants should ever have been rendered dicœcious. There would be no such conversion unless pollen was already carried regularly by insects or by the wind from one individual to the other, for otherwise every step towards dicœciousness would lead towards sterility. As we must assume that cross-fertilisation was assured before an hermaphrodite could be changed into a dicœcious plant, we may conclude that the conversion has not been effected for the sake of gaining the great benefits which follow from cross-fertilisation."

Mr. Darwin is led to find an explanation in the advantage to the plant in the diminished strain of producing sexual organs of only one kind instead of both. And the process of manufacturing dicœcious plants is one which can be actually seen in process. The cultivated strawberry under the influence of the American climate is a marked instance. In such cases the hermaphrodite state can be traced into the dicœcious with every intermediate grade. The ultimate fate of heterostyled plants is perhaps to be converted into dicœcious ones, and in this instance the change would be more immediate and with fewer connecting links. The functional diversity already exists and the corresponding suppression of the sexual organs is all that is needed to render it complete.

The concluding chapter on cleistogamic flowers certainly does not yield in interest to any preceding portion of the book. The existence of these curiously-modified structures has long been known, but it is only within the last twenty years that they have been attentively studied, and Mr. Darwin's account is a very masterly discussion of all that has been written on a very puzzling subject, tested

and enriched by his own observations and experiments. As their name implies, these flowers never open, and in some cases they have been passed over as abortive bud-conditions of flowers of the normal conspicuous type. Their petals are, of course, superfluous, and are usually completely suppressed, or nearly so, the stamens and pistil are also much reduced in size, but though morphologically reduced, are physiologically fully developed, and such flowers are very fertile. In fact, in some instances, as in *Viola canina*, the production of seed is principally dependent upon them, the ordinary flowers, from want of pollen, or the absence of the visits of bees, rarely producing capsules.

At first sight the suggestion seems a tempting one, that in these curiously degraded flowers, in which all the laboriously-acquired adaptations for cross-fertilisation are entirely discarded, we have a reversion to a less highly organised ancestral type. And this may still to some extent be true, though Mr. Darwin shows that they "owe their structure primarily to the arrested development of perfect ones." In some cases, as Oliver has shown in *Campanula colorata*, and Scott in *Eranthemum ambiguum*, the same plant bears as well as cleistogamic and perfect flowers, intermediate forms between the two. What is, however, still more significant, is that the cleistogamic flowers are themselves sometimes the starting point of structural adaptations, to effect more perfectly the self-fertilisation which ordinary flowers have been so marvellously modified to avoid. Thus, in *Specularia perfoliata* the rudimentary corolla is modified into a perfectly closed tympanum, and in *Viola canina* the pistil is much modified. Mr. Darwin, however, has shown that cleistogamic flowers do not invalidate the general principle as to the disadvantage in the long run of self-fertilisation. After two years' growth, crossed seedlings of *Ononis minutissima* beat those produced from cleistogamic flowers in mean height in the ratio of 100 to 88.

It seems that the end really gained by cleistogamic flowers is the production of a large supply of seeds with little expenditure; the plant does the work more cheaply and makes the numbers pay. It is curious to reflect what, relatively speaking, an enormous expense a plant puts itself to in such a case as *Viola* in producing in the spring a large number of conspicuous flowers furnished with nectaries and all the complicated apparatus needed to insure cross-fertilisation, with the result, perhaps, of securing a very few cross-fertilised capsules. Having made these sacrifices, it proceeds during the summer to insure the production of a sufficient crop of less costly seeds by the inconspicuous aid of cleistogamic flowers.

Mr. Darwin, with characteristic ingenuity, adduces another instance of this balancing of conflicting advantages in the effort to secure before all things the perpetuation of the race. A seed in the ground—to parody a common proverb—is worth a good many exposed to depredation above it; and though dissemination is a gain, secure sowing is no less important. Many cleistogamic plants, therefore, having deliberately given up the advantage of cross-fertilisation, give up those attaching to change in the place of growth, and bury their fruits even before they are mature. This is the case with *Viola odorata* and *hirta* and *Oxalis Acetosella*. In other instances—and Mr. Darwin will pardon the remark that he has scarcely dwelt on the distinction—the buried fruit is the product of *subterranean* flowers. This is the case with *Vandellia sessiflora*, *Linaria spuria*, *Vicia amphicarpos*, *Lathyrus amphicarpus*, and *Amphicarpæa*, the three last cases belonging to *Leguminosæ*. The distinction is important because, while flowers produced under such abnormal circumstances as on subterranean branches must be necessarily cleistogamic, it by no means follows that aerial flowers which subsequently bury their fruits should also be cleistogamic, and Mr. Darwin very properly excludes the well-known earth-nut (*Arachis hypogæa*) from his list, as, though the ovaries are buried, the flowers are conspicuous. In such cases it is possible that the comparative humidity of the soil favours the maturation of the capsules, and especially so with small herbaceous plants in dry climates. Mr. Bentham in fact has pointed out in the case of *Helianthemum* that a prostrate habit which brings the capsules in contact with the surface of the ground postpones their maturity, and so favours the seeds attaining a larger size. *Cyclamen* (in every species except *C. persicum*), by the spiral contraction of its peduncle, brings its capsules down to the surface of the soil, though it does not appear to actually bury them, as some authors have supposed to be the case. If this is advantageous we need not wonder that the local amphicarpic races of *Lathyrus sativa* (of which there seem to be several) found in such dry countries as Portugal on the one hand, and Syria on the other, should acquire the habit of bearing actually subterranean fruit.

The steps, however, by which such a specialised mode of burying the fruit has been attained as exists in *Arachis*, are not easy to follow. Of few plants have the structure and habit been more misunderstood. Descriptive writers, from Rumphius to Endlicher, have represented it as having two kinds of flowers—and as being in fact what Mr. Darwin would call andromonœcious. It really, however, appears according to the careful examination of Poiteau and Bentham to have only flowers of one kind. These are apparently stalked, but the long stalk is in reality the attenuated calyx tube, which is a very peculiar feature for a leguminous plant. At the bottom of the calyx tube is the ovary which, after fertilisation, is gradually carried away by the development of a gynophore or subovarian stalk. It is the elongation of this gynophore—and not as Mr. Darwin states, by an oversight, the flower-stems drawing the flower beneath the ground—which buries the ovary. The careful observations of Correa de Mello show that though the gynophore may become three to four inches long, the ovary does not enlarge till it is buried, which confirms what has been said above as to the meaning of the habit generally. The details of the process by which the gynophore manages to bury the ovary would be a most interesting subject for investigation.

The obscurity which has attached to *Arachis* has also extended to *Voandzeia*, another leguminous plant cultivated like *Arachis* in hot countries for its subterranean pods. Mr. Darwin remarks that the perfect flowers are said never to produce fruit (pp. 327 and 341). Correa de Mello, however, never succeeded in detecting the cleistogamic flowers, and declares that it is "placed beyond all doubt that the hermaphrodite petaliferous flowers *do*

produce fruit."[1] Perhaps therefore *Voandzeia* may have to be expunged from the list of cleistogamic plants, while on the other hand *Kraschenínikowia*, according to a thoughtful criticism of Mr. Darwin's book in the *Journal of Botany*, must be restored to it.

It may also be noted that according to Bentham *Martinsia* was a genus founded on a cleistogamic state of *Clitoria glycinoidis; Cologania* also should possibly be added to the list since Zuccarini's *Martia mexicana* appears to be an apetalous condition of some species of the genus.

Although the habit of producing cleistogamic flowers is pretty widely diffused amongst flowering plants it is locally concentrated in particular groups. This is particularly true in the case, as Mr. Darwin has pointed out, of *Malpighiaceæ* and *Acanthaceæ*, and amongst *Leguminosæ* in the *Glycineæ*. The genus *Viola* is remarkable in this respect; it is rich in cleistogamic species except in the section *Melanium*, to which *V. tricolor* belongs. In this species, besides conspicuous flowers adapted for self-fertilisation, smaller and less conspicuous flowers adapted for self-fertilisation are produced. These are not closed, but, as Mr. Darwin points out, "they approach in nature cleistogamic flowers," and though they differ in being produced on distinct plants they are perhaps destined to be as completely modified as the self-fertilising flowers of other sections of the genus.

The question as to the causes predisposing to the production of cleistogamic flowers is one of very great interest. In the first place Mr. Darwin points out that the larger proportion of known cases belong to plants with irregular flowers, that is, to plants whose flowers have been adapted for insect cross-fertilisation. Cleistogamy in this light is a resource to fall back upon when the elaborate adaptations for making insects do their work fail, as they seem to do more or less in *Viola*. It is a remarkable contrast that in heterostyled flowers, which are absolutely dependent upon insects for their legitimate fertilisation, irregular flowers are extremely exceptional, the adaptation, as far as it goes, being so complete that anything further in that direction is superfluous.

Four cleistogamic genera are normally wind-fertilised, and this shows that the cause alluded to above must be a subordinate one. Mr. Darwin urges with much force as the most potent agency, the unfavourable influence of climatic changes. From the time of Linnæus, it has been observed that exotic plants may be fertile, though their flowers have never attained proper expansion, that is to say, for the nonce they have become cleistogamic and self-fertile. The same thing occurs on a large scale with *Juncus bufonius*, in Russia, which in some districts never bears perfect flowers, while in Liguria, *Viola odorata* never bears cleistogamic ones. It is perhaps, however, doubtful whether winter-flowering plants are absolutely sterile, since the well-known *Chimonanthus*, whose name records its habit, is known to fruit, though sparingly, in this country. The evidence is, however, strong enough to render it highly probable that plants which are normally cross-fertilised, are driven into the abasement of cleistogamy when their geographical limits are extended beyond the limits not favourable to their receiving visits from appropriate insects, or to their properly expanding their flowers.

[1] *Journ. Lin. Soc.*, Bot xi. p. 256.

Here our comments must cease, content for our part if they attract a few more readers to a most fascinating research.

LETTERS TO THE EDITOR

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts. No notice is taken of anonymous communications.*

[*The Editor urgently requests correspondents to keep their letters as short as possible. The pressure on his space is so great that it is impossible otherwise to ensure the appearance even of communications containing interesting and novel facts.*]

Elements of Articulate Speech

As a corollary to the interesting observation with the phonograph recorded by Prof. Fleeming Jenkin and Mr. Ewing in the last number of NATURE, will you allow me to point out that every capital letter of the Greek alphabet except Γ and Ρ is actually (either as written or when turned through an angle of 90°) a reversible or a reduplicate symbol.

With regard to gamma, although the capital is not, the small letter (γ) is reversible; and as to Ρ (or R, which is another ancient Greek form of it), many facts seem to show that by itself it does not as a rule represent a complete part of articulate speech; witness its frequent reduplication in Greek, the aspirate so often employed with it both in Greek and Latin, and the way in which it is frequently omitted, as if of no importance, from Latin words ordinarily spelt with it. The French or Italian pronunciation of this letter amounts to a reduplication in the English ear, while the English pronunciation of it amounts to its omission altogether in the ear of a Frenchman, an Italian, or a Scotchman.

In the Roman alphabet F, G, L, P, and R, are the exceptions; much might be said about each of these, but I will content myself by saying that L is obviously only an apparent exception, as it is easily derived from A. W. H. CORFIELD

10, Bolton Row, Mayfair, March 30

Phoneidoscopic Representation of Vowels and Diphthongs

I HAVE just obtained the two following results with the phoneidoscope[1]:—

1. If a vowel be steadily sung on a single note, a constant colour-figure is produced; but if the vowel be spoken in the ordinary conversational tone, a change of figure occurs before the sound ceases. The slurring alteration of pitch which takes place in pronouncing a single vowel is thus rendered perceptible by the eye.

2. When a diphthong is slowly intoned, two distinct figures successively present themselves, which are found on trial to be those corresponding to its constituent vowel-sounds. The two-fold nature asserted in the word "diphthong" receives by this experiment a visible illustration. SEDLEY TAYLOR

Trinity College, Cambridge, April 1

The Southern Drought

YOU ask in last week's NATURE (p. 436) for information respecting the drought in the southern hemisphere. A few days ago I received letters from Samoa and the Gilbert Islands telling me of its severity there. Droughts are of frequent occurrence in the Gilbert Islands, but my correspondent (a native of Samoa) tells me they have had an extraordinary one there, which commenced in 1876, and which continued up to the date of his letter—December 4, 1877. He says many of the people have died from starvation in consequence.

A letter from a missionary who has been forty years in Samoa contains the following:—"We have had the greatest drought I have ever known." The Samoan Islands are wonderfully fertile, and even during what is called the dry season it is rarely that more than a fortnight passes without rain. The atmosphere is always full of moisture, and there are very heavy dews at night, so that the vegetation never gets burnt up, except the drought be very extraordinary. Now, however, my correspondents speak of scarcity of food in those most fertile islands.

Blackheath, March 29 S. J. WHITMEE

[Can our correspondent favour us with the date of the last drought or series of droughts?—ED.]

[1] See NATURE, vol. xvii. p. 426, note 2.