to its junction with the Gauley River the hills rise on either side higher as the distance from the mouth increases, until they fairly earn the title of mountains. At the confluence of the Greenbrier and New Rivers the mountains recede to left and right in the Flat Top and Greenbrier ranges, the latter sharply defining the course of the Greenbrier River while the New comes through the numerous chains—collectively the Alleghanies—between the Blue Ridge and the Cumberland Mts. The whole region is wild beyond description. The hills along the Kanawha are densely wooded with beech, ash, oak, walnut and tulip, interspersed with patches of pine and cedar. Deep rugged ravines run back from river to hill-top, the work of the torrents of the Quaternary. These valleys are easy of access by means of the Chesapeake and Ohio R. R. which, commencing at Huntington on the Ohio River, passes up the Kanawha and New Rivers as far as the Greenbrier, where it branches off and passes out of West Virginia near the White Sulphur Springs. I can think of no more desirable botanical tour, in which cheapness is an object, than to take the Chesapeake and Ohio R. R. at Huntington, spend a week or two at Charleston, Kanawha Falls, Hinton, Hawk's Nest and White Sulphur, with short side trips to desirable points by local conveyances. The limited time spent at Charleston gave promise of many good things if we had only had an opportunity to prosecute our labors at greater length. Many of the dry banks were covered with *Aristida oligantha* and *Arenaria serpyllifolia*. In a clump of pines we picked *Silene Virginica*, *Tradescantia Virginica*, *Pentstemon pubescens*, *Pinus rigida* and the rarer one *P. pungens*. Along shaded hill-sides was *Rosa lucida* and climbing over the low shrubs, *Smilax glauca*. The dry grade of the C. & O. R. R. abounded in stunted specimens of *Geranium Carolinianum* and *Trifolium procumbens* while on the adjacent hill-sides were much larger and finer individuals showing the beneficial influence of shade and moisture. A deep shady gorge yielded such species as *Kalmia latifolia*, *Magnolia Umbrella*, *Cedronella cordata*, *Fragaria Indica*, *Ilex opaca*, *Azalea viscosa*, *Scutellaria galericulata* (white), *S. serrata*, *Asclepias quadrifolia*, *Polypodium vulgare*, *Asplenium ebeneum*, *Aspidium marginale*, *Ligustrum vulgare*, etc. These are enough to indicate the character of the flora, and make us wish to spend the season in roving these coal valleys and romantic hills.

C. R. B.

On the Self-fertilization of Plants.—In the American Journal of Science and Arts for June, Dr. Gray gives the following review of Rev. Geo. Henslow's paper on the above subject:

This paper is elaborate, mostly able as well as ingenious, in all respects considerable, and unconvincing. Its thesis is, the Darwinian "Nature abhors perpetual self-fertilization," read backward. It concludes that, "not only are the majority of plants self-fertilizing, but that those which are exclusively so propagate abundantly and with extraordinary rapidity, are best able to establish themselves in foreign countries, as, being quite independent of insects, they run no risk of extermination on that score; . . . that, so far from there being any necessarily injurious or evil effects resulting from the self-fertilization of plants in a state of nature, they have proved themselves to be in every way the best fitted to survive in the great struggle for life." The hypothesis is also advanced "that they are all degraded forms," and that *therefore* "their ancestral life history is a longer one than that of their more conspicuous and intercrossing relations." We fail to see how this follows, except upon the assumption that the earliest phænogamous plants had the most highly organized blossoms; and that would not accord with vegetable paleontology.

Mr. Henslow rejoices that he has one staunch supporter; "for, as has been seen, Mr. T. Meehan has arrived at the same conclusion;" and indeed he builds not a little upon facts supplied by Mr. Meehan's observations. He cites the latter's "admirable paper, which was reproduced in the 'Gardner's Chronicle' for Sept. 11, 1875, and is in fact an 'apology' for self-fertilization." As he then marshals twenty reasons for believing particular plants to be normally self-fertilizing, and nineteen "chief facts which may be regarded as occurring correlatively with self-fertilization, some being actual causes which directly or indirectly bring it about," it would appear that it is no longer self-fertilization, but rather the existence and *raison d'etre* of cross-fertilization that stands in need of apology, or of explanation.

He freely concedes that the flowers of many plants, and some whole orders, are so constructed that intercrossing is for them a necessity; also that most of those which are believed "to be normally self-fertilizing" because they can and do fertilize themselves habitually," yet "may in some cases be cross-fertilized by insects." It is admitted that the structure of the latter is *adapted*—most variously and wondrously adapted—to being fertilized by particular insects. As this comes to pass in plants and flowers of the highest organization and greatest specialization, Darwin and his school conclude that this is a most advantageous outcome, and means some real good to the species; that when this is accompanied with a loss of self-fertility, it is the loss of something no longer useful, something better than self-fertili-

ty having taken its place. But Mr. Henslow, reading this the other way, having determined "that self-fertilization is *per se* a decided advantage," and free from injurious liability, comes to regard intercrossing as merely "a compensatory process for the loss of self-fertility."

But how and why did this "compensatory process come to pass? It is conceived on both sides that flowers were "primordially inconspicuous." (To this Henslow adds hermaphrodite and self-fertile; but that need not here come into account.) Both agree that insects have mainly determined their conspicuousness. Darwin says this has been determined through natural selection by the survival of the more and more conspicuous variations, correlated with their producing something good for the insect of which the coloration was a sign, and that the preferential survival of the more showy and attractive was a consequence of some benefit of the intercrossing. Henslow propounds the view that insects have determined the conspicuousness more directly, and not by benefiting but by irritating the flowers. "These, by being greatly stimulated by the repeated visits of insects, tend to become hypertrophied. Hence the corolla enlarges, becomes more brightly colored, the nectariferous organs increase the quantity of secretion, and the stamens develope more pollen. Such being the case, nourishment is withheld from the pistil, which is delayed in its development; consequently such a flower is very generally proterandrous." Mr. Darwin might accept this as an ingenious conception of the way the specialization comes about, still insisting on the advantage of the resulting intercrossing—"or else the thing would hardly come to pass," as the poet has it. And Mr. Henslow's hypothesis has to be supplemented to account for proterogyny, which is not much less common. But Henslow's supposed process works evil instead of good, and is therefore utterly anti-Darwinian and "dysteleological." For the result is a disturbance of the equilibrium and proper correlation between the androecium and gynoecium; and this, carried further, should upon this view result in the monoecious and dioecious states. So, accordingly, the cross-fertilization which comes into play in the case of separated sexes, and in that of self-sterile hermaphroditism, is not for any good there is in it *per se*, but because it may no better be. And all the elaborate, exquisite, and wonderfully various modes of adaptation of flowers to insects are only ways of repairing the damages inflicted upon blossoms by insects through their persistent visits! Did Mr. Henslow ever ask himself the question why the sexes are separate in animals?

The conclusion which Mr. Darwin had helped us to reach is, that intercrossing should be regarded as the aim in nature and on the whole most beneficial, and self fertilization as a safe-guard against the risks of crossing; that most hermaphrodite flowers have the advantage of both, the latter for immediate sureness, the former for ultimate benefit. Upon the new view, self-fertilization is the aim and the consummation, and cross-fertilization at best a succedaneum. By it insects may repair the damage they have caused to blossoms through endowing them with "the fatal gift of beauty," and stimulating their organs of secretion; and by it the winds may bring chance relief to those which at length abandoned by their spoilers, have lost this attractiveness and fallen to the degradation of unisexuality. For these last, as has already been stated, are hypothetically regarded as degraded from higher floral types.

We are bound to glance at some of the considerations which are adduced in support of this thesis. They are multifarious and of unequal value. As has occurred in other cases, so here also, the weightiest objections to Mr. Darwin's view are those which he has himself brought out, namely, the fact that, as tested experimentally under cultivation, while some plants are much increased in vigor and fertility by artificial intercrossing, others are not sensibly benefited; and that the benefit derived in marked cases is not cumulative, but reaches its maximum in two or three generations. And even close breeding under cultivation occasionally gives rise to very vigorous and fully prolific self-fertile races. Then many plants are fully self-fertile in nature, and it is not proved that any such have lost or are in the way of losing either fertility or vigor through continued interbreeding. But, before drawing from this the conclusion that cross-fertilization is of little or no account in nature, it should be remembered that bud-propagated races are in similar case. Races exist which have been propagated only from buds for hundreds of years, with seemingly undiminished vigor, and there is no proof that any one has succumbed under the process. But for all that we do not doubt that sexual reproduction contributes something to the well-being of the species, besides facilitating its dispersion. Again, no one questions the necessity of fertilization by pollen to the production of embryo in the seed; yet, even in this, the necessity is not so imminent but that some embryos may originate without it.

In short, the facts brought out by Darwin and others, and all the considerations of the present essay, are best harmonized by the conception which the former has consistently maintained, namely, that

an occasional cross suffices to secure the benefit of inter-crossing, whatever that may be. Nothing yet appears which seriously disturbs our conviction that just this is what nature generally provides for.

Mr. Henslow's proposition, "The majority of flowers are self-fertile," is doubtless true in the sense that they are capable of self-fertilization, and is not improbable in the sense that they "can and do fertilize themselves habitually." But his inference that the majority of flowers, or that any flowers, actually propagate for a series of generations by self-fecundation, or that a cross if it occur is "exceptional," and of no account, is surely unwarranted by the evidence which he has adduced.

Occasionally the reported facts will not bear scrutiny. *Gentiana Andrewsii*, it is said, never opens at all in America. It opens in sunshine in the middle of the day here in New England. And while looking at closed flowers we have seen a humble bee emerge from one. We have, in this Journal, shown how it is that self-fertilization is impossible during the first three or four days of anthesis, but neatly practicable afterwards. It is rash to infer (as on p. 330) that papilionaceous flowers which shed their pollen early in proximity to the stigma are therefore self-fertilized. In most of the cases adduced the pollen is not lodged upon the stigma, but upon the style below it, and the adaptations for intercrossing, though the mechanism be different, are as explicit as in the analogous case of Campanula. "Fremont pathetically describes the solitary bee that rested on his shoulder at the top of Pike's Peak." The pathos is wasted as respects all but this particular bee; for the entomologists find that alpine region of the Rocky Mountains to be as well stocked with flying insects as are alpine regions in other parts of the world. They do not superabound, but if from the alpine flora we subtract the evidently entomophilous and the anemophilous blossoms, the remainder will be nearly nil. And as to the correlation of this comparative scarcity of insects with the marked conspicuousness of blossoms, this is the way the lesson is read by a most eminent physiologist: "Even the glowing hue of alpine flowers is accounted for by the attraction which brighter-colored individuals exercise upon the insects, scarce in those heights and necessary for fertilization."

One or two of the author's own observations are perhaps to be revised. "*Gaura parviflora* . . . has no corolla and is cleistogamous, in that it is self-fertilizing in bud, as I found in specimens growing at Kew." Were they not imperfectly developed blossoms, perhaps late

in the season? Here the flowers open freely and have rose-colored petals. If he will examine fresh specimens of *Scrophularia*, it will soon be clear that his idea of their self-fertilization (p. 371) is a mistake. It is a mere slip in the Genera Plantarum through which abortive stamens are attributed to the cleistogamous flowers of *Epiphegus*. The authors evidently meant to describe the case just as Mr. Henslow found it to be, but used a wrong word.

"Weeds are probably all self-fertilizing or anemophilous. A weed is simply an unattractive plant, and possessing no feature worthy of cultivation." It may be as difficult to define "a weed" as to define "dirt." But, turning to the Handbook of the British Flora, we find, as we expected, that the showy Corn Poppy, Cockle, and Larkspur are denominated weeds. Why weeds should possess the vigor and gain the predominance which they do is a large question, to which other solutions have been offered than the one which is in this essay very plausibly maintained. We cannot take up the topic here; but, without acceding to his general proposition, we are much disposed to agree with the author in this essay, as respects some of them, that aptitude for self-fertilization may have given them the advantage which has determined their wide dispersion.

The insistence upon the importance of self-fertilization is what gives this essay its value. As a whole it fortifies the proposition, well laid down by Herman Mueller, which Mr. Henslow cites:—"that, under certain conditions, the facility for self-fertilization is most advantageous to a plant, while, under other conditions, the inevitableness of cross-fertilization by the visits of insects is the more advantageous." But this is not our author's thesis. It comes to this: the plan of nature is either cross-fertilization supplemented by close-fertilization, or close-fertilization tempered by cross-fertilization. As restricted to plants the difference is not wide. Regarded generally, the Darwinian axiom is still best sustained.

Forests of Central Nevada.—In an article on the Forests of Central Nevada, with some remarks on those of adjacent regions, Mr. Chas. S. Sargent, says:

A comparison of the arborescent vegetation of Nevada with that of the region lying directly east and west of the "Great Basin" may be interesting. Such a comparison will serve to more clearly demonstrate the remarkable poverty of the Nevada forests. It will afford, too, another illustration of the relation of moisture to forest distribution, especially with reference to the multiplication of species.