Schimper, the latter having been applied by him to true Eocene floras.

With regard to the flora of the Great (1st group of Lesquereux) Lignite, I entertain no doubt whatever that it is of the age of our *Middle Eocene*, and perhaps partly of our Lower Eocene. I am not in a position yet to furnish any list of the fossil plants common to both, but the proportion is very considerable. The only groups I have studied are the ferns. Of a small list from our Middle Eocene, two of the most abundant have been described by Lesquereux from this formation, *Lygodium kaulfussi* Heer (*L. neuropteroides* Lesq.) and *Osmunda*[1] *(?) subcretacea* Saporta (*Gymnogramma haydeni* Lesq.). Mr. Lesquereux has very generously himself assisted in these identifications, and I desire to express to him my thanks for his disinterested aid.

In addition to the similarity of the floras, there is other strong proof that the two formations are approximately contemporaneous. While in our lower Eocene deposits there appears but a small mixture of North American forms, so far as I know at present, in the Middle Eocene they suddenly greatly preponderate, almost to the exclusion of the Australian element previously manifest, and even of what was possibly an older indigenous flora. Judging as well from the Great Lignitic flora as from our own Middle Eocene, it appears evident that at this period land communication somewhere existed between them, which enabled them to mingle to a very great extent; so much so, indeed, that the Pliocene flora of California, lately described by Lesquereux, more resembles our Middle Eocene Bournemouth flora as a whole, not specifically, than any other with which I am acquainted.

——:o:——

NOTES ON THE FLOWERING OF SAXIFRAGA SARMENTOSA.

BY PROF. J. E. TODD.

ONE often sees in window-gardens the plant popularly called strawberry geranium. As commonly seen, perched in a flower pot on a bracket, it seems to delight in letting down its young plantlets at the ends of thread-like runners, sounding the airy depths for resting places for them. Thus its native instincts appear, though many generations have passed since its ancestors

[1] More properly a new genus.

were learning the advantages of such an accomplishment on the mountains of China.

In flowering it throws up from a rosette of radical leaves a slender naked scape which gradually develops into a cymose panicle. The flowers are of the unique form shown in Figs. 1 and 2. The two lower petals are white, and from two to three times longer than the three upper ones, which are pink, and each marked by two darker spots and one yellow spot, the latter at the base. There are ten stamens arranged in two whorls, those alternate with the petals maturing a day or two earlier than the others. There are two pistils, and on the upper side of their ovaries a triple nectary, *vide* Fig. 3 *c*. This nectary, in its structure and position, suggests the idea that it may be formed of abortive pistils.

The flowers open with surprising regularity. There is first only one at the top of the scape, then when it has passed maturity the first at the ends of the branches open simultaneously; after these have passed their maturity, then the second ones on each branch open, and so on. This regularity is most apparent in the earlier flowering. When the panicle is crowded, unequal distribution of light, heat, etc., seems to confuse and break up this order somewhat. The table subjoined shows these facts. It should be remarked that the position of the plant examined was changed from time to time. There is an irregularity in the flowering of branches VIII and IX, which may be due to their unfavorable position at the very base of the panicle.

Several very curious facts concerning the order of development of the different organs of the flower, were noted.

1. Of the lower petals, which are always unequal, the longer one is always on the side toward the branch which forms the flower next succeeding. As this is on opposite sides in successive flowers, it follows that the longer petals of flowers on any branch of the panicle are towards each other. This relation is shown in Fig. 1.

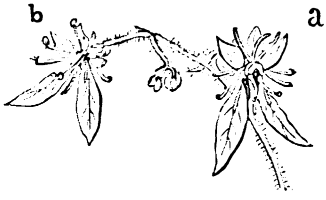

FIG. 1—*Saxifraga sarmentosa* (natural size); *a*, pistillate stage; *b*, staminate stage.

2. In both sets of stamens, those on the lower side of the whorl develop first. No. 1 (*vide* Fig. 2) always develops first, then Nos. 2 and 5 before Nos. 3 and 4; and in the second set Nos. 6 and 7 before 8 and 10, and No. 9 always last.

3. Of those stamens in pairs horizontally on the *lower* side of each whorl, the stamen in each pair on the side of the *longer* lower petal develops first. That is, if the longer petal is on the right side (facing as the flower), No. 5 will mature before No. 2, and No. 6 before No. 7, but contrariwise if the larger petal is on the left side. No exceptions were found in thirty-one observations.

4. Of those stamens in pairs horizontally, on the *upper* side of each whorl, the stamen in each pair on the side of the *shorter* lower petal develops first. If the longer is on the right side, No. 3 matures before No. 4, and 8 before 10, and *vice versa.* In forty-two observations only two exceptions were noticed, and those where No. 8 preceded No. 10 contrary to rule.

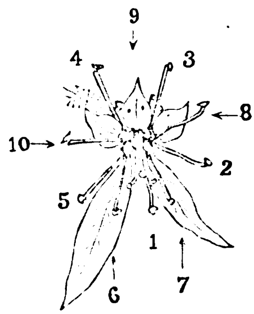

FIG. 2.—*S. sarmentosa* (enlarged); stamen No. 9 in position discharging pollen.

In a flower whose longer lower petal is on the right side, the stamens mature in the following order, 1, 5, 2, 3, 4, 6, 7, 8, 10, 9 —6 sometimes preceding 4; in one where it is on the left side, 1, 2, 5, 4, 3, 7, 6, 10, 8, 9—7 sometimes preceding 3.

5. The pistils very rarely reach maturity till, No. 9 of the same flower has discharged pollen and withdrawn from position. Sometimes No. 9 becomes entangled with the nectar and is held in the position represented in Fig. 2 longer than the regular time.

6. This brings us to the most remarkable fact of all, viz: *the automatic movements of the stamens.*

The stamens, when immature, stand nearly at right angles with

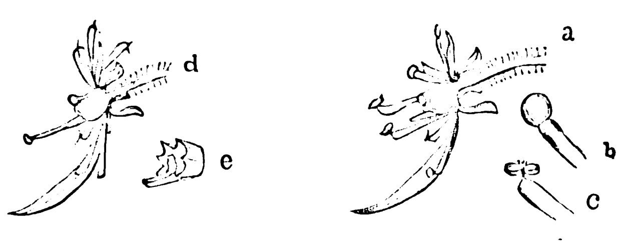

FIG. 3.—Views of the right halves of two flowers of *S. sarmentosa*; *a*, staminate stage; *b*, stamen as before the pollen is discharged; *c*, do. after, *d*, pistillate stage; *e*, nectaries and immature pistils.

the axis of the flower, but when mature they promptly (*i. e.*, probably in 30–130 minutes, according to circumstances) come into the position represented in Fig. 3 *a*. The exact time has not been noticed in a single case. Sometimes two or three stamens came into position between observations as many hours apart, but in no case was the motion rapid enough to be perceptible. After remaining in position from 2–10 hours they return to their original position, and those alternating with the petals are often thrown back much further, as is shown in Fig. 3 *d*. The stamens on the lower side of the flower, from the nature of the case, move through an angle of about 45°, those on the sides through 90° and those on the upper side about 130°–170°.

7. Another motion is quite as remarkable. The anthers are first in the relation to the filament represented in Fig. 3 *b*, but as they approach maturity they turn up, in every case, and take the position represented in Fig. 3 *c*, which shows also their peculiar dehiscence. After quite a careful examination, no peculiar organs or structures were found to explain either of these movements.

8. The pistils, when mature, bring their stigmas into the same relative position to the axis of the flower, as is shown in Fig. 3 *d*. This is done, however, merely by the lengthening of the styles and the unfolding of the stigmas.

Such an array of mysterious movements and adjustments demands an explanation. Many of them are easily explained by the doctrine of cross-fertilization. The "contrivance" is so obvious that further explanation seems scarcely necessary, but a word or two may make some points clearer. The conspicuous panicle attracts the passing insect, the highly colored petals direct to the nectar, the large petals offer a platform for him to alight and regale himself; but he must pay the price, which, however, is only to have his breast well powdered with pollen in a flower in the staminate stage, which, when he visits another in the pistilate stage will be conveyed exactly to the stigmas. The nectar is protected from insects which do not fly by the glandular hairs bristling all over the peduncles and sepals.

Close-fertilization seems scarcely possible. The only chance seems to be this. In case no insects visit the flower the nectar accumulates and may become so thick that when No. 9 comes into position it is held there until the pistils are mature, as is shown in Fig. 2, then the wind or something else, jarring the plant, may toss the pollen upon the pistils. Cross-fertilization between flowers on the same plant, or even the same branch, is possible, as may be seen by studying Fig. 1, which represents a real case, or by referring to the table and noting the conditions of the flowers on April 11th, 16th, etc. As was remarked by the writer in a previous article (*vide* this journal, Jan., 1879) there is nothing in the structure of most dichogamous flowers to prevent this, or even to make cross-fertilization between different plants any more probable, except as we postulate some fixed uniform habit in most insects visiting such plants.[1]

In the plant under consideration, however, we find a plan to insure cross-fertilization between flowers on different plants, no matter in what order insects visit the flowers. This may be briefly shown, by referring to the table representing the order of flowering. It will be seen, with the exception of the flowers on the eighth and ninth branches, which are clearly abnormal, and from their position have little part in the general economy of the plant, that each set of flowers first pass four or five days as staminate flowers, then one to three days as pistilate flowers before the next set mature any stamens. Thus the first chance is invariably given to the pollen of another plant. If that is not secured, the pistils are then likely to be fertilized by the pollen of the flowers of the next set upon the same plant. Query: Do other plants with cymose panicles present similar cases? Clearly, therefore, is the conclusion impressed, that the more diverse the circumstances of the flowers the greater the advantage of cross-fertilization. Is cross-fertilization nature's plan for distributing the advantages resulting from a favorable locality to all the individuals of a species, or, on the other hand, neutralizing the evils of a disadvantageous position? Does it render species more uniform?

There remain two or three facts concerning the development of the petals and stamens which demand explanation. We cannot see how their existence is of the least advantage to the plant. Why should one of the lower petals be longer than the other? Or, if we might attribute so much to accident, why should there be regularity about it? May it be that the petal is longer on the side toward the branch because there is a greater amount of nourishment passing on that side to supply the branch, and a proportionate amount is conveyed onward to the flower?

May not a similar relation explain why the stamens on the

[1] Cf. an abstract of a paper by Mr. A. S. Wilson in AM. NAT., Vol. XIII, p. 39.

lower side of a whorl develop first? The lower petals are enlarged to serve the purpose mentioned above. This requires more nourishment to pass through the lower side of the peduncle, and in this nourishment the stamens on that side share.

The earlier development of stamens on opposite sides of horizontal pairs, according as those pairs are above or below, is a very curious fact indeed. To explain it and the whole order in the maturing of the stamens, we will venture the following.

The flowers are quite perfectly pentamerous; the leaves also present the five-ranked arrangement. Remembering the order in which leaves unfold from the bud, and following, for the stamens of the first flower at the top of the panicle, a spiral in the same direction, as that found in the rosette of leaves at its base, we have the numbers in Fig. 4 *a* expressing their order of maturing. Assuming that the increased size of the lower petals is associated with an increase of nourishment in the lower side of the peduncle, and that the stamens are likely to share in this excess of nourishment according to their distance from the lower side of the flower, the numbers in Fig. 4 *b* express the probable order of maturing

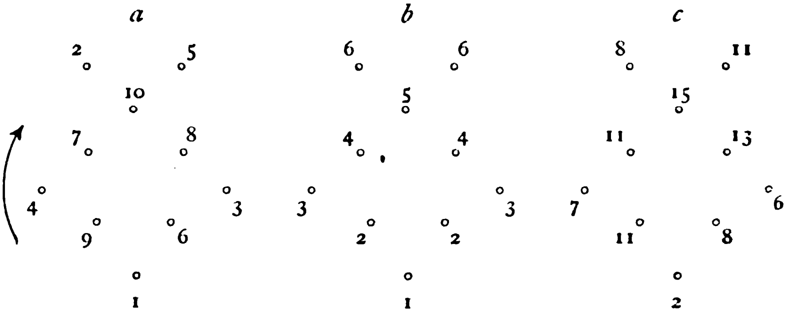

FIG. 4.—A diagram illustrating the order of development of the stamens of *S. sarmentosa*; *a*, order of development derived from phyllotaxy; *b*, order resulting from distance from lower side of flower; *c*, *a* and *b* combined.

if left to this influence alone. If we assume that both influences are acting simultaneously, the sums of these numbers as given in Fig. 4 *c*, will express the order in which the stamens ought to mature when the longer lower petal is on the left side, for such was the case in the particular flower under consideration. Using the numbers for the stamens given in Fig. 2, and referring to Fig. 4 *c*, we find that theoretically they should mature in the following order: 1, 2, 5, (4,7,) (3,6,10,) 8, 9. This corresponds exactly with the order frequently observed. The only discrepancy is that the numbers joined might theoretically come at once. Our theory seems, therefore, to be proved correct as far as it goes, and sufficiently so to justify another inference, viz: that when the longer petal is on the right side, the parts of the flower are arranged in a right handed spiral; and when it is on the left side the spiral is left handed; and, therefore, that in the inflorescence successive flowers on the same branch have spirals in opposite directions.

But why in opposite directions? And why, too, should stamens imitate leaves in the order of their development? Is it a kind of structural memory, or material instinct? The habits of growth impressed by one set of circumstances where they are advantageous, showing themselves where they clearly have not the same advantage, if any at all?

Where shall we stop? But before leaving the case, let us not overlook the fact that in the later explanations, we have been giving reasons of a very different order from those in the earlier. We then thought it sufficient to show the advantage in a particular arrangement, now we are almost satisfied when we see *how* certain forces, more or less familiar, may have produced the facts under consideration. Neither kind of solution is complete. Let us not be deceived by the ambiguity of the word *why*. It should still be asked *how* the structures so admirably adapted to cross-fertilization have been produced, and we may still ask *why* the facts concerning the stamens exist. Whether they are advantageous and serve a purpose in the economy of nature, or whether they are, as it were, rudimentary phenomena, the incidental effects of laws which have been established for some really important purpose. Such questions we have now no time to follow.

———:o:———

DESTRUCTION OF OBNOXIOUS INSECTS BY MEANS OF FUNGOID GROWTHS.

BY PROF. A. N. PRENTISS.

ENTOMOLOGISTS have been, for a long time, endeavoring to discover some available means for checking the ravages of obnoxious insects, and of late the possibility of employing fungoid growths for this purpose has been receiving considerable attention. The most important paper which has appeared upon