Botanical Notes.

By Moses N. Elrod.

Tecoma radicans (L.) D C. The trumpet-flower presents many peculiar characters that are of great value in securing cross-fertilization, and it seems to be constructed on a plan admirably adapted to meet the needs of the humming-bird.

One among the first things in its structure to attract attention is the nearly horizontal position of the flower, its short, unexpanded lower lip, the opposite of the arrangement in many flowers dependent upon insect visitors for fertilization, and the manner in which the filaments are twisted right and left so as to bring the dehiscing anther on the same plane with their backs against the upper lip of the corolla. This grouping of the anthers is effected by the outer and longer pair of the angular, dimorphous filaments making one turn on their axes and the inner pair making a half turn. The pistil is a little longer than the stamens and terminates in a two-branched, foliaceous, spatulate stigma.

In July, 1902, I noticed that the stigma is sensitive. While searching in my pocket for a magnifying glass the lobes of a plucked flower had closed so that the stigmatic surfaces were in close contact. The use of force failed to separate them for more than a moment and when one of the thin lobes was cut away the other curled up into a loose roll. At the time, I supposed that I had made a discovery, but soon found that I had been anticipated. In Müller's "Fertilization of Flowers" it is stated that when the stigma of *Bignonia* has been "touched by an insect visitor they then close up immediately." He also quotes the experiments of his brother on a South American species, showing that successful fertilization was secured only when the pollen applied came from a plant growing "at a distance." It was to test the sensitiveness of the stigmas and the conditions under which cross-fertilization was effectual that my observations of *Tecoma radicans* were made.

The stigmatic lobes of a flower which had just come into bloom, when irritated with the point of a knife-blade or any other hard substance, closed in five seconds, and those of the faded flowers in thirty seconds. A drop of water acted as an irritant when applied soon after the stigmas

had matured, but a warm rain had no effect. Fresh flowers placed in a refrigerator were not affected by the reduction of the temperature, while those exposed to cold rains seemed to have their irritability diminished. The application of pollen from the same or another flower had no effect when care was exercised not to roughly touch the stigma. Pollen was applied one evening to the tip of the lower lobe, which is the larger and longer of the two lobes, and it did not hinder their opening next morning. After closing up from the use of an irritant alone they opened again in about two hours. But if the irritation had been accompanied with the application of pollen from the same or another vine they rarely opened again, and never if the ovary was fertilized.

More than fifty experiments to determine the effects of pollenization with pollen from the same flower as the stigma treated, or from another flower growing on the same stock, gave negative results. In some cases the ovary seemed to swell and remained attached to the vine longer than those not pollenated, but they all turned black or dropped off within fifteen days.

All the stigmas treated, to determine their irritability, and the effects of pollen applied to them coming from a distance, grew on vines in the back yard of No. 823 Washington Street, Columbus, Indiana. Six strong stocks, coming from the same root, cover the fence and an old apple tree. In the autumn of 1901 they produced many matured capsules. August the 19th and 20th, 1902, eleven stigmas were pollenated from flowers collected two and one half squares distant. Six of these began to develop in fine style, but came to naught. September 9th and 10th, six stigmas were treated with pollen from a vine found growing outside the city limits, one-fourth mile west on the Nashville road. As a result, the ovary, in one instance grew to be one inch long and then withered. The others were failures and their ovaries did not appear to have grown a little bit. The season closed with nothing to show for my work and the distance theory unverified. The vine in my yard began blooming again July 1st, 1903, and the first experiment of that year was made to see how much influence the soil in which the vine grew had to do in determining the final results of cross-fertilization. July 5th, I collected flowers from a vine growing in the rich bottom land of Clifty Creek, two miles south of the city, and twenty stigmas growing in my yard were pollenated. The flowers treated, were in all stages of blooming, from those just opening to others that were fading, but none where the lobes of the stigma did not promptly

close when irritated. These experiments resulted in twelve full grown capsules. July 31st and August 3d eighteen stigmas were pollenated from flowers found growing on clay soil, one mile south of the city, which resulted in three mature capsules. August the 14th and 18th, nineteen stigmas were treated with pollen from a vine growing in clay soil one-half square north of my vine, and three mature pods were the result. Ten stigmas were pollenated August 19th from a vine growing in clay soil, at the root of a large elm tree, about one square northwest of the home vine, and eight mature capsules were the result.

Summarized, the results show that sixty per cent. of the pollenations made with pollen from a vine growing in rich loam were successful; fifteen and sixteen per cent. were successful when the pollen came from clay soil, and the vines grew in the open, under conditions nearly the same as that of my back yard, and eighty per cent. as the result when the pollen came from a vine whose roots were planted in clay soil and entertwined with those of a big elm. From this it seems that the soil in which the vine grows, has some influence on the fertilizing power of its pollen. The pollen used in the 1902 experiments, which resulted in failures, came from vines growing in the open and rooted in clay soil. The idea that pollen coming from the big elm tree vine is in some way peculiarly efficacious in producing seed is confirmed by the fact that a vine within one hundred yards of it, and favorably located to encourage humming-birds to visit between the two, has borne an abundant crop of capsules for the past two years.

The only insects noticed on the trumpet-flowers were robbers, whose visits were without compensating advantages. Black ants and little sweat bees came early and stayed late; the ants to get nectar, and the bees to collect pollen. Sometimes they found an entrance between the lobes of the corolla limb before the flower was open. The bees made short work of collecting all the pollen in sight—half of it going within fifteen minutes. When the pollen was knocked down into the tube they did not seem to be in any way put out, but went on collecting until all was gone. As many as six bees were seen together in a corolla, very busy, crowding and fighting for place. Had they found any pollen on a stigma they would have taken it. During a drouth conical holes were found in the calyx, of many flowers, that reached down to the ovary, and as mud-dauber wasps, *Sphegidæ*, were seen about the holes they were charged with making them. After rain came they disappeared, and may have done the

drilling to get at the nectar as food, or as a substitute for water in tempering their building material. Humble and honey-bees occasionally were seen prospecting around the flowers, but they rarely stopped for more than a moment.

It is remarkable, while the mechanism of *Tecoma* is peculiarly effective in preventing self-pollenation, that its pollen is impotent except when applied to the stigma of another plant under restricted conditions, and that the humming-bird is its only visitor of service in its fertilization.

Impatiens aurea Muhl. The pale touch-me-not is a common plant in Indiana, growing best in the damp, rich soil of the shaded river bottoms.

The mechanism of the flower is generally understood, but the part played by the scales, on the inner side of the filaments, is not so well known. The filaments are so arranged as to form a group, which is held together by the coherent scales. With reference to the mouth of the spur the posterior part of the group is closed by a single filament and the sides by two filaments, leaving the front with a larger opening between the anterior pair than elsewhere. The scale of the posterior filament is divided into two parts which are continuous with the coherent scales of the sides. The two resulting appendages are symmetrical, and are in close contact, on an antero-posterior line, so as to form a roof or hood over the end of the stigma. On the under side of the hood is a pocket into which the stigmatic end of the ovary is inserted. The end of the ovary is marked by a slight papilla near the anterior end of the dividing line of the hood. The pocket is so placed with reference to the plane of the hood that the end of the ovary does not push at right angles, but in an oblique direction. The filaments cease to grow when the flower opens, while the ovary continues to increase in length, and by this arrangement with reference to the hood it pushes against it without protruding, until the filaments are broken from their attachment to the receptacle. When the connection with the receptacle is broken the filaments curl backward with such force as to often cause the cap of withered anthers to fall to the ground. If this does not happen, the cap is easily displaced by the first insect-visitor that attempts to enter the spur.

When it is recalled that the touch-me-not flower is suspended from the end of a slender peduncle, and bobs and swings with every breeze or touch of an insect, the function of the hood in excluding self-pollenation becomes evident. Observations show that the hood is frequently covered with pollen that has sifted through the chink between the anthers, or has

been carried to it by small insects. But the stigmas are not always so well protected as the foregoing might indicate. As the season advances flowers begin to appear in which the stigmatic end of the ovary is exposed. On the 16th of September a patch of *I. aurea* was visited and the ovary found protruding in a majority of those examined. That this change was due to the waning vigor of the plant seems to be shown when, at a later date, after rain and continued warm weather, only one out of twenty-five flowers was found with the stigma exposed. Examination with a microscope showed pollen adhering to the papillæ of the stigma. Soon after the exposed stigmas are seen cleistogamous flowers begin to appear.

Just over, or anterior to the protuberance, made on the hood by the end of the ovary, is an erect, membranous appendage, composed of two pieces about one line long. Its function is not obvious, but it may serve as an increased protection to the stigma against self-pollenation. So far as seen it is peculiar to *Impatiens aurea*.

Impatiens biflora, Walt. After two years of observation, I am led to believe that the spotted touch-me-not produces its crop of cleistogamous flowers in the spring only, before the conspicuous flowers begin to appear. This fact has led some writers, who looked for them in autumn, to state that this species does not produce concealed flowers. Last spring hundreds of them were examined and concealed flowers found in the axils of the leaves of all the plants over six inches high. The glaucous stem of the *I. aurea* distinguishes the young plant of that species before it blooms, but to make sure of the species, they were again visited after conspicuous flowers had become abundant. The first conspicuous flowers had the stigmas exposed through a hole in the hood. But this exposure of the stigma was confined to the spring flowers. The first normal flower seen in my yard came into bloom June the 9th, and produced a seed-bearing capsule. The distance at which this plant grew, from any others then in bloom of the same species, probably excludes the possibility of cross-fertilization. Those blooming a few days later had holes in the hood.

The touch-me-not is cross-fertilized through the agency of bees. Rarely a humming-bird poises over a flower, but does not seem to find anything to detain it long. Its bill is too long and slender to make it a good instrument for carrying pollen. Humble-bees become numerous about the flowers late in the season, and by their size and clumsy move-

ments, not only detach the anther cap, but frequently manage to bring themselves to the ground imprisoned in a withering corolla. Other smaller bees, in search of honey, enter the spur without touching the anthers.

Claytonia Virginica L. The movements of the stamens and stigmas of this plant are curious and somewhat puzzling. When the petals first open the pistil is longer than the proterandrous stamens, but of the same length after the branches of the stigma are recurved. In some flowers the stamens remain clustered around the style and closed stigma for a time after the petals have opened, and while in this position, the under part of an insect-visitor readily becomes dusted with pollen. Later the stamens are bent backward until the anthers rest on the face of the horizontal pistils. When this outward movement of the stamens takes place the lobes of the stigma are also bent outward and in position for cross-fertilization. Quite often it happens that it can scarcely be said that the stamens are proterandrous, all the movements before described occurring at the time the anthers become dehiscent. When this takes place the insect-visitor has little chance of collecting pollen, but it leaves the stigma in an ideal position for cross-fertilization. Flowers can be found in all of these stages at the same time; and the honey-bee in making its rounds soon becomes dusted with pollen, without having to depend on the recurved stamens for a supply.

Unlike many flowers that are in part or wholly dependent on insects for fertilization, the spring beauty lasts but one day. It comes into bloom early in the season and its day is past before insects become numerous, hence, as might be expected, there is a provision which assures self-pollenation. The petals that open in the morning begin to close in the afternoon, and by night are gathered into an imbricated roll. If the day has been cold and the lobes of the stigma have not become fully recurved, so as to bring their papillæ on a level with the anthers, the process of recurvation is completed before they are caught by the closing petals. Examination shows that after closing the anthers with pollen still adhering are in close contact with the stigma. Pollen was found at night on the papillæ of the old flowers that was not there before insects ceased to fly that afternoon. No insect other than the honey-bee was seen about them, and, as its visits were rather rare, the numerous and well filled capsules must have been the result of self-pollenation.

Hydrophylum appendiculum Michx. is proterandrous. When the flower first comes into bloom the pistil is about one-half the length of the mature stamens. The dehiscing anthers are gray with pollen, which disappears within six hours. By the time the pollen is gone the pistil has grown to the same length as the stamens, the two lobes of the stigma are recurved and ready for cross-pollenation. Bees are the pollen carriers, which they get from the anthers of flowers that bloom at irregular hours throughout the day. A plant in my yard began to bloom early in May and was still producing a few flowers August 8th. During dry weather in July, the flowers were less than one-half the normal size, the tube very much shortened, and in others the corolla changed from campanulate to rotate.

Polemonium reptans L. The stamens are not as long as the pistil. Dehiscence begins when the corolla is about half open, and before the lobes of the stigma are recurved. Later the stamens are bent outward and the pistils left to occupy the center field. Honey-bees enter the half-blown flowers and come out well dusted with pollen, which they carry to the older flowers. Invariably, when a bee comes to a plant, it pays its respects first to the half-blown flower, and may not visit the older ones at all. It seems to know that they have been exhausted of nectar. As it enters the slenderly supported flower it clasps all the organs at once, and its movements are about as graceful as those of the humble-bee.

The pistil of *Lysimachia quadrifolia* L. and of *L. terrestris* (L.) B. S. P. when the flowers first open are sharply curved to one side by a bend near the middle of the style. After the anthers have shed their pollen the pistil is erected and the stigma in position for cross-fertilization by the insect-visitor. That this may be accomplished, the blooms last for several days.

The stigmatic lobes of *Sabbatia angularis* (L.) *Pursh.* are as long or longer than the supporting style and the whole pistil only about one half the length of the stamens when the flower first opens. To make it doubly sure that self-pollenation shall not occur, the lobes are closely twisted together until the coiled anthers have unrolled and shed their pollen. In the meantime the pistil has increased in length and the lobes curved back at right angles to the style. The lobes are stigmatic along the inner side, and remained twisted after they are recurved, so that an insect passing over or under them with pollen on its back or under parts, would be likely to effect fertilization. Many of the flowers are in bloom

at the same time, are quite handsome, fragrant, and stay in bloom a week or more. It is curious that finding the plant in a certain locality one season is no sign that it can be found there next year.

Taraxacum Taraxacum (L.) Kerst. While watching the effects of temperature on the dandelion in June a number were found which were not producing pollen, the heads were perfect in every way, but had no pollen on the styles or branches of the stigmas when the bees were excluded.

The connate anther-tubes, which were of the normal form in all stages of development, were examined under the microscope and not a grain of pollen found in them. The sterile heads were of a uniform pale yellow and lacked the golden tinted center of the fertile heads found growing near by. Bees indifferently passed from one kind to the other. Seed was formed on the sterile heads, but there were more aborted achenes than usual.

The dandelion is very sensitive to change of temperature, while the absence of sunshine has very little effect. Early in the season the same heads may be exposed as often as three days in succession, and the involucre not be opened for more than two or three hours at any one time. As the temperature increases they stay exposed from early morning until shut up by the falling temperature of the afternoon, and may not open again next day.

Ruellia strepens L. produces a large crop of cleistogamous flowers during late summer and autumn. The flowers are clustered in the axils and hidden by the long segments of the calyx. The change from conspicuous to concealed flowers involves more than a change from gamopetalous to apetalous. The stamens are reduced in length to that of the ovary with a small pollen-producing surface at the tip, which is in close proximity to the sessile stigma. The resulting capsules are numerous and well filled with seed.

Falcata comosa (L.) Kuntze sends forth long, slender, stoloniferous runners in early summer that produce apetalous flowers before the conspicuous blooms appear. Not only is the form of the flower quite different from that of those coming later, but the early, ovoid, single-seeded, fleshy pod is very unlike the three-seeded, bean-like pod of the later flowers. The mature single-seeded pods are found on or near the ground after the conspicuous flowers have come into bloom.

If *Oxalis stricta* L. produces cleistogamous flowers on recurved scapes, at the base of the plant I have not seen them, but have found flowers in

July in which the calyx remained closed over the dwarfed corolla. The only change in structure noted was that the five shorter stamens bore aborted anthers, and that the pollen-bearing anthers were in contact with the stigma. Contrary to what some writers state the stamens of *O. Stricta* are often dimorphic. The self-pollenation of the normal flower is accomplished by the corolla closing after exposure, and pressing the anthers against the stigma.

One of the most interesting changes in structure from a conspicuous to a cleistogamous flower is seen in the violet. The showy flowers are so constructed that the honey-bee is the only insect that I know to be of service in its fertilization, and only a part of the anthers are called into use by it. To reach the spur in which the nectar is stored, the bee, after it settles, has to reverse its position, and force its tongue between the two appendages on the lower stamens. In doing this it comes in contact with the stigma and at the same time is dusted with pollen from the appendaged stamens. The anthers of the other three stamens do not aid in supplying the bee with pollen, and seem to be of very little if any use to the plant. In the concealed flowers, they are aborted. The pistil, of the cleistogamous flowers of *Viola Striata* Ait., is declined, so as to bring the stigma against the end of the ovary, and in contact with the two connivent anthers. Two appendages grow from the fertile stamens, just below the anthers, that are expanded so as to cover the anthers and the whole of the pistil.

V. striata continues to produce showy flowers longer than many other species, and as a consequence its concealed flowers come in summer.

Viola pubescens Ait. develops a few yellow flowers in early spring. It continues to grow until August, and as it grows, concealed flowers are developed in the axils of the leaves.

The abruptness of the change from a showy to a cleistogamous flower was beautifully shown on a plant of *Impatiens biflora* that produced a well-developed, conspicuous flower on one branch of a peduncle and a concealed flower on the other branch.

The fact that the stigma of *Tecoma radicans* returns to its former position in two hours after it has been changed in response to an irritant, unless the irritation has been accomplished by pollen of a certain quality, shows that the process of fertilization begins within two hours after the right kind of pollen has been applied, and that the stigma is endowed with remarkable selective power. The whole process suggests the shad-

owy beginning that has culminated in the will, and recalls Professor Minot's definition of consciousness, "the function of consciousness is to dislocate in time the reactions from sensations." In *Tecoma* the reaction is not dislocated from the sensation, for there can not be such a thing as sensation in a plant, but there is a curious tendency in that direction.

The calyx of *Scutellaria cordifolia* Muhl. splits back to the base at maturity, and the helmet-like upper lip falls away. Before the upper lip falls the ripe nutlets lie loose in the bowls of the persistent lower lip. A gust of wind strong enough to set the dry leafless stems to swaying will detach the upper lip and send the seeds flying with the wind.

The following plants, which are not included in Professor Coulter's "Flowering Plants and Ferns of Indiana," are known to occur in Bartholomew County. *Quercus Schneckii* Britton is common in the western part of the county, and frequently wherever red and black oaks grow. *Quercus Alexanderi* Britton formerly was abundant on the Knobstone hills of Bartholomew and Brown counties and the north part of Jackson County. Locally it is known as chestnut oak or tan-bark oak. Some years ago the bark was an important source of revenue to the inhabitants of Brown County. Along the line of the Baltimore & Ohio Southwestern Railroad, where it grows in dense forests, it is being shipped for use as telephone poles.

Perilla frutescens (L.) Britton grows on the south side of Columbus, Hope & Greensburg Railroad one-fourth mile east of Lambert's Switch. It is abundant in that locality.

Tradescantia bracteata Small occurs sparingly, and *T. reflexa* Raf., commonly, on the sandhills of Bartholomew and Brown counties. *T. bracteata* blooms in April, and does not last later than May. The oaks above named have been reported as occurring in the State by Professor Coulter, the others are believed to be new to the Indiana list.