

Pollination in the Genus  
Solanum

by James Arthur Harris

*1903*

Submitted to the Department of Botany of the  
University of Kansas in partial fulfillment of the  
requirements for the Degree of Master of Arts

Master Thesis

Botany

Harris, J. A.

1908

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Prefatory note.

The present paper is a brief abstract of material presented to the Department of Botany of the University of Kansas for the Degree of Master of Arts. It is deposited in its present form until such <sup>as</sup> time the observations and conclusions may be presented in detail in published form.

Introduction.

Of the Family Solanaceae, the genus Solanum is by far the most important, containing about nine hundred of the fifteen hundred species. It is of wide geographical distribution, being found in all the warmer parts of the world, but reaching its highest differentiation into species into South and Central America.

During the summer of 1901, the writer became much interested in <sup>the</sup> pollenation of S. rostratum and in connection with one of his students, Mr. Oscar M. Kuchs, published a paper in the Kansas University Science Bulletin, giving the results of their observations. Since he has been at the Missouri Botanical

Garden, opportunity has been offered for examination of other material, as well as much rare and valuable literature. The writer soon came to feel that a monographic treatment of the pollination of the species of this genus is desirable. The present paper is a brief abstract of a part of the material so far collected for this monograph.



Structure  
of the  
Flower  
of  
Solanum.

- I. Calyx.
- II. Corolla.
- III. Stamens.
- IV. Pistil.

The calyx of Solanum is gamosepalous, normally five or ten parted; prickly or unarmed, persistent, remaining unchanged in fruit or increasing greatly in size and <sup>en</sup>veloping the fruit. In the pollination of the plant, so far as known, it plays no part. A difference in form of the calyx in male and hermaphrodite flowers will be noticed in a later section.

The gamopetalous corolla is usually regular, but zygomorphous in some of the species of the section Nyctium. The zygomorphy in this case has, so far as known, no direct biological significance, the only

function of the two larger lower lobes being the enfolding the enfolding of the pistil and the larger lower stamen or stamens.

The stamens of Solanum, five sometimes four to six in number, are inserted on the corolla by very short filaments, or sometimes one filament very much produced; anthers long and tapering or short and thick in outline, closely approximated or united; dehiscing by two terminal pores which are sometimes increased by lateral splits.

Waltstein, in Die naturliche Pflanzenfamilien, uses more than any other author in the division of the genus into sections, characteristics offered by the stamens. While they are ill defined, grading

as they do into each other, he recognizes five sections; Pachystemonium, Lycianthes, Leptostemonium, Lycopersecum and Nycterium.

Of these, Lycopersecum and Leptostemonium contain species which show equal stamens and include about 410 species; while Pachystemonium includes species in which the stamens are equal, or nearly equal, in length; Lycianthes contains species whose filaments are of unequal length, one exceeding the other; while in Nycterium, we have about fourteen species of the most

pronounced zygomorphous type, sometimes with unequal stamens only, sometimes with a zygomorphous corolla as well. Pachystemonium includes about 400 species principally South and Central American, while Lycianthes includes about 80 Central and South American and South-eastern Asian forms. In his division, there are about 94 species which show marked irregularity of the stamens. Of course other characteristics besides the length of the stamens are used in defining the sections, but it is not advisable to

consider these characteristics at this time. The writer is free to admit that he does not fully understand Wettstein's arrangement, and since so far as he has been able to discover, Wettstein has never published a list of the species which he would refer to the general sections, there seems to be no means of determining just what he intended each section to include.

Todd, in his paper, gives a list of seven species which show stamens similar to those of S. rostratum. Owing to better facilities, the writer has been able to increase

this list greatly, so that now we have a list of 69 species showing a more or less marked difference in the form of the anthers.

The occurrence of a dimorphism in the stamens of *Solanum* as a teratological phenomenon is not unknown. Todd records it for *S. tuberosum* and *S. Carolinense*. It has also been recorded for *S. Dulcamara* and the writer has observed it in *S. nigrum*. Todd's figure of the abnormal *S. tuberosum* shows a marked difference between the stamens; he does not figure the condition he describes in



S. Carolinense, and since the writer has never been so fortunate as to observe it in the immense series of material which has passed through his hands, he is inclined to think that Todd mistook the perfectly normal projection of the lower anther, due to the slightly oblique position of the androecium on the corolla, for a real difference in length.

As genera to contain the species showing the most marked difference in the form of the anther, Androcera and Nyc-  
terium have been proposed, but are now recognized only as sections, even if they are

accorded this rank.

An attempt to classify the modified stamens would, in a way, be useless, since what might be called the different types are so connected by transition stages as to make any clean-cut division impossible. There may, however, be recognized the two types, one in which the filament alone is effected, and the other in which there is also a marked increase in size and modification of form in the anther. While it is almost always the lower stamen or stamens which undergo the modification,

at least one exception to this is found in S. lycioides. S. inaequale presents three distinct types of stamens.

In certain cases the dimorphism in the stamens extends not only to form, but to color as well; the larger anther in at least three cases being decidedly different in color from the smaller four, and the list will probably be increased by an examination of living material of other species, since, in herbarium material, the anthers soon fade to a uniform color.

The pistil of Solanum is provided with a filiform or capitate stigma, which is sometimes somewhat lobed. In the zygomorphous forms, the style is for the greater part of its length, somewhat decurved and then curved upward at the tip. Several of The Floras, in characterizing the genus, describe the pistil as being more or less curved at the tip. The function of this arrangement will be made clear when the pollination of some of the species is discussed.

Polygamous Inflorescence  
in the  
Genus *Solanum*.

The genus Solanum is generally characterized as hermaphrodite. No indication to the contrary is given in Gray's manual, Button and Brown's illustrated Flora, Button's manual, Chapman's Flora of the Southern United States, Bentham's Flora Australiensis, Hooker's Flora of British India, or Trimen's Handbook of the Flora of Ceylon. No indication of any but perfect flowers is given in the treatment of the genus is given in Bentham and Hooker's Genera Plantarum, or Engler and Prout's Natürliche Pflanzenfamilien.

While the presence of <sup>fruit</sup> polygamous flowers is infre-

frequently noted in characterizing  
 the genus in general systematic  
 works, it has by no means remain-  
 ed unnoticed for the abortion of  
 the pistil has been recorded in  
 the description of many species,  
 and, indeed, has been several  
 times considered in the description  
 of the genus. Dunal, in 1813 (His-  
 torie des Solanum) said: "Stylus  
 filiformis, rectus vel deflexus, in  
 floribus fertilibus staminibus  
 longior; in floribus sterilibus,  
 filamenta subaequante." He also  
 discusses at some length in the  
 text of the same work the condi-  
 tion of the different elements of  
 the flower in the two forms,  
 laying some stress on his section

Melougenia.

In a recent paper Heckel quotes Dunal's work and makes further observations on an African species. It is at least one representative of the Dunal's section.

Melougenia he found a partial abortion of the pollen in the anthers of the physiologically female flowers as well as the abortion of the pistil in the flowers of the other type.

Dunal in De Candolle's Prodrôme in his Conspectus Generis Soriani recognizes certain sections with polygamous flowers. From his synopsis of Species 82 of his 898 species would be characterized as Polygamous.



Sendtner in Flora Brasiliensis uses a somewhat different method of division and gives no section to those species with Polygamous inflorescence.

Darwin publishes a letter <sup>from</sup> Fritz Müller in which a difference in the length of the style in different flowers of the same plant of a South American species is noted and those with short styles are characterized as male in function since they are visited by pollen collecting insects which would hardly touch the pistil.

Early in the summer of 1902 the writer observed that there occurs in many of the

flowers of S. Carolinense a strong reduction in the size of the pistil. The only reference in the literature seems to be that of Lindtner who says of this species: "Flores vidi non nisi steriles, absque pistillo". The pistil shows considerable range in form being sometimes exerted for as much as two thirds the length of the anthers, while in others capitate green stigma extends only to the end of the anthers & even a less distance. In the sterile form this pistil is simply reduced in size having about the same length as the filaments. The stigma has sometimes assumed

the characteristic green color and sometimes not. The form of the pistil in the mature sterile flower corresponds to that of the pistil in the young bud of the perfect flower. The development of the stamens is at first more rapid than that of the pistil.

While he has not before him such series of material the writer feels confident that in the material that he has examined, there was a complete series of mature flowers extending from the longest styled forms to those in which the pistil is most reduced. At the same time, transition stages are rare, the reduction where

it occurs being usually very pronounced.

Of 1048 flowers gathered at random in St Louis, Mo., between July 20 and Aug. 5, 1901, 863 were Hermaphrodite and 185 staminate, giving 82+ percent of perfect flowers and 17+ percent of those with undeveloped pistil. Somewhat similar results were obtained from an examination of material at Thayer Kans. and Lawrence Kans.

The reduction of the pistil may occur in any or all of the flowers of an inflorescence.

The lower flowers of a cluster are almost always perfect while those near the end are

much more likely to be simply  
 staminate. When the results  
 of the examination of 100 racemes  
 are expressed in a graphic curve  
~~the~~ <sup>with</sup> vertical lines ranged from  
 left to right representing the  
 sequence of flowers from base  
 to tip of the central axis of the  
 raceme, it will be seen that in  
 the first two numbers, 98 percent  
 of the flowers are perfect after which  
 the curve drops quite regularly to  
 zero in the fifteenth number which  
 was the largest number pro-  
 duced on any raceme. The  
 proportion of the two types is  
 by no means the same for  
 different localities. On some  
 spots the perfect flowers are

present in the average proportion or even almost exclusively while a short distance away will be found an unusually high percentage of sterile flowers, as many as 23 staminate to 4 perfect flowers being noticed on one plant.

On *S. Symbriifolium* much the same condition was found to obtain. In this case however there is some indication that the abortion of the pistil has progressed somewhat further than in *S. Cassiense*. A curve compiled from a much smaller series of material shows a marked decrease in the number of per-

fect flowers as the end of the raceme is approached.

In both of these species the polygamous inflorescence seems to serve no biological purpose. So far as known neither of the plants are commonly visited by insects. Robertson observed Bombus collecting pollen. The writer has only once seen this insect visiting the plants in ~~the~~ <sup>two</sup> summers in which they have been quite carefully watched.

It is certainly of interest to note that in other species of the genus the pistil is not the only organ affected. In D. Amazonian the calyx, corolla,

and stamens are markedly different in the two types of flowers, while in the group Trichanthera the calyx is also affected and according to the observations of Hecke in some cases the stamens of the pistillate flower show partial abortion of the pollen.

In conclusion then some species of Solanum are markedly polygamous through the failure to completely develop <sup>of</sup> the pistils of certain flowers. In some species the polygamous arrangement evidently performs no biological function and the greater percentage of aberrant forms in the later flowers of an inflorescence



might suggest defective nutrition as its cause. In other species the arrangement seems to have a true biological significance; other parts of the flower, as well as the pistil being strikingly modified in form. This is probably most prominently shown in *D. andersonian* while the conditions ~~are~~ prevailing in the group *Melou-*  
*gena* are of especial interest.

# Observations

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## Individual Species

- I. *Solanum carolinense*
- II. *Solanum dulcamara*
- III. *Solanum elaeagnifolium*
- IV. *Solanum nigrum*
- V. *Solanum rostratum*,
- VI. *Solanum sissymbriifolium*
- VII. *Solanum tuberosum*,

S. Carolinense L.

The polygamous inflorescence of this species has been discussed in its proper place. Robertson, Acad. Sci. St. L. 5: 582, says:

S. Carolinense L. - Like the preceding [S. nigrum] this flower is adapted to Humble-bee females, which visit it only for pollen. I have seen Bombus Americanorum ♀♀ collecting the pollen.

The flowers of this species open early in the morning and close early in the evening, the corolla folding down close over the stamens and pistil, and it is very unusual to find in the evening a flower that has failed to close. In the largest percentage of cases, the

pistil is decidedly curved at the tip, and, in nearly all cases in which the closed flowers are examined, the stigma is found to be in contact with the corolla. Insect visitors are rare. During two summers in which the plants have been quite carefully watched only once has a Bombus been seen collecting pollen. It seems, then, that pollination must be effected by the pollen falling upon the corolla and being transferred to the stigma when the flower closes in the evening, as is said to be the case in S. tuberosum. This species has no odor.

## I Dulcamara.

This species is of especial interest, since so far as the writer is aware, it is the only species which is not clearly a pollen flower. Delpino considers it a good beautiful representative of his "Tipo Borago"; He saw Bombus italicus collecting pollen. Delpino is criticized for his disposition of this species, by Müller who had already published observations which he considered show that the plant is sometimes pollinated by flies deceived by the appearance of the base of the flower. This has a glistening appearance as if moistened by some fluid

and the insects examine with their proboscis lobes first this surface, then the stigma and the pollen-yielding tip of the stamens, thus he thinks recurring cross pollination when the process is repeated on other flowers. According to most writers *S. Dulcansara* is rarely visited by insects. Hoffer, however, found that this species was persistently visited by Bombi in great numbers and he secured several species of this genus. He found that they secured pollen by squeezing it out of the anthers with their jaws, the anther being

sometimes bitten through in the process. In one species he noticed a localization of habit, since in some places it visited S. Dub-camara persistently, and in another place did not. The observations of Hoffer rather tend to bear out Delphin's idea, but Müller's suggestion is certainly very interesting.

S. elaeagnifolium

The only observation on the pollination of this species is that of Cockerell who records numerous insect visitors in N. Mex. and calls attention to the fact that in this respect the species is markedly different from those described by Darwin and Müller.



S. nigrum L.

Henslow concludes that S. nigrum is decidedly self-fertilizing. Müller saw Syrphidae feeding on the pollen. Robertson considers the flowers especially adapted to Humble-bee females which visit them only to collect pollen, which they milk out of <sup>the</sup> apical slinks of the anthers, using their jaws as in Cassia; the visits of the Syrphidae recorded by Müller, he thinks, have little significance.

*Solanum rostratum.*

In 1882 Prof. Todd published his interesting results on the pollination of *S. rostratum* and *Cassia Chanicrista*. Since that time little has appeared on the subject of an original nature.

During the summer of 1901 opportunity was afforded the writer for making quite extensive observations on the pollination of this species and through the kind cooperation of Mr Kuchis a considerable amount of material was accumulated and presented in Vol. I of the Kansas Univ. Science Bulletin. The results obtained by the writer did not agree very well with those of

Prof. Todd but the disagreement must be attributed largely to the inferior quality of his material, S. prostratum having been but recently introduced into Iowa and apparently not ~~having~~ been thriving very well the largest number of flowers mentioned as being produced on one plant being ten, a very small number for this species. While also not native to Kansas it has been long and well established and seems to be ~~as~~ perfectly adapted to the region, growing luxuriantly. The plant is a low-growing bushy annual, sometimes attaining a height of one and one half feet with

a diameter of five or even as much as seven feet. The plant seems to be quite xerophytic in habit but not so much so in structure; the root system is deep enabling it to withstand long and severe periods of drought, but there seems to be no very marked adaptations for the prevention of transpiration. Native of the dry plains of the South West it has during recent years spread over a large portion of the Eastern United States and has also been reported from several European localities.

The flower is of the characteristic Androcera or Nycterinum

type one of the lower anthers  
 being much longer than the  
 others, about twice their length,  
 crooked somewhat to the out-  
 side and strongly rip curved  
 at the tip. The sulphur yellow  
 corolla is markedly zygomor-  
 phic, the two lower lobes ex-  
 tending considerably beyond  
 the others, and in the bud,  
 enclosing the large stamens  
 and the pistil, as is charac-  
 teristic of several of the species  
 of Wettstein's section Nycter-  
ium. The color of the large  
 anther has been referred to  
 earlier in the paper. As to  
 histological structure, Hal-  
 stead concludes that while

much larger than the others, the large anther does not exceed the smaller in pollen-producing capacity. The writer has not satisfied himself as to the correctness or fallacy of this conclusion.

In the bud, the pistil lies immediately over the large stamen, but upon the opening of the flower, extends down and out between the filaments of the large stamen and that of the small stamen, either to the right or the left. Thus the flowers are "right or left-handed", those flowers in which the pistil extends to the right

hand, with the observer facing in the same direction as the observer does being designated as right-handed, while those extending to the left are designated as left-handed. The flowers on the right-hand side of the raceme, as we pass out from the central axis of the plant, are always left-handed; those on the left side, right-handed.

The flowers are arranged on racemes which extend upward at a considerable angle, instead of horizontally, as stated by Professor Todd. This, by bringing the flowers above the foliage, renders them con-

spicuous.

Extensive and detailed observations have shown that in a series of plants, the number of righthanded and left-handed flowers is nearly equal, there being 93 right-handed and 94 left-handed flowers on one lot of ten plants. The greatest difference was noticed on one plant of fifteen flowers, where 40 per cent. were right-handed and 60 per cent., left-handed. Todd states that all the flowers opening on a given branch at one time are either all right- or all left-handed. Statistical observation has shown this to be incorrect. Of 36 raceme-



bearing branches observed on three plants, 18 produced only one type of flower, but of these eighteen branches, 15 produced only one flower each. In the larger ramifications of the plant, the number of right- and left-handed flowers is generally about equal, and even in the smaller branches this is not unfrequently the case. When on a plant there occurs one morning a marked excess of one type of flower, there is an access of the other type the following morning, a condition which is necessary to the production and maintenance of an equal number of the two

types of flowers on the plant, and one which is to be expected from the alternate occurrence of the two types on the opposite side of the raceme.

In this place it seems advisable to note the occurrence of right- and left-handedness in other groups. While it would hardly belong to the class of modifications here considered, it is of interest to note that Darwin describes a right and left-handed arrangement in the essential elements in the flowers on the opposite sides of the stalk of one of the Orchidaceae, *Mormodes ignea*. In other species of the section

Mycterium with only one modified stamen, we may suppose that the arrangement is similar to that in S. rostratum, although an examination of suitable material or figures of these species has not made a direct proof possible. The inflorescence in these types, so far as the writer is aware, is very similar to that of S. rostratum. In the species of this section which have modified stamens, the lateral asymmetry of the pistil is hardly to be expected, since anatomical considerations would seem to render this almost, if not quite impossible. In the interesting monotypic genus

Santpoulia, there occurs a right- and left-handed arrangement of the pistil very similar to that of S. rostratum, but the material available for study was too meagre to determine any law giving the production of the two types, further than that they seem to be present in about equal numbers. An abnormal form was noticed in which the pistil extended straight forward over the two adnate anthers instead of to either side. In another genus of the Fesmeriaceae there is reason to believe that there occurs the same condition as in

Saintpaulia. In Lobelia  
lanceolata, Brown finds the  
right and left-handed ar-  
rangement, as in S. rostratum  
and concludes that the method  
of pollination is the same.  
In Cassia, the right- and left-  
handed arrangement was  
noted in C. chamaecrista by  
Todd, and much more exten-  
sive observations published  
by Harris and Kuchs. Here,  
on an average, the number  
of right- and left-handed  
flowers produced on a plant  
is about equal. There seems  
to be no law governing the  
production of right- and left-  
handed flowers on the oppo-

site sides of the main axis.  
 No law governing the pro-  
 duction in the extra-auxili-  
 ary clusters could be deter-  
 mined, except that more  
 than one flower was never  
 open at a time and in a  
 cluster where a flower was  
 blooming, there was never  
 found a bud which would  
 open the following morning.  
 In his treatment of "Arbeits-  
 theilung bei Staubgefäße von  
 Pollenblumen", Hermann  
 Müller describes four species  
 of Cassia. In the first and  
 third, C. chamaecrista and C.  
multijuga, there is a decided  
 right- and left-handed ar-

arrangement. In the second, C. neglecta, he describes a less marked right- and left-handed condition, somewhat similar to that which the writer has observed in C. morlandica.

The arrangement in this case, the writer believes, has little or no biological significance, being purely incidental.

The flowers open early in the morning and remain open from three to four days, depending somewhat upon the condition of the weather, and partially close at night. Of a lot of material examined during the summer of 1901, thirty six per cent. had not

~~had not~~ closed at all at 9 P. M.  
 Of the 32 closed flowers, 20  
 had the pistil touching the  
 corolla, while 12 did not. When  
 compared with the results  
 obtained from S. Carolinense  
 these figures are very inter-  
 esting.

In a limited series of ex-  
 periments in artificial pollen-  
 ation of S. rostratum, seed pods  
 were obtained from pollen from  
 the large anther of flowers on  
 the same raceme as well as  
 from other plants. No experi-  
 ments were made with pol-  
 len from the small stamens.  
 microscopic examination re-  
 veals no marked difference in



the pollen from the two types of anthers. In one plant which was covered, self-pollination seemed to occur in one of the thirteen flowers. It would seem that the most plausible explanation would be that the pistil obtained pollen from the corolla upon the closing of the flower, as is the case in other species of this, as well as of other genera.

Professor Todd observed only a small humble-bee visiting the flowers of this plant. The writer has secured a considerable list of species, which list will probably be still more increased by more extensive

collecting. The writer found that Humble-bees were the principal agents effecting cross-pollination. Among other insects observed visiting the flowers, the honey-bee was the most frequent.

As opposed to Professor Todd's statement, the writer observed that the flowers have a very noticeable odor, especially, early in the morning.

As to the method of pollination, it is observed that the insect generally rests on the projecting large stamen and pistil as on a platform, while it collects pollen from

the small stamens by milking it out with the mandibles. Professor Todd's theory was that by the jarring of the large stamen, a puff of pollen was thrown upon the left or the right side of the insect and subsequently transferred to the pistil of a flower of the opposite type when that was visited. A considerable quantity of pollen may be thrown from the large stamen upon tapping it, but that pollination should be secured exclusively in this manner when the insect is so completely dusted with pollen from the small stamens seems highly improb-

able. Some insects visit the plant without touching the tip of the large stamen or the pistil, so that pollination would not be effected. Some insects secure pollen from the large stamen by taking it directly from the terminal pores. The method of collecting pollen agrees with that observed by Hoffer for S. Dulcamara and Robertson for S. carolinense and S. nigrum.

Of course the statement of Professor Todd that the next flower of the opposite type which is visited by the bee is is very apt to be on another plant loses entirely its signif-

icance, since it has been shown that the flowers on a branch are not at all likely to be all right- or left-handed.

Insect visitors are most numerous early in the morning. In one patch examined between eight and nine o'clock, nearly all the flowers had already been visited. Under these circumstances, a great many flowers will be visited by the insect before one is found which has not already been despoiled of its pollen.

The insects work rapidly, as many as twenty flowers being sometimes examined in a minute, and, being so

thoroughly dusted with pollen, cross-pollination is almost sure to take place.

That pollination rarely fails to be effective is seen from the fact that, in a series of material examined, less than seven per cent. of the flowers fail to produce seed-pods. The number of seeds is very high, being estimated at about 7000 in ordinary plants; one was noted upon which 40000 seeds were estimated, while an estimate of 100,000 seeds is on record.

Before drawing the conclusions for this species, it seems advisable to consider

some forms in which the structural adaptation for pollination are very similar.

While a large number of zygomorphic flowers show an adaptation to cross-pollination by deposition of their pollen upon the ventral surface of the visiting insect, the forms apparently most closely related to the zygomorphic *Solanums* are certain representatives of the Cassalpiniae, where the structure is strikingly similar. In the genus Cassia are a number of forms extending from those with perfectly similar stamens to those in which the upper stamens are aborted, the central

stamens furnish pollen to the visiting insect, while the lower, together with the pistil, form a platform upon which the visitor may rest. In Dicorynia, a South American genus of two species, there are two stamens, one of which is about twice the length of the other, borne on a stouter filament and having a smaller anther; the anther of the small stamen has eight, instead of four locules, and apparently a much greater pollen-producing capacity.

Moldenhousera, a South American genus of four species, has eight or ten stamens, of



which seven or nine are, short and have almost basifixed anthers, while the lower stamen is much larger and has a small and usually sterile anther. Martia is a South American genus containing two species; the stamens, dehiscing by terminal pores, are usually four and unequal, the two lower being the longer. In macrobium, which is apparently nectiferous, the anthers of the three long lower stamens dehisce by longitudinal slits, while there are seven or fewer staminoidia or sometimes none. Rabichea an Australian genus of seven

species, closely related to Cassia, has only two stamens, of which the lower one is sometimes much produced, and, according to the descriptions, pollenbearing for only about the lower third of its length. Brown, who has examined living material at Kew, considers that pollination takes place as described by Todd for S. rostratum. In Bauhinia, a genus of about 150 species widely distributed in the tropics of both hemispheres, stamens may be ten and all fertile, or from one to nine may be reduced to staminoidia or absent. In the monotypic genus Tamarindus,

the method of pollination is doubtless similar to that of some of the *Bauhinias*. In the genus Swartzia of about 60 species, we have one section in which some of the anthers are larger and borne on longer filaments than the others.

While only direct ecological observations could settle some of the points in the biology of these flowers, some idea may be obtained from anatomical considerations alone. In Cassia micilandica, Michx. considers that fertilization is effected by pollen from the small stamens and this the

writer has found to be fertile  
 in artificial pollination exper-  
 iments. In Dicorynia the  
 larger size of the anther of the  
 shorter stamen would suggest  
 that it furnishes the pollen  
 while the small size of the  
 anthers and the large size of  
 the filament of the large  
 stamen would indicate the  
 function of support. In Labi-  
 chea the condition might seem  
 to be very similar. In Molden-  
 howera, the much longer  
 lower stamen with its usually  
 sterile anther would seem to  
 serve only as a support for  
 the visiting insect. In Bau-  
 linia, however, when the

androecium is reduced to a single stamen, pollination must of course be effected by it. In the genus Swartzia the pollen for fertilization would seem to be furnished by the lower stamens, since the anthers are vastly larger than those of the numerous shorter stamens, and the significance of this in comparison with S. rostratum cannot be overlooked.

In conclusion then in S. Rostratum there are present right and left handed flowers in almost equal numbers. As a general rule on a raceme only one flower opens

at a time, but very commonly two will open on the same raceme during the same morning giving a right and a left handed flower opening simultaneously and thus permitting in a considerable number of cases, pollination between flowers on the same raceme, even if Prof. Todd's theory of the method of pollination be the correct one. Various species of insects visit the flower for pollen. The flower has a distinct odor, autogamy sometimes takes place. In some cases at least, the pollen from the large anther has been shown to be fertile.

The source of the pollen which affects fertilization is not definitely decided, and in this species as well as in structurally similar forms in other families there are some points in favor of the theory that the pollen for fertilization is furnished principally by the large stamen or stamens as well as in favor of the theory that this stamen or stamens serve simply as a support for the visiting insect.

S. sisymbriifolium, Lam.

The flowers are rather large and conspicuous, white or blue in color, and with a pronounced odor very similar to that of S. rostratum. The flowers close in the evening, as do those of S. Carolinense, and to a great extent, pollination is probably effected in the same way. Contrary to the descriptions noted in systematic works, the terminal pores are increased by lateral slits extending to the base of the anthers. The presence of a decided odor would suggest that insect visitors are something of a factor in the pollination of this species.



S. tuberosum

According to Kerner and Oliver (2: 120-128) the flowers become pendulous during the night, by a bending of the individual flower-stalks. They state also that the corolla closes at night, unfolding again in the morning. Müller says that the peduncles stand almost horizontal at the time of flowering, and the corolla becomes almost vertical. The flowers are little visited by insects; autogamy may take place by the pollen falling upon the corolla in the nodding flowers, and its subsequent transference to the stigma. Halstead states that in some of the cultivated

varieties the condition of the anthers is almost sterile, and often they do not dehisce at all.

Darwin speaks of the fertility of self- and cross-pollination in varieties of this species.

*Conclusion.*

In conclusion then:

Solanum is for the most part regular, but in about one tenth of the species is more or less zygomorphous. Zygomorphy is most pronounced in the section Nycterium, where it is in some species at least, a decidedly advantageous adaptation to pollination. In at least one species of this section there occurs regularly a right and left handedness in the arrangement of the pistil and the one aberrant stamen. The right and left handed arrangement has also been observed in genera of very different families as

Leguminosae and Gesneriaceae. That it has any direct significance in the crossing of flowers of opposite type has not been satisfactorily shown. The lower larger stamen or stamens and pistil undoubtedly serve as a support for the visiting insect, and while there are some points in favor of a theory that pollination is effected by the pollen from the large stamens, there are also strong indications in this as well as in other genera in favor of the theory that the principal function of the large stamens is simply that of supporting the

insect.

The flowers do not offer nectar to the visiting insect, so that fertilization, when effected by insects, is by pollen-collecting species. The only exception to this is the possible one of S. Dulcamara, which Müller regards as having a Pseudonectary, which sometimes deceives flies. Bombi are apparently the principal insect agents in pollination of the flower. They secure pollen by squeezing it out of the terminal pores of the anthers, using their jaws as in the case of Cassia. The corolla is often conspicuous, white-blue or

yellow in color, some species show a decided odor.

A large number of species seem to depend largely on self-pollination which is probably affected by the falling of the pollen upon the corolla and its subsequent transference to the stigma when this closes at night.

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