

POLLINATION OF *CAMPANULA AMERICANA* AND OTHER PLANTS.

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*Campanula Americana* L. is markedly proterandrous. In the bud the anthers are in contact with the pilose two-thirds of the style and discharge their pollen introrsely before the corolla opens. As the flower bud opens the filaments wither beyond their more persistent bases. In the meantime the style grows rapidly in length, so that in a few hours it is long-exserted, declined and the pilose, pollen covered end turned upward. No matter whether the flower is on an erect or inclined branch the pilose end always turns upward, while the other portion of the style assumes a horizontal or slightly declined position. One or two days after the bud has opened the hairs on the style begin to wither and drop their charge of pollen. At the same time stigmatic papillæ are exposed and ready for cross-pollination. Nectar is secreted by a fleshy disk surrounding the base of the style, and is protected from rain and the predatory incursion of many insects by the triangular bases of the five stamens.

Honey-bees and the beautiful metallic-green *Agaostemon radiatus* Say are frequent visitors. They readily gain access to the honey by lighting on the petals of the rotate corolla and inserting the tongue between the style and bases of the stamens. Their visits, however, do not promote fertilization, as their movements, in approaching the flower or in collecting honey, never bring them into contact with the pollinated portion of the style nor do they ever touch the stigma.

*C. Americana* is cross-fertilized by a leaf-cutter bee, *Megachile brevis* Say. It differs from the honey-bee in its structure and the way in which it approaches the honey disk. It is armed with a dense brush of hairs on the under side of the tail, instead of having pollen baskets on the legs; it comes to the flower on the wing, in a direct, unhesitating way, over the upturned stigma, which it frequently touches with the hairs of its tail; it settles on the style with its head directed away from the stigmatic end of that organ, and never comes in contact with the corolla except with its fore feet. While in this position collecting honey the

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hairs of its tail are in contact with the pilose portion of the style and become pollinated, if the flower has recently come into bloom and the style has not yet shed its hairy coating. But this leaf-cutter is not wholly dependent on its position while collecting honey for a supply of pollen. On several occasions it was seen clinging to the style and transferring pollen to its abdomen with its hind-legs, a maneuver that no other bee seems capable of performing. With the hairs of its tail charged with pollen it is easy to understand how cross-fertilization is effected, as it passes from one flower to another; and so systematic are the movements that they appear to be evolved for the purpose they fulfil. So far as the writer has been able to discover, no other insect than *M. brevis* is of use in fertilizing the tall bellflower. Another leaf-cutter, *Megachile infragilis* Cresson, was often seen collecting honey from *Impatiens aurea*



Figures. CAMPANULA AMERICANA L.

- a. Triangular bases of stamens.
- b. Pilose end of style covered with pollen and bee collecting honey.
- c. Style denuded of hairs, bee about to brush against lobes of stigma.
- d. Style denuded of hairs and bee in position on style while collecting honey.

Muhl. and pollen on *Helianthus annuus* L. growing nearby, but was never seen on *C. Americana*.

The tall bellflower, on which the observations described were made, grew in the back yard of a city residence, and was in bloom from July

to November 8, 1904, at which last date forty-seven perfect flowers were counted. Long before November heavy frost had ended all insect visits and the plant had been dependent on self-pollination for fertilization for a month. With frost came some noticeable changes in the mechanism of the flower. The end of the style was not so uniformly bent upward, and the pollen-bearing hairs were much more persistent. During the latter period self-fertilization was effected by the lobes of the stigma bending back until the papillose extremities touched the pollinated hairs. The same movement may have occurred earlier in the season, but if it did it was not so obvious, and many times it would have been useless, as the styles were denuded of their hairy appendages, and the lobes not yet reflected more than usual.

Within the inflated limb of *Pentstemon Pentstemon* (L.) Britton the filaments are free, and clustered with the style under the upper lip. One pair of the didynamous filaments is nearly free from the corolla tube, while the other pair and the sterile filament are imbedded in the wall of the tube below the inflation. The bases of the free filaments are dilated, with a concavity on the inner faces in which honey is secreted.

As a result of this arrangement the throat of the corolla is so obstructed by the two free filaments and the style as to prevent any insect from reaching the honey glands, without some special adaptation to overcome the obstruction. To secure honey the visiting insects must be armed with a stout pair of jaws to force an opening between the filaments and style and with a tongue 14 mm. long. These necessary equipments are found in *Anthophora abrupta* Say, a small bumble-bee. For two seasons this bee has been the only insect seen to enter the corolla of a large, cultivated plant, under daily observation while in bloom. *Anthophoræ* never missed putting in an appearance during some part of the day, if the weather was fair, and sometimes as many as half a dozen were seen on the plant at the same time.

*Anthophoræ abrupta* never were seen collecting pollen, but as they forced their bodies into the inflated portion of the flower they were well dusted with it on their hairy backs. This pollen was carried to the next stigma under which they passed, where some of it was left, provided the stigma was ready to receive it. Usually the stigmatic end of the style is pressed against the upper lip of the corolla during the first day of anthesis, after that period it is bent downward and is cross-fertilized

by coming into contact with the pollinated back of a passing *Anthophora* in search of honey. There does not seem to be any provision for the self-fertilization of *P. Pentstemon*.

The longer of the dimorphic pistils of *Mertensia Virginica* (L.) D.C. are of the same length as the stamens and may be self-fertilized by contact with the dehiscing anthers. The shortest of the other form do not reach beyond the end of the narrow tube, and are fertilized by honey-bees. Honey is secreted at the base of a tube 25 mm. long and is further protected by a pubescent ring 2 mm. above the receptacle. No insect was found on the flowers that could reach the honey in a legitimate way, but a big bumble-bee was seen on the corolla making slits in the tube just above the pubescent ring. Through the opening the tongue of the bee was inserted and the honey removed, with ease, as it passed rapidly from one flower to another.

A calendine poppy, *Stylophorum alphyllum* (Mich.) Nutt., under cultivation came into bloom April 23, early in the forenoon. At 3:40 p. m. the petals began closing and by sundown were completely folded over the stamens. Although it was raining the next day the petals under observation again opened in all their golden splendor. It was not clearly evident that the stamens of this plant were proterandrous, though the stigma greatly increased in size after the bud had opened. Usually the flowers did not wither under two days. Small bees were noticed crawling on the flowers, a single honey-bee was seen collecting pollen, and it is probable cross-fertilization was the result of their movements. Flowers protected by a net from insect visitors produced capsules of the normal size, well filled with seeds.

In July it was noticed that while the calendine poppy was producing an abundance of seeds none could be found on the ground under the plant. The seeds of a dehiscing capsule, which were placed in a heap on a small stone, all disappeared by next morning. When it was recalled that ants are known to carry small seeds into their nests they were suspected of carrying them away. This inference seemed probable, as the seeds were provided with a fleshy crest on one edge which an ant could grasp. At last a common black ant, about 6 mm. long, was seen with a seed in its mouth and watched until it disappeared in a round hole. Later the ant was followed to another hole. The mouth to these holes was level with the surface of the ground and not through the usual billock of sand

of their nesting places. They were located 5 dm. from the stem of the plant, and when opened were found to be about 6 mm. deep. One of them was tunnelled along the edge of a rotten chip and contained seven seeds. The crest of one of the seven seeds was withered while the papillæ of the others were plump. Nothing was seen to indicate that they had been stored for food or that the crest contained anything they cared to eat.

