

SOME ENTOMOPHILOUS FLOWERS OF CEDAR POINT, OHIO.

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In a region with such a diverse flora, and where even the casual observer is struck by the great numbers of Hymenoptera (bees) and Diptera (flies), it is but natural that the study of those flowers depending upon insects for pollination should prove interesting and instructive. The observations which form the basis for this article were made during the summer of 1911 under the direction of Dr. O. E. Jennings, Instructor in Plant Ecology at the Lake Laboratory, Cedar Point, Ohio, and his suggestions have been of great aid. Reference has been freely made to books at hand, especially to the "Hand-book of Insect Pollination" by Knuth.

Sir John Lubbock and Hermann Mueller state that blue flowers are the favorites of bees and the occurrence in this region of a fauna, rich in Hymenoptera, especially the solitary forms, and a flora marked by many blue and violet flowers, especially in or near the sandy spots chosen by the bees for their burrows would tend to confirm this theory.

Labiates and others alike show a remarkable similarity in the relative positions of stamens and stigma. The majority of types under consideration possess two pairs of stamens of unequal length, the outer pair being the longer. In nearly all cases the anthers are found in the upper lobe of the two-lipped corolla, this being the most advantageous position for scattering pollen upon the insect visitor. In addition, such a position makes difficult the stealing of pollen by unwelcome visitors, especially the creeping forms. The styles, especially in the Labiates were found to elongate with age and undoubtedly in some cases self-pollination could occur as the stigmatic surface was being pushed past the anthers.

The species, with one exception are found in Knuth's Class 4, Flowers with Concealed Nectar. This class of flowers shows much zygomorphism, thus indicating a high degree of flower specialization. Reds, blues, and violets are the predominating colors as opposed to the whites and yellows of the flowers with more exposed nectar. The higher degree of specialization in the flowers calls for a corresponding advance in the specialization of their visitors. The nectar can be conveniently sipped by short-tongued bees and long-tongued wasps, as well as by certain of the Diptera (Bombylidae and Syrphidae) and a number of the Lepidoptera. This is more difficult for the shorter tongued flies (Muscidae) and for the same reason the beetles are very infre-

quent visitors. A comparison with the observations of Bem-bower, made in the summer of 1910, shows a remarkable but not unexpected contrast in the type of insect visitors noted. The shorter-tongued flies and the flower beetles (*Donacia* and *Diabrotica*) were not observed on the flowers under consideration in this report, while in the white and yellow forms studied by Bem-bower these were almost invariable visitors. Undoubtedly some of the flowers under consideration are hymenopterid flowers, that is, flowers modified especially for the Hymenoptera. Knuth states (*Hand-book of Insect Pollination*, Vol. 1, p. 117) that in the case of flowers with completely concealed nectar, accessible to bees, similarly colored species are in flower together. This was especially noteworthy in the case of *Stachys*, *Teucrium*, *Verbena*, and *Mimulus*, as described below.

Nearly all the species observed were found to be protandrous, which appears to be a common method for preventing self-pollination in entomophilous flowers.

Labiatae (Mint family.)

***Blephilia ciliata*.**

Found here, growing in communities closely associated with *Nepeta cataria* (catnip) this bluish-purple flower, though small in size, the corolla tube being about 9 mm. in length, is conspicuous because of the dense, globose whorls of the inflorescence. The corolla is nearly equally two-lipped; the upper lip entire, the lower three-cleft, the lateral lobes rounded and longer than the middle one. The throat of the corolla tube is dilated and here are found the style and anthers, the former slightly exceeding the latter in length.

VISITORS—Diptera; *Syrirta pipiens*; Hymenoptera; *Microbembex monodonta*, *Agapostemon radiatus*, *A. splendens*, *Odynerus forminata*, *Bombus virginicus*, *B. fervidus*, *Megachile latimanus*; Lepidoptera; *Pieris rapae*.

***Stachys tenuifolia*, var. *aspera*.**

Found along the shores of the coves and marshes, closely associated with *Teucrium*. The lilac or pinkish corolla is bilabiate, the upper lip arched and entire, the lower lip longer and spreading, three-lobed, with the middle lobe entire and marked by a darker colored nectar guide. Nectar is secreted at the base of the ovary and stored in the smooth lower part of the corolla tube, which is 8 mm. long. The flowers are protandrous. The four stamens are in two pairs of unequal length, the outer dehiscent first, followed by the shorter, inner pair. The former then diverge so that they project laterally between the lips of the corolla. The style elongates with age, so that the stigma lobes are brought to the mouth of the flower, thus receiving pollen from the dorsum of the larger insect visitors.

VISITORS—Diptera; *Sphaerophora cylindrica*: Hymenoptera; *Microbembex monodonta*, *Agapostemon radiatus*, *Odynerus foraminata*, *Bombus fervidus*, *B. affinis*, *Andrena carlini*, *Megachile latimanus*.

Teucrium canadense.

This species, which varies in color from cream to purple, is common along the shores of the coves in this region. It was observed that the species was closely associated in habitat with *Asclepias incarnata* (swamp milk-weed), a flower of about the same hue, and insects were seen to be attracted first to the *Asclepias*, then later to visit the *Teucrium*.

The corolla is very irregular, the four upper lobes are approximately equal in size, but so placed and directed forwards that there appears to be no upper lip, the lower lip is larger and forms a convenient landing-place for insects. The four stamens are unequal in length, the outer pair exceeding the inner by about 3mm. The style, which lies between the inner pair is approximately the length of the outer pair, but curves less, so that without external causes self-pollination would not occur.

The larger bees alight on the lower corolla lobes and insert the proboscis at either side into the corolla tube. As the bee's head is pushed down into the corolla the anthers are brought into contact with the dorsal part of the visitor's thorax, which in many bees is distinctly pilose, and thus pollen is dusted off. Since this could hold true for larger insects, the writer does not believe that smaller Hymenoptera or Diptera are important factors in cross-pollination. Several smaller species of Hymenoptera and Syrphidae were observed to alight directly on the anthers, grasping the filaments for support, and possibly in this way could affect cross-pollination.

VISITORS—Diptera; *Syrirta pipiens*, *Allograpta obliqua*, *Syrphus americana*, *Eristalis tenax*: Hymenoptera; *Agapostemon radiatus*, *A. splendens*, *Ceratina dupla*, *Odynerus foraminata*, *Melissodes* sp., *Bombus virginicus*, *B. americanorum*, *B. affinis*, *Psittyrus clatus*, *Xylocarpa virginica*, *Andrena carlini*, *Elis plumipes*: Lepidoptera; *Papilio philenor*, *Epargyreus tityrus*, *Pieris rapae*.

Acanthaceae (Acanthus family.)

Dianthera americana.

Along the water's edge on the sand spits in Sandusky Bay, the water willow forms close communities. The corolla is two-lipped and spreading, the upper lip notched, the lower spreading and three-parted. The anthers are bi-lobed, the lobes separated and somewhat unequal, giving to the genus its name, since the separated lobes appear like two anthers on each filament. The styles lies against the upper lip, its position being marked by a

groove in the basal part of the lip. The corolla tube is short, being about 4 mm. in length, and the nectar is more accessible than in the other species under consideration. *Microbembex monodonta*, which was the most frequent visitor, either alighted in the lower lip thus coming in contact with the anther lobes facing inward, or alighting on the upper lip reaching the nectar by crawling down with inverted body, thus touching the anther lobes on the ends of the filaments.

VISITORS—Coleoptera; *Anomala lucicola*: Lepidoptera; *Pieris rapae*; Diptera: *Syrirta pipiens*, *Tropidia quadrata*, *Lucilia caesar*: Hymenoptera; *Microbembex monodonta*, *Agapostemon radiatus*, *Andrena* sp., *Megachile latimanus*.

Scrophulariaceae (Figwort family.)

Minulus ringens.

This rather conspicuous blue flower is found in the marshes along the bay shores of Cedar Point. The corolla is irregular bi-labiate, with a narrow tubular throat 15 mm. in length; the upper lip bi-lobed and erect, the lower lip three-lobed and spreading, the middle lobe with a yellow platform or palate which partially guards the entrance to the corolla tube. The stamens are arranged as in *Stachys*. The style, which exceeds the outer stamens in length, lies between the inner pair and bears a bi-lobed plate-like stigma. No evidences of protandry or protogyny were noted, but the action of the irritable stigma renders this unnecessary, for an insect forcing its way into the flower, first comes in contact with the stigmatic lobes, and these being irritable close, preventing self-pollination.

VISITORS—Diptera; *Syrirta pipiens*, *Allograpta obliqua*, *Sphaerophora cylindrica*, *Syrphus americana*: Lepidoptera; *Papilio philenor*, *Epargyreus tityrus*: Hymenoptera; *Microbembex monodonta*, *Agapostemon splendens*, *A. radiatus*, *Ceratina dupla*, *Bombus virginicus*, *B. americanorum*, *Megachile latimanus*.

Verbenaceae (Vervain family.)

Verbena hastata.

This well-known herb, the "Simpler's Joy", decorates the sedge communities along the cove shore with its slender spikes of small blue flowers. The corolla tube is about 4 mm. in length, with a distinct curve so that the upper part of the tube lies horizontal, affording both nectar and pollen protection from dew and rain.

The limb of the corolla is five-lobed, the lower three lobes slightly exceeding the upper two. The throat of the slender corolla tube is closed by a ring of stiff hairs that effectually protects against the entrance of creeping forms. The stamens,

which are of two lengths, are united with the corolla tube for some distance above the stigmatic surface. As the bee's proboscis is inserted into the flower it pushes past the retrorse anthers to the nectar at the base of the tube. As the proboscis is withdrawn, in passing the anthers it bends them upward so that the dehiscent surfaces, which normally lie downward and against the corolla tube, deposit pollen upon the tip of the proboscis wet with nectar. Should insect visits fail, automatic self-pollination may occur between the shorter stamens and the stigma, according to Knuth.

VISITORS—Lepidoptera; *Epargyreus tityrus*, *Spragueia onagrus*, *Lycaena scudderi*; Diptera; *Syrirta pipiens*, *Allograpta obliqua*, *Sphaerophora cylindrica*, *Tropidia quadrata*, *Helophilus latifrons*, *Phthiria cyanoceps*; Hymenoptera; *Microbembex monodonta*, *Agapostemon radiatus*, *Ceratina dupla*, *Odynerus foraminata*, *Megachile latimanus*.

EXPLANATION OF PLATE XXIV.

- Fig. 1. *Blephilia ciliata*.
- Fig. 2. *Stachys tenuifolia*, showing relative position of anthers and stigma.
- Fig. 3. *Teucrium canadense*, showing relation of anthers to stigma.
- Fig. 4. *Dianthera americana* showing separated anther lobes.
- Fig. 5. *Mimulus ringens*.
- Fig. 6. *Verbena hastata*.
- Fig. 7. Longitudinal section of *V. hastata*, showing ring of hairs in throat of corolla, retrorse anthers with dehiscent surfaces downward and against corolla tube.

