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## Pollination of Cucurbits

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## POLLINATION OF CUCURBITS.

BY L. H. PAMMEL AND ALICE M. BEACH.

During the season of 1892 one of us was engaged in crossing some of the cultivated cucurbits. Incidentally some attention was given to their pollination. As comparatively little has been published concerning the pollination of these plants, these notes may be of interest.

The insects collected in 1892 were identified by Mr. Gossard, who assisted in noting them in the field. We are greatly indebted to Mr. Charles Robertson for determining some of the *Hymenoptera*. Mr. Stewart, who assisted in crossing cucurbits, also frequently noticed the honey bee on various cultivated forms of the Cucurbitaceæ. Most of the drawings were made by Miss Charlotte M. King.

The literature on the pollination of Cucurbitaceæ is very scanty. The European *Bryonia dioica* was studied by Herman Müller.<sup>1</sup> Mr. T. C. Gentry<sup>2</sup> has given a short account of *Cucurbita ovifera* and *C. pepo*, but it is quite inaccurate in some important particulars. G. O. Müller<sup>3</sup> has also given a short account.

The species considered in this paper are pollinated mainly by insects belonging to the order Hymenoptera. The assumption of Thomas C. Gentry that they are pollinated by the agency of the wind is erroneous. G. O. Müller<sup>4</sup> is correct when he states that wind pollination is excluded because of the large size and the small number of pollen grains.

## SEX IN CUCURBITACEÆ.

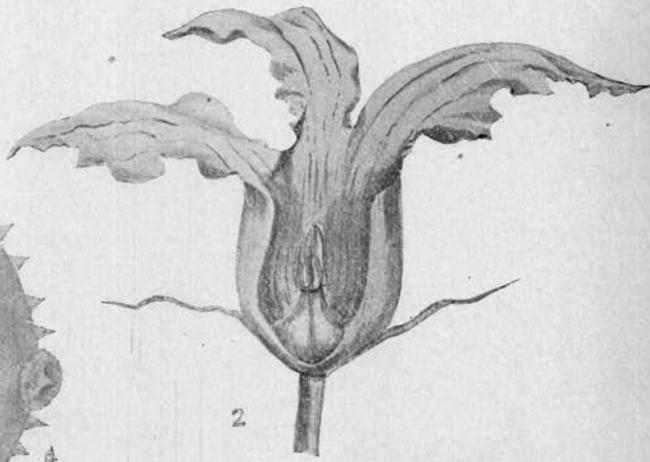
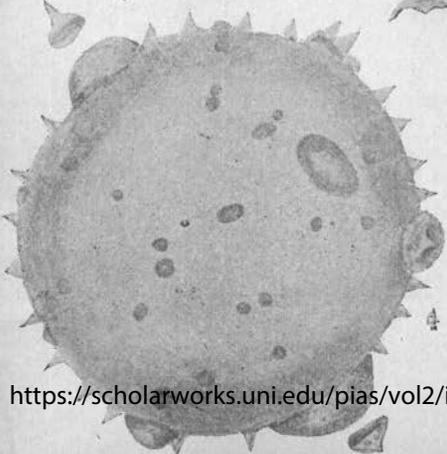
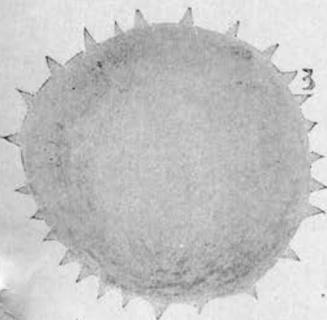
They are usually said to be monœcious or dioecious, although G. O. Müller says occasionally polygamous. It has been known for some time that the same species are polygamous and dioecious.

(1) Fertilization of Flowers. English Translation, p. 268.

(2) American Naturalist, Vol. IX, p. 263.

(3) Die Naturelichen Pflanzenfamilien Engler and Prantl IV. Theil 5 Abth. Bogen 3, p. 8.

(4) L. c., p. 264.



Crozier<sup>5</sup> says in regard to the watermelon: "In making some crosses to-day on the Volga watermelon, a variety from Southern Russia, I discovered that the so-called pistillate flowers possessed stamens." As I had not given the subject much attention, I was surprised to find that some of the flowers of *Citrullus vulgaris* were perfect. The different varieties were noted, and the observations show that Cuban Queen is strictly monœcious; frequently very small rudimentary stamens occur, but they are always sterile. This is also true of Colorado Preserving, which is strictly monœcious. Mountain Sweet and Peerless are monœcious, with rudimentary stamens. In the citron the flowers are monœcious. In New White Gem all of the pistillate flowers had stamens. The number of stamens varied from two to three.

*Cucumis sativus* (Improved Long Green, Early Russian and Early Green Cluster), monœcious.

Bailey<sup>6</sup> has called attention to the fact that some varieties of *Cucumis melo* have perfect flowers. Munson<sup>7</sup> also mentions the fact. "The female blossoms on the variety under consideration, 'Emerald Gem,' were found to bear partially developed stamens." At Ames the large Yellow Cantelope, Improved Green Nutmeg, and Montreal Improved had perfect flowers.

All of the forms of *Cucurbita pepo* (New Golden Bush, Italian Striped, Sweet Sugar, Long Warded, Nest Egg, Gourd, Common Pumpkin and Perfect Gem) are strictly monœcious. *Cucurbita maxima* (Hubbard, American Turban, Mammoth Chili, New Mediterranean, New Prolific Marrow), flowers monœcious.

*Lagenaria vulgaris* (Dipper Gourd), monœcious.

#### POLLINATION.

*Cucurbita maxima* Duch. The flowers are large yellow, and in some forms like the Hubbard have a very pleasant odor. The corolla is five cleft and adherent to the bell-shaped tube of the calyx. The flowers are therefore of easy access to insects. The staminate flowers differ in some important respects from the pistillate. In the former the nectar is contained in the lower part of the staminal tube, and an insect in searching for the same goes over the stamens down along the grooves of the united filaments. The insect thrusts its tongue into the slit at the lower end. Before the flowers have been probed for nectar

(5) Bot. Gazette, Vol. XIII, p. 244.

(6) Third Annual Rep. Cornell University Exp. Station, p. 185.

(7) Annual Rep. Maine State College Agr<sup>l</sup> Exp. Station, II, 1892, p. 43.

furrows only can be seen, but when probed several times the filaments separate. The thorax and back of the insect are covered with pollen, as it falls out very easily. An insect frequently probes the other slits of the androecium. When an insect goes to a pistillate flower it passes over the stigmas and down to the nectar which is here found in an open cup. The amount of nectar contained in flowers is large. In some pistillate flowers, which were covered with bags, it was found outside of the nectary. In one or two cases a half teaspoonful of sweet nectar might easily have been obtained. The pollen grains are very large and spiny. The flowers usually last only a day and open early in the morning. In this latitude, however, late in the season, after cold weather begins, they last more than one day. They usually begin to wilt and close before 12:00 M., but the day and the time of the year makes some difference. It is much later in the afternoon in September than in August.

*Insect Visitors—*

Hymenoptera—Apidæ: (1) *Apis mellifica* Linn.; (2) *Bombus pennsylvanica* DeGeer; Formicidæ: (3) *Formica rufa?* Linn.

Coleoptera—Chrysomelidæ: (1) *Diabrotica punctata* Oliv., *D. vittata* Fab., (3) *D. longicornis* Say.

Of these visitors the honey bee and the bumble bee are the chief pollinators. The striped cucumber and other beetles may also effect pollination as they are often found covered with pollen. The red ants feed on the nectar contained in the flower.

In addition the following insects were observed from the first of August to the first of October, 1894:

Hymenoptera—Apidæ: (1) *Apis mellifica*, Linn., frequent especially during the latter part of the season, when three or four were present in every flower, often the only visitors except the beetles, (2) *Bombus pennsylvanica* DeGeer, ♀; (3) *Xenoglossa pruinosus* Say, ♂; (4) *Melissodes bimaculata* St. Farg., ♀ ♂, almost invariably present in the earlier part of the season, (5) *Melissodes* sp. ♀ ♂, (6) *Calliopsis andreniformis* Sm. ♀; Andrenidæ: (7) *Andrena* sp., ♀; (8) *Agpostemon* sp.; (9) *Angochlora pura* Say, ♀; (10) *Halictus albipennis* Rob., ♀, (11) *H. tegularis* Rob., ♀, (12) *H. fasciatus* Nyl., ♂; (13) *Halictus Zephyrus* sm.; (14) *Xenoglossa* sp., ♀ ♂.

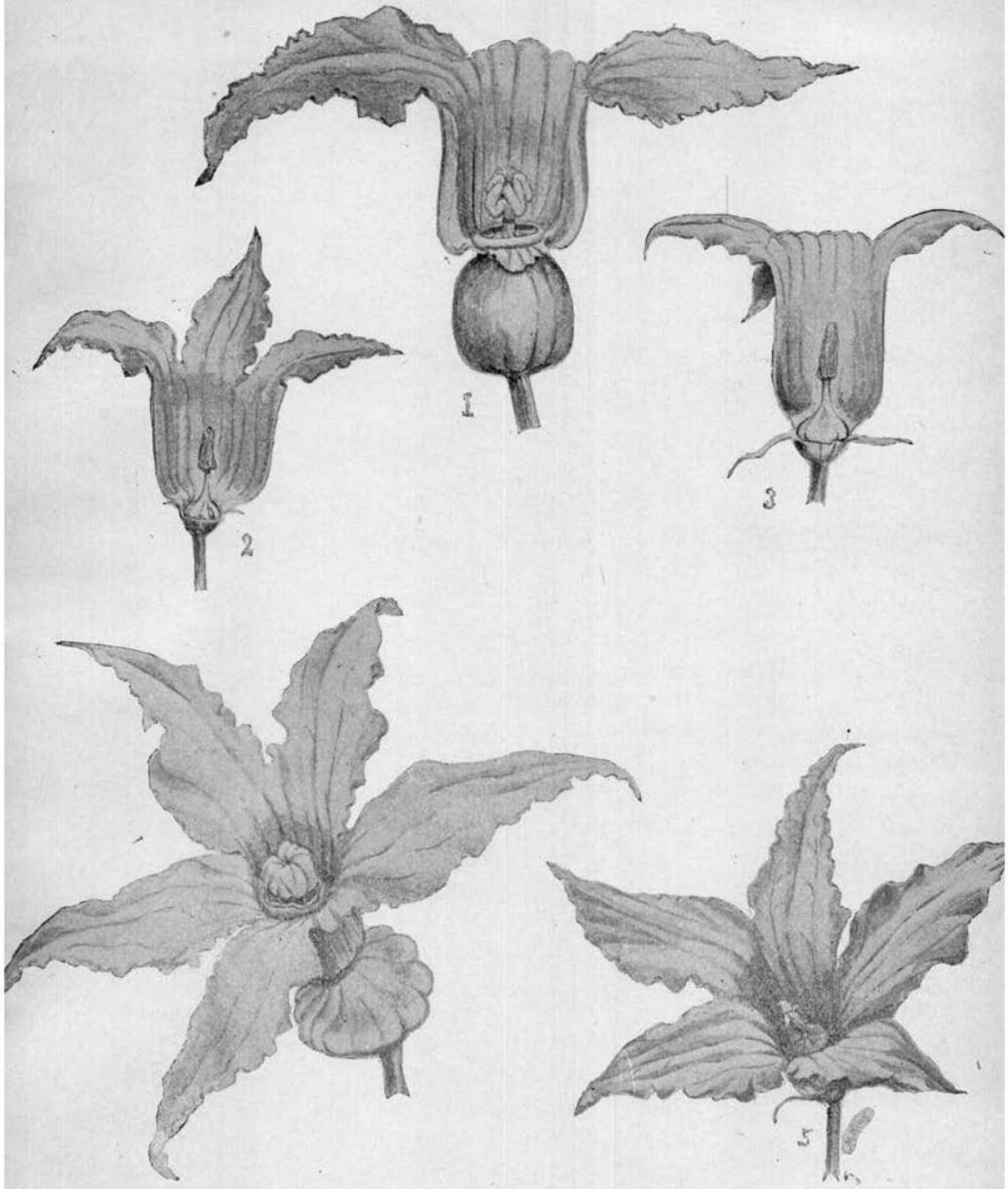
*Cucurbita pepo*, Linn.

The different forms of this species have the general arrangement and structure as are found in *C. maxima*. The odor of the large yellow flowers is not so pleasant as in that species, but

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PLATE XII.



rather disagreeable. Nectar is abundant, and the insect reaches it in essentially the same way. The flowers open early in the morning, and when mature the pollen falls out, frequently filling the bottom of the flower. The grains are very large, round and spiny. When placed in water the spines in several places are thrown off, and in a short time the contents pass into the water.

*Insect Visitors*:—

Hymenoptera—Apidæ: (1) *Apis mellifica* Linn.; (2) *Bombus pennsylvanica* DeGeer; Formicedæ. (3) *Formica rufa* ? Linn.

Coleoptera—Chrysomelidæ: (1) *Diabrotica 12-punctata* Oliv.; (2) *D. vittata* Fab.

The Coleoptera in this species bear the same relation to the flowers as in the squash.

Additional visitors taken on pumpkin in 1894:—Hymenoptera—Apidæ: *Melissodes sp? aurigena* Cr., ♂. *Xenoglossa pruinosa* Say ♂. Patton also records the latter species. He remarks\*, “The loose scopa seems particularly adapted to retain the large spiny lobes which form the pollen of the pumpkin. In the blossoms of these plants the bees delight to revel.”

The following were noted on the summer squash;

Hymenoptera—Apidæ: (1) *Bombus fervidus* Fab. ♀; (2) *X. pruinosa*, Say, ♀ ♂; (3) *Melissodes* sp.; Andrenidæ: (4) *Halictus coriaceus* Sm., ♀; (5) *H. tegularis* Rob., ♀; (6) *H. zephyrus* Sm., ♀; (7) *Halictus* sp.; (8) *Augochlora similis*, ♂; (9) *Andrena* sp.

*Citrullus vulgaris* Schrad.

The pale yellow corollas are widely spreading. The honey is secreted at the base of the flower. It is easy to observe how the honey bee obtains its nectar. It uses the petals as a resting place, and obtains the nectar through the opening. It first probes one side, and then passes over the stamens to the opposite side of the flower from which the nectar is taken. When its work is finished it flies to another flower. Its visits are confined chiefly to one variety, but occasionally other varieties are visited. It was noticeable that when flies collect pollen, honey bees flit about the flower a moment, and then go to another. The flowers are open all day.

*Insect Visitors*:—

Hymenoptera—Apidæ: *Apis mellifica* Linn., chiefly.

Diptera—Several species of *Syrphus* flies. These active insects find a resting place on the petals, where they collect

\*Bull U. S. Geol. and Geog. Survey, Vol. V, No. 3, p. 473.

pollen. In no case did they seem to collect nectar in staminate flowers.

Coleoptera—Chrysomelidæ: (1) *12-punctata* Oliv.; (2) *D. vittata* Fab.

Hemiptera—Capsidæ: *Clocorusa* sp.

*Cucumis melo.*

Few observations were made. The yellow flowers open early in the morning and remain open the greater part of the day.

*Insect Visitors—*

Hymenoptera—Apidæ: *Apis mellifica* Linn.

Coleoptera—Chrysomelidæ: *Diabrotica vittata* Fab.

In addition, the following visitors were observed on July 20th, 27th and 30th, 1894:

Hymenoptera—Apidæ: (1) *Ceratina dupla* Say; (2) *Calliopsis andreniformis* Sm., ♀, frequent; Andrenidæ: (3) *Augochlora pura* Say, ♀, frequent; (4) *Halictus fasciatus* Nyl., ♀ ♂, abundant.

Diptera—Bombylidæ: (5) *Sistechus vulgaris* Loew.

*Cucumis sativus.*

The light yellow flowers are ready to receive the pollen early in the morning, but the corolla remains firm much longer than in *Cucurbita pepo*. Honey bees were observed.

In 1894 observations were continued from July 18th to September 28th, and the following insects observed:

Hymenoptera—Apidæ: (1) *Apis mellifica* Linn., very abundant; (2) *Melissodes bimaculata* St. Farg., ♀, frequent; (3) *Ceratina dupla* Say; (4) *Calliopsis andreniformis* Sm., ♀ ♂, frequent; Andrenidæ: (5) *Agapostemon* sp., ♀, abundant; (6) *Aradialus* Say; ♂, abundant; (7) *Agapostemon texanus* Cr., ♀, abundant; (8) *Halictus coriaceus* Sm., ♀; (9) *H. fasciatus* Nyl., ♀ ♂, frequent.

Diptera—Dolichopidæ: (10) *Psilopus sipo* Say; Bombylidæ: (11) *Systechus alopec?* O. S., abundant.

Lepidoptera—Papilionidæ: (12) *Pieris protodice* Bd.—Lec.

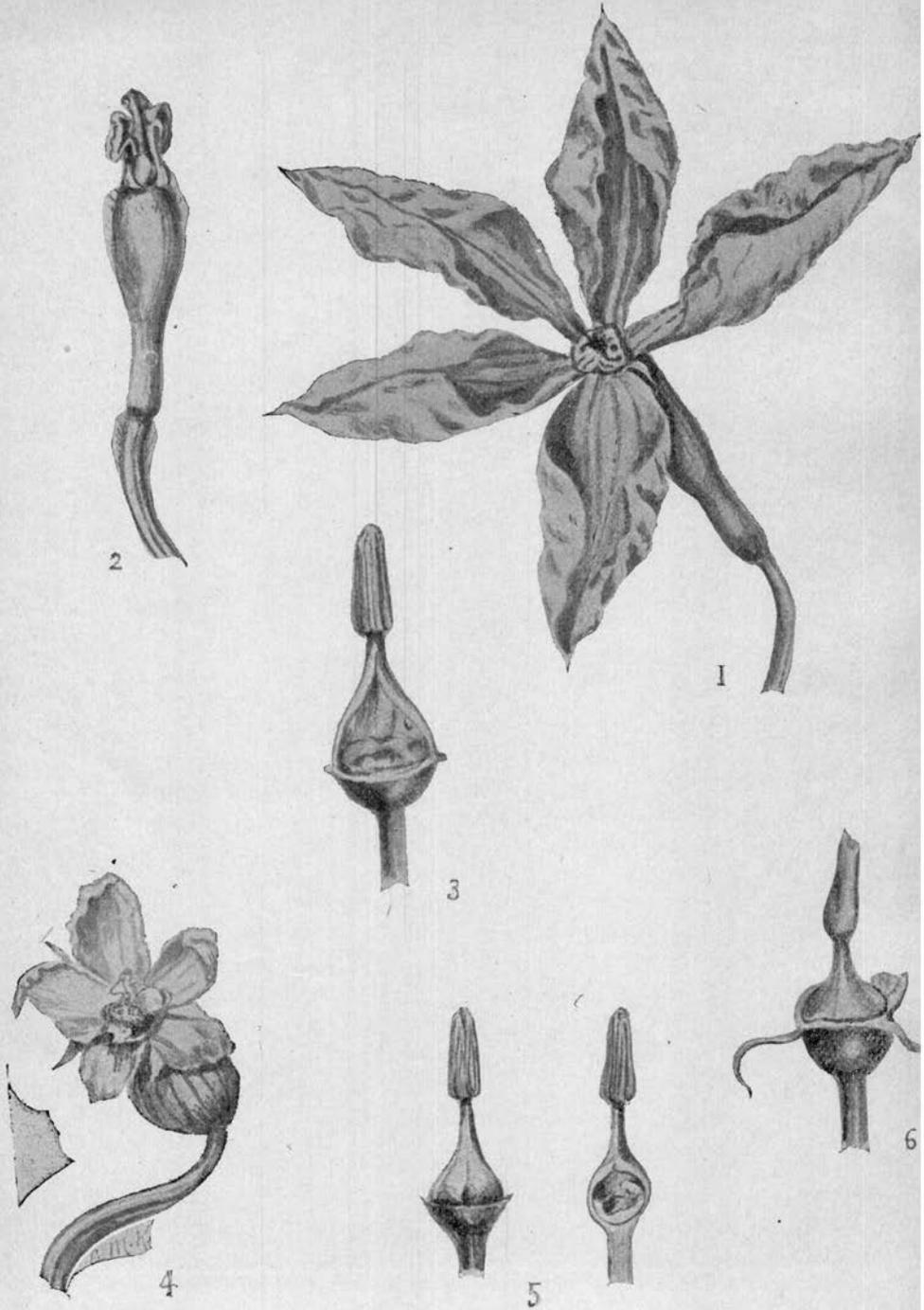
Coleoptera—Chrysomelidæ: (13) *Diabrotica vittata* Fab.

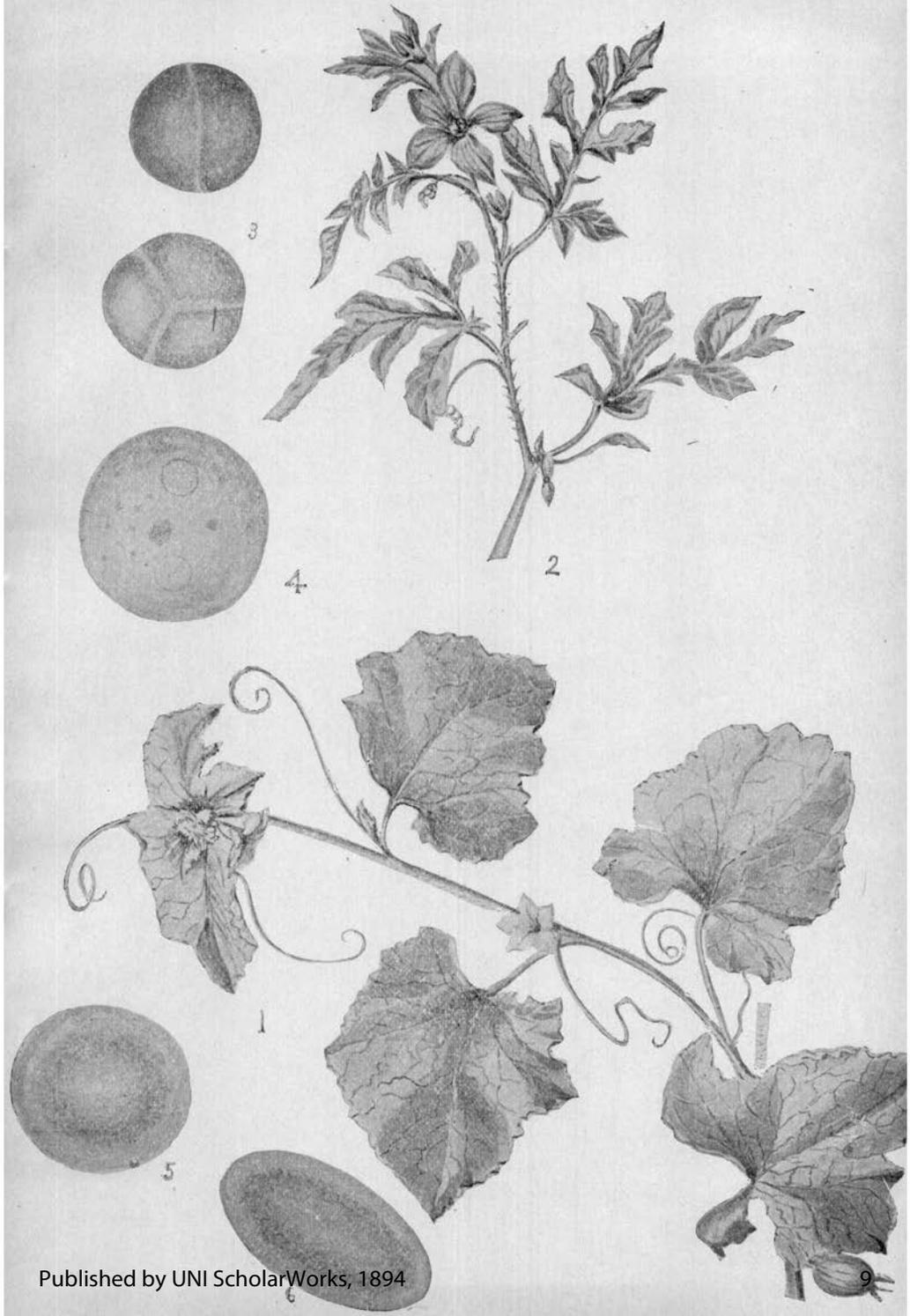
Hemiptera—Capsidæ: (14) *Calicoris rapidus* Say.

Numbers 10 and 14 are accidental pollinators.

*Lagenaria vulgaris* Ser.

The musk-scented flowers of the dipper gourd have a funnel or bell-shaped calyx with a long tube. The white petals are persistent a much longer time than in *Cucurbita pepo*, and the nectar is not so easily accessible and exposed as in *Citrullus* and





*Cucurbita*. The three stamens effectively block the way for the larger insects. The flower is adapted to hummingbirds, which can easily get the nectar with their long tongues. The color and odor would seem to indicate that it is adapted to Sphingidæ, but as the plants were so far away observations were not made at night. In addition to the hummingbird, *Bombus pennsylvanica* was observed collecting pollen. *Diabrotica vittata* was also found covered with pollen.

## PLATE XI.

Hubbard Squash, *Cucurbita Maxima*. Fig. 1. Pistillate flowers showing shallow nectary with membrane. Fig. 2. Staminate flowers. Fig. 3 and 4. Pollen grains; 3, before the addition of water; 4, pollen grains after the addition of water. Large nectar on one side, and drops of oil over the surface. On addition of water several of the spines come off in the form of caps. Camera sketches from Zeiss B. B., obt. and compensating ocular, reduced one-half. Figs. 1 and 2 one-half natural size. Drawn by Charlotte M. King, except Figures 3 and 4.

## PLATE XII.

*Cucurbita pepo*. Figs. 1 and 2. Perfect Gem Squash. Fig. 3. Pistillate flower showing stigma, style and saucer like nectary. Fig. 4. Bush Scalloped Squash, pistillate flower with open nectary. Figs. 3 and 5. Long warted staminate flowers. Fig. 3 Cut lengthwise to show slits near base of filaments, used by insects to get the nectar. One-half natural size. All drawn by Charlotte M. King.

## PLATE XIII.

Fig. 1. Musk Melon, *Cucumis melo*. Fig. 2. Perfect Gem Water Melon. *Citullus vulgaris*. Figs 3 and 4. Pollen grains of *Lagenaria vulgaris*; fig. 3, previous to the addition of water; fig. 4, on the addition of water, nucleus shown at one side. Figs. 5 and 6. Pollen grains of *Echinocystis echinata*. fig. 5, before the addition of water; fig. 6, after the addition of water. Drawn to same scales as pollen grains in plate XI. Figs. 1 and 3 drawn by Charlotte M. King.

## PLATE XIV.

Figs. 1 and 2. *Largenaria vulgaris*. Fig. 1. Staminate flower showing corolla. Fig. 2. Pistillate flower with petals removed. Fig. 3. Staminate flower of Perfect Gem Squash

(*C. pepo*) cut lengthwise to show nectary. Fig. 4. New White Gem Water Melon with perfect flowers. Figs. 5 and 6. Long warded; fig. 5, one flower cut lengthwise to show nectary, the other shows an opening near base. All natural size. Drawn by Charlotte M. King, and pollen grains drawn by L. H. P.

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## PSYLLIDÆ FOUND AT AMES.

BY C. W. MALLY.

While studying Hackberry Psyllidæ last year, several other interesting species were found. This led to a general study of the family as represented in this locality. It was the original intention to give a general account of the anatomy and life history, with descriptions of new species. However, only the latter part is given at this time.

One important fact has been brought out again during this study, and that is that in order to generalize in regard to any group of insects, we should have a good representation of the species. Many statements that would be true for a small representation may need to be considerably changed in order to include other nearly related forms, which may not only show valuable structural characters, but in their life history present phases of development having an important bearing on other facts at hand.

Another thing of importance is to know, so far as possible, what has been done. To show this in the present instance, the best way will be to give a list of the American species already described. Dr. C. V. Riley, in Proc. Biol. Soc. Wash., v. 2, p. 67, gave a list and the synonymy up to that time. Since then quite a number of new species have been described and so many new facts brought to light that it seems best to present them altogether, showing clearly the synonymy, the species since recorded, and for the benefit of those interested in the Iowa fauna, indicate the species found here.\*

\*NOTE.—The following list was prepared in connection with a bibliography of the family. The most important paper in this connection is the one by Dr. C. V. Riley just mentioned, and the synonymy is the same as there recorded. The names of the species recorded since that list was published were taken, as far as possible, from the articles in which they were first mentioned. Inaccuracies were avoided as much as possible. If it proves to be of value to other investigators and induces them to publish their observations on this family, it will have served its purpose.