are those who term this the "red rust," but so far as I have been able to learn by talking with farmers in Alabama, and from the specimens received, the term here is applied to the early, or arrested stages of "black rust" as I have described above.

Auburn, Ala.

Flowers and insects. VI.

CHARLES ROBERTSON.

Triosteum perfoliatum L.—In the bud the style is bent and the stigma is pressed against the opposing lobes of the corolla. As soon as the lobes separate the style straightens and the stigma is thrust out. The stigma rises from 3 to 4 mm. above the anthers and appears to be receptive while they are still indehiscent, so I regard the flower as proterogynous. The corolla continues to lengthen until the second stage. In this stage the anthers are dehiscent, and the stigma is turned to one side. The flowers are rather dark purple and collected in inconspicuous clusters in the axils of the perfoliate leaves. Nectar is secreted in a gibbosity in the base of the corolla. The corolla is from 14 to 16 mm. long and is adapted to long-tongued bees.

Visitors: (May 18 and 23) *Apidae:* (1) Bombus Ridingsii Cr. ♀, s.; (2) B. vagans Sm. ♀, s., visited all of the open flowers and forced its proboscis into several buds, whose lobes had hardly begun to loosen, but which contained an abundance of nectar; (3) B. americanorum F. ♀, s.; (4) Anthophora abrupta Say ♂, s,; *Andrenidae:* (6) Augochlora pura Say ♀, s. and c. p., crawls into the tube; (7) Halictus Lerouxii St. Farg. ♀, c. p.

Cephalanthus occidentalis L.—The first peculiarity of the flower that strikes one is the great difference in the height of the anthers and stigma. Indeed, it looks like a long-styled dimorphous flower. The anthers are at the mouth of the tubular corolla, while the stigma rises 7 mm. higher. It looks as if the pollen could never touch the same part of the insect which comes in contact with the stigma. The disparity is accounted for by the fact that the style itself serves to expose pollen to the visitors. In the bud the anthers dehisce, depositing all of

their pollen in a conical mass upon the summit of the style. The style rises to its usual height and holds the pollen where it will easily touch insects lighting upon the globular head of flowers. After the pollen has been removed, the stigma becomes receptive, and the flower is now in the second or female stage.

Meehan[1] has taken the loading of the pollen upon the tip of the style as a plain case of self-fertilization. But it is no more a case of self-fertilization than the loading of pollen upon the style brush of Campanula. As far as they go, Meehan's observations do not support the view that self-fertilization occurs even in absence of insects, for he says: "Numerous seeds are in every head examined. Carefully dissecting one, I found it had 279 flowers, of these 225 perfected seeds, and only 54 failed." He had made the gratuitous assumption that fullness of fruit is evidence of self fertilization.[2] As between cross and self fertilization, the 225 fruitful cases prove nothing; the failure of one in five flowers is presumptive evidence against the power to self-fertilize.

The round heads of white flowers are very attractive to insects. The corolla tubes are 9 mm. long and are very narrow, especially below. The flowers are thus adapted to long and thin tongues. The nectar rises in the tube so that shorter tongued insects can reach some of it, but the predominant visitors are butterflies. On 11 days, between July 5th and August 17th, I observed the following visitors:—

Hymenoptera — *Apidae:* (1) Apis mellifica L. ☿, s., ab.; (2) Bombus virginicus Oliv. ☿, s. and c. p., freq.; (3) B. separatus Cr. ♂♀☿, s., ab.; (4) B. Ridingsii Cr. ♂, s., one; (5) B. americanorum F. ♂♀☿, s. and c. p., ab.; (6) B. pennsylvanicus De Geer, ♀☿, s., freq.; (7) B. scutellaris Cr. ☿, s., one; (8) Emphor bombiformis Cr. ♀, s., one; (9) Xenoglossa pruinosa Say ♂, s.; (10) Melissodes obliqua Say ♀, s.; (11) M. bimaculata St. Farg. ♂, s.; (12) Ceratina dupla Say ♀, s.; (13) Megachile mendica Cr. ♀, c. p.; (14) Nomada texana Cr. ♀, s.; *Andrenidae:* (15) Halictus Lerouxii St. Farg. ♀, s., one; (16) H. ligatus Say ♀, s., one; (17) Agapostemon nigricornis F. ♀, s.; (18) A. radiatus Say ♂, s.; (19) A. texanus Cr. ♀, s.; (20) Prosopis affinis Sm. ♀, f. p.; *Pompilidae:* (21) Priocnemis ful-

[1] Contributions to the Life Histories of Plants. Proc. Acad. Nat. Sci. Phila., 1887, 323-333; 4 figs. See also Bull. Torr. Bot. Club, xv, 54.

[2] Bot. Gazette xiii, 157.

vicornis Cr., s., one; *Scoliidae:* (22) Myzine sexcincta F. s., one.

Lepidoptera—*Rhopalocera:* (23) Papilio philenor L.; (24) P. asterias F., ab.; (25) P. troilus L.; (26) Pieris protodice Bd.-Lec.; (27) P. rapae L.; (28) Colias caesonia Stoll; (29) C. philodice Godt.; (30) Danais archippus F. ab.; (31) Argynnis cybele F.; (32) Phyciodes tharos Dru.; (33) Pyrameis atalanta L., ab.; (34) P. huntera F.; (35) P. cardui L.; (36) Limenitis disippus Godt.; (37) Satyrus alope F.; (38) Thecla humuli Harr.; (39) Chrysophanus thoe Bd.-Lec., ab.; (40) Lycaena pseudargiolus Bd.-Lec.; (41) L. comyntas Godt.; (42) Pamphila zabulon Bd.-Lec.; (43) P. huron Edw.; (44) P. peckius Kby.; (45) P. cernes Bd.-Lec.; (46) P. delaware Edw.; (47) Nisoniades juvenalis F.; (48) Eudamus tityrus F., ab.; *Arctiidae:* (49) Utetheisa bella L.; *Pyralidae:* (50) Scepsis fulvicollis Hübn.—all s.

Diptera—*Conopidae:* (51) Physocephala tibialis Say, s.; *Syrphidae:* (52) Sphaerophoria cylindrica Say, s.; (53) Volucella evecta Walk., s.; (54) Eristalis tenax L., s., ab.; (55) E. latifrons Lw., s. and f. p.; (56) Syritta pipiens L., s.; *Muscidae:* (57) Musca domestica L., f. p.

Coleoptera—*Coccinellidae:* (58) Hippodamea 15-maculata Muls., f, p.; *Scarabaeidae:* (59) Trichius piger F., f. p.

Hemiptera—*Lygalidae:* (60) Oncopeltes fasciatus Dall., s.

Lobelia[1] *spicata* Lam.—In my neighborhood this is the earliest blooming Lobelia. The plants are scattered and are neither so attractive to insects nor so easily observed as the next species. The flowers are white and are arranged in rather loose spikes. They are proterandrous, like the other species which have been observed. The corolla tube is 4–6 mm. long, and the nectar is therefore only readily accessible to tongues of medium length.

Visitors: (5 days, May 31 to June 12) Hymenoptera—*Apidae:* (1) Ceratina dupla Say ♀; (2) Megachile brevis Say ♀; (3) Alcidamea producta Cr. ♀.

Lepidoptera—*Rhopalocera:* (4) Pieris protodice Bd.-Lec.; (5) P. rapae L.; (6) Chrysophanus thoe Bd.-Lec.; (7) Ancyloxypha numitor F.; (8) Pamphila peckius Kby.; (9) P. cernes Bd.-Lec.—all s.

Lobelia leptostachys A. DC.—Resembles L. spicata, but the spikes are more conspicuous, and the corolla tubes are a

[1] On the fertilization of Lobelia see Mueller: Fertilization of Flowers, 365, 633.

little longer. On account of later blooming, the list shows less of the genus Melissodes and an increase in Megachile.

Visitors: (7 days, July 8 to 31) Hymenoptera—*Apidae:* (1) Apis mellifica L. ☿, s.; (2) Bombus separatus Cr. ☿, s.; (3) B. americanorum F. ☿, s.; (4) Melissodes obliqua Say ♂, s.; (5) M. bimaculata St. Farg. ♂, s; (6) Ceratina dupla Say ♀, s.; (7) Megachile rufimanus Rob. (MS) ♂, s.; (8) M. brevis Say ♂♀, s. and c. p.; (9) M. petulans Cr. ♂, s.; (10) M. exilis Cr. ♂, s.; (11) Anthidium emarginatum Say ♂♀, s.; (12) Andronicus cylindricus Cr. ♀, s.; (13) Coclioxys 8-dentata Say ♂, s.; *Andrenidae:* (14) Agapostemon nigricornis F. ♀, s.; (15) Augochlora pura Say ♂♀, s., the male sucking through the slit in corolla; (16) Halictus fasciatus Nyl. ♂, s.; (17) H. pilosus Sm. ♀, c. p.

Lepidoptera—*Rhopalocera:* (18) Lycaena comyntas Godt.; (19) Pamphila cernes Bd.-Lec.; (20) Nisoniades juvenalis F.—all s.

Diptera—*Bombylidae:* (21) Systoechus vulgaris Lw., s.

Lobelia syphilitica L.—The large blue flowers are specially adapted to bumble-bees. Delpino saw it visited by Bombus italicus and B. terrestris. In this country Trelease[1] saw it visited by several species of Bombus. As intruders he observed Osmia sp. and Ceratina dupla Say ♀ collecting pollen.

Visitors: (4 days, Aug. 12 to Sept. 3) *Apidae:* (1) Bombus separatus Cr. ♀, s.; (2) B. virginicus Oliv. ☿. s. and c. p.; (3) B. vagans Sm. ☿, s. and c. p.; (4) B. americanorum F. ♀☿, s., ab.; *Andrenidae:* (5) Augochlora pura Say ♀; (6) Halictus connexus Cr. ♀—both collecting pollen which they work out of the anther-tube with their jaws and front feet.

Lepidoptera—*Rhopalocera:* (7) Danais archippus F.; (8) Papilio philenor L.—both s.

Lobelia cardinalis L.—Trelease (*l. c.*) saw this flower visited by humming-birds, Trochilus colubris L. I have never failed to find them about the flowers, and there is no doubt that the flowers are specially adapted to them. The pendant lip shows that the flower is intended to be visited by a bird or insect which is in the habit of sucking the sweets from flowers without resting upon them. I have also seen the flowers visited by Papilio philenor L. and P. troilus L.

On two occasions I counted five individuals of Bombus americanorum F. ☿, about the flowers. Sometimes one of

[1] On the fertilization of several species of Lobelia, Am. Nat. xiii, 427–432.

them would try to reach the nectar in front, but failing, would crawl down to the base of the flower and insert its tongue through the slit, but most of them only tried to reach the nectar through the slit. This is the only time I have seen a bumble-bee obtaining nectar illegitimately.

Augochlora pura and Halictus connexus also visit this plant for pollen, behaving as on the flowers of L. syphilitica.

Since the flowers of Lobelia are intended to be visited by insects entering below the stamen tube it is an imperfection that the tube has openings between the bases of the upper filaments, for this allows improper visitors to steal the nectar through the slits in the upper side of the corolla. Trelease saw Augochlora pura treating flowers of L. erinus in this way and I have observed the same thing in L. leptostachys and L. cardinalis.

Lobelia cardinalis × *syphilitica.*—Very many plants of the two preceding species grew together in a large patch. The ruby-throated humming-bird passed by L. syphilitica and only visited L. cardinalis. The bumble-bees visited L. syphilitica regularly, only stealing the nectar of L. cardinalis in the cases indicated; and they might not have done so, if they had not been drawn among them by L. syphilitica.

The insects which occurred on both species and which effect hybridization are Bombus americanorum, Augochlora pura, Halictus connexus and Papilio philenor.

Among the plants I found nine specimens of the hybrid. The corolla is shorter and broader and the lobes shorter and firmer than in L. cardinalis, and is described by Schneck[1] as of a deep reddish or crimson-purple. There is abundant nectar, but the others seem imperfect.

Twice I saw Bombus americanorum visit the flowers in the regular way, showing that it could reach the nectar easily. This led me to wonder if the humming-bird would visit the hybrid. Seeing one alight upon a limb over my head, I drew back and was rewarded by seeing him come down and visit the hybrid along with L. cardinalis. It was interesting to observe that, while Bombus americanorum could not suck the nectar of L. cardinalis properly and humming-birds did not visit L. syphilitica at all, the nectar of the hybrid was easily accessible to the one and its colors were attractive to the other.

---

[1] Bot. Gaz. iii, 35.

Campanula Americana L.[1]—In the GAZETTE, xiii, 225, I have observed that this flower is in the first stage of irregularity, and that bees land upon the style and insert their tongues between the bases of the upper stamens. But, although the stigma is turned so as to strike the ventral surface of the bee, the stamens still retain the useless habit of covering the style on all sides with pollen. At first the style is straight so that the bee touches only the upper side, but afterwards it bends so that the bee may touch the sides and even the underside near the tip. But still much pollen is wasted by being fixed on the lower side. Megachile exilis, which visits the flower for pollen, regularly turns and hangs under the style so as to clean the pollen off the lower side. This is another illustration of the fact that in dichogamous flowers, which as a rule are only properly visited for nectar, the pollen often acts disadvantageously by attracting insects which remove it and neglect the flowers in the female stage.

The larger bees, which are the only insects adapted to the flower, visit it only for nectar and only touch the upper side of the style. I repeat the list given in the GAZETTE, l. c., with some additions.

Visitors: (11 days, July 10 to Aug. 28) Hymenoptera—*Apidae:* (1) Apis mellifica L. ☿; (2) Bombus virginicus Oliv. ♂☿; (3) B. separatus Cr. ♂; (4) B. americanorum F. ♂☿; (5) Melissodes bimaculata St. Farg. ♂♀; (6) Megachile brevis Say ♂☿—all sucking; (7) M. exilis Cr. ♂♀, s. and c. p.; *Andrenidae:* (8) Agapostemon radiatus Say ♂♀, s; (9) Augochlora pura Say ♀, c. p.; (10) Halictus Lerouxii St. Farg. ♂, s.; (11) H. coriaceus Sm. ♂♀, s; (12) Prosopis affinis Sm. ♀, f. p.; *Specidae:* (13) Ammophila sp. searching for nectar; *Scoliidae:* (14) Myzine sexcincta F. s.

Lepidoptera—*Rhopalocera:* (15) Pyrameis cardui L. s.; (16) Pholisara hayhurstii Edw., s.

Apocynum[2] *cannabinum* L.—The flowers are white, much smaller than in A. androsæmifolium, and the nectar is lodged in rather shallow receptacles, so that flies and other short-lipped insects can reach it. A. androsæmifolium, according to Ludwig, is visited by butterflies and cements its pollen to their tongues. I have found the pollen-masses of this species on the maxillary and labial palpi of bees, and but

[1] See Barnes: Bot. Gaz. x, 349, pl. x and vol. xi, 99.

[2] On literature of genus see Mueller: Fertilization of Flowers, 396, 631.

rarely on other parts of their tongue. The insects in the list are marked m. l. or t. according as the pollen masses were found on the maxillary or labial palpi, or on the ligula proper.

Visitors: (June 21, 25) Hymenoptera—*Apidæ:* (1) Apis mellifica L. ☿, l.; (2) Coelioxys 8-dentata Say ♂♀; (3) Stelis lateralis Cr. ♀; (4) Nomada articulata Sm. ♂, m. l.; (5) N. incerta Cr. ♀, m. l.; *Andrenidæ:* (6) Macropis steironemæ Rob. (MS) ♂♀; (7) Agapostemon radiatus Say ♀, m.; (8) Augochlora lucidula Sm. ♀; (9) Halictus fasciatus Nyl. ♀; (10) H. connexus Cr. ♂♀; (11) Colletes sp. ♂, m.; (12) Prosopis affinis Sm. ♀; *Eumenidæ:* (13) Odynerus foraminatus Sauss. t.; *Bembecidæ:* (14) Monedula ventralis Say; *Larridæ:* (15) Astata bicolor Say; *Sphecidæ:* (16) Ammophila vulgaris Cr.; (17) Isodontia philadelphica St. Farg., t.; (18) Prionony x thomæ F.; (19) P. atrata St. Farg.

Diptera—*Mycetophilidæ:* (20) Sciara sp.; *Bombylidæ:* (21) Anthrax alternata Say; *Syrphidæ:* (22) Allograpta obliqua Say; (23) Sphærophoria cylindrica Say; (24) Tropidia mamillata Lw.; (25) T. quadrata Say; *Empidæ:* (26) Empis sp.; *Tachinidæ:* (27) Cistogaster divisa Lw.; (28) Ocyptera sp.; (29) Jurinia apicifera Walk.; (30) Micropalpus sp.; (31) Acroglossa hesperidarum Will.; *Sarcophagidæ:* (32) Sarcophaga sp.; *Muscidæ:* (33) Lucilia caesar L.; (34) L. macellaria F.; *Anthomyidæ:* (35) Anthomyia sp.; (36) Limnophora sp.

Lepidoptera—*Rhopalocera:* (37) Argynnis cybele F.; (38) Thecla calanus Hübn.

Coleoptera—*Scarabaeidae:* (39) Trichius piger F.

Hemiptera—*Capsidae:* (40) Lygus pratensis L.; *Lygaeidae:* (41) Lygæus turcicus F., s.

Carlinville, Ill.

Notes on technique. II.

JAMES ELLIS HUMPHREY.

In the study of zoöspores, especially those of Fungi, it is not always easy to demonstrate clearly the number and attachment of the cilia. The iodine preparations usually recommended for that purpose have not proved satisfactory with me on account of their tendency to shrivel and distort the body of the