FLOWERS AND INSECTS. XXI

DATA OF ANTHECOLOGY

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In KNUTH'S *Blütenbiologie* is found a mixture of the botanical subject of insect visitors of flowers, the entomological subject of flower visits of insects, and collectors' notes which have no definite relation to either subject but rather to the personal movements of collectors. He states that his work is based upon MÜLLER'S, but he fails to include data from works which follow MÜLLER'S method (MÜLLER'S *Alpenblumen* and MACLEOD'S works on flowers of the Pyrenees and Flanders), and includes collectors' notes which suppress it, although such notes from French and Italian records are excluded as perhaps not justifying the labor of compilation. In a work which repeats MÜLLER'S lists for Low Germany for the third time American anthecological lists are suppressed.

ANTHECOLOGICAL DATA.—These are lists of insect visitors made to show the species, their frequency, their efficiency as pollinators, and the possibility of their having some influence in determining the characters of the flowers. MÜLLER'S lists show these details. In the case of the bees he indicated the sexes, and whether they were sucking nectar or collecting pollen. To note the sexes is important because female bees fly longer than males and are more likely to make repeated visits. To note the fact of pollen-collecting is also important. A female bee will carry pollen all day from flowers on which the male rarely occurs. From observations at Carlinville the females of nest-making bees average 20.6 visits to the males 10.3. The inquiline bees show females 8.8 to males 8.0. In anthecology MÜLLER'S lists are valuable as regards species and visits, but they fail to indicate the frequency. In 1908 I rejected MÜLLER'S method and adopted the practice of capturing the visitors as they came, noting species, and counting individuals. It is impossible to indicate the importance of insects to flowers by lists of species, because efforts to increase the lists involve an exaggeration of the importance of rare and exceptional cases.

ENTOMOLOGICAL DATA.—If lists of visitors of flowers are broken up and the visits are redistributed under each insect, the subject changes from a botanical to an entomological one. It would require as much space and as many entries to make the second set of lists. If these insect visits are distributed under the different flower classes and colors, they may still hold an indirect relation to anthecology. To be correctly arranged as entomological data

TABLE I

Data	Lists	Bees	Diptera	Other Hymenoptera	Lepidoptera	Coleoptera, Hemiptera	Total
1. First 62							
Entomological	122	82.5	4.2	6.3	4.6	2.3	476
Anthecological	175	33.3	41.8	4.8	10.1	9.7	1647
Next 38							
Entomological	108	90.5	1.4	2.1	4.8	1.0	475
Anthecological	141	60.6	9.5	1.6	25.6	2.5	1077
Total 100							
Entomological	230	86.5	2.8	4.2	4.7	1.6	951
Anthecological	316	44.1	29.1	3.5	16.2	6.8	2724
2. 65 Compositae							
Entomological	213	79.2	10.2	5.8	3.0	1.5	985
Anthecological	255	35.6	37.0	5.1	14.7	7.3	3309
59, Germany, Müller	.....	48.1	27.1	7.7	9.8	7.0	1103
85, Illinois	.....	40.3	27.1	16.9	11.2	4.4	4030
3. 51 plants							
Flowers and insects	.....	40.4	25.1	15.5	13.8	4.9	1386
Anthecological, Europe	.....	42.5	34.7	6.3	8.9	7.5	887
Entomological, Europe	.....	88.6	4.2	2.3	1.5	3.1	256
4. Visits in Knuth	.....	44.6	25.4	12.4	11.7	5.7	6127
Other observers	.....	53.2	17.8	11.0	10.6	7.2	3289
Flowers and insects	.....	43.4	26.5	12.2	12.3	5.3	6163

they should be distributed under the natural families of plants. The visits of each nest-making bee should be distributed under three headings: one showing the pollen visits of the female, another showing the nectar visits of the female, and a third showing the nectar visits of the male. If they are arranged under alphabetical lists of plants, and the sexes and pollen and nectar visits of the bees suppressed, they have little use as entomological data.

MIXING ANTHECOLOGICAL LISTS AND COLLECTORS' NOTES.—In his *Blütenbiologie* KNUTH gives a list of 37 entomologists whose notes are included as if they furnished anthecological data. The

difference is quite definitely shown in the first 100 cases in which collectors' notes and anthecological lists are given for the same flowers (table I, 1). The latter show for visits: bees 44.1 per cent and flies 29.1, while the former show bees 86.5 per cent and flies 2.8. One indicates a rather miscellaneous assemblage, while the other shows such a strong preponderance of bees as to reveal the fact that most of the entomologists were collecting bees particularly. In the first 62 cases the bee visits stand 82.5 per cent, flies 4.2, against bees 33.3, flies 41.8, the maximum changing from bees to flies. In the next 38 cases the bee visits are 90.5 and 60.6, a difference of 29.9. These are Papilionaceae and rather melittophilous, so that the bee collectors' notes give a more correct approximation. In many cases they did not say whether the bees were collecting pollen or not, and often did not mention the sexes at all.

In the case of 65 species of Compositae for which there were both collectors' notes and anthecological lists (table I, 2) the percentages of visits stand: for the former, bees 79.2, flies 10.2; for the latter, bees 35.6, flies 37.0, the maximum again shifting from bees to flies. Comparing 59 species observed by MÜLLER (*Fertilisation of flowers*), 65 observed by anthecologists in Europe, and 85 observed by me in Illinois, there is more resemblance between the European and Illinois lists than between collectors' notes and anthecological lists based on the same 65 species observed in Europe.

In the case of 51 plants observed both in Europe and Illinois (table I, 3) the percentages of bee visits show: for the collectors 88.6, for the anthecologists, Europe 42.5, Illinois 40.4. Here again there is more resemblance between anthecological observations for Europe and Illinois than between anthecological lists and collectors' notes for Europe. As entomological data the collectors' notes are just as unsatisfactory. In the three cases the percentages of visits of flies range: for the collectors, 1.4 to 10.2, with an average of 4.5; for the anthecologists, 9.5 to 41.8, with an average of 29.5.

The insect visits to flowers recorded in my *Flowers and insects* are not included in KNUTH'S work, but are broken up in a final list and redistributed under the insects, making a quasi-entomological subject of them, but they are vitiated by being mixed with collectors' notes. These visits recorded in KNUTH (table I, 4) show for bees 44.6 per cent of the total. The visits recorded for other

observers show bees as 53.2 per cent. This is a higher percentage than is shown in anthecological observations of any region, and indicates that observations were introduced which discriminated in favor of bees to the exclusion of other insects. My *Flowers and insects* shows for bee visits 43.4 per cent instead of 44.6. The difference comes from using some entomological notes which were separated from my anthecological lists and were never intended to be used as anthecological data.

DYSTROPIC VISITS.—Useless visits of insects should be considered from the standpoint of the flowers and regarded as marks of imperfect adaptation. LOEW has called insects which make such visits "dystropic," and MÜLLER has called *Bombus mastrucatus* a "dysteleologue," as if these insects were under some teleological obligation to make useful visits. So far as the flower is concerned, a bee collecting pollen from it without effecting pollination cannot count among the useful visitors. So far as the bee is concerned, however, the visit is legitimate and the flower must be counted among its pollen visits. In the case of a family of small bees (Halictidae) 165 visits, mostly for pollen, were observed to flowers which they failed to pollinate. KNUTH, while omitting American visits under the plants to which they relate and redistributing them under the insects which make them, has indicated the so-called dystropic visits under conditions which make them entomologically irrelevant.

EXAGGERATION OF FRAGMENTARY OBSERVATIONS.—Probably anyone who contemplates methods of publication will notice this as a common characteristic. Fragmentary observations, as regards publication, reviewing, or abstracting, get more consideration than they are entitled to, for the reason that it is easier and cheaper to do so. When it was complained that KNUTH suppressed anthecological lists, the statement did not apply to the most fragmentary, the most worthless ones. His work gives 55 of my lists averaging 2.8 visits, and excludes 207 lists averaging 28.9 visits. There is only one reason: the short lists are easier to copy and to print.

One list containing 18 Syrphidae and 128 other insects is omitted, while another list for the same plant, consisting exclusively of 5 Syrphidae, is given. Special mention is made of the occurrence

of one Syrphid on a flower of which a list containing 10 Syrphidae and 21 other insects is not included. In *Blütenbiologie* 2:254, KNUTH specially mentions the hive-bee and *Syritta pipiens* as visitors of *Ptelea trifoliata*, but in 3:444 a list containing these two insects together with 49 others is merely grouped. In 2:476, *Andrena combinata* (sex?), observed by SCHMIEDEKNECHT, is specially mentioned, while MACLEOD'S list containing 6 bees (sexes given) and 70 other insects is combined. In the third volume of *Blütenbiologie* the seeming discrimination in favor of collectors' notes as against anthecological lists perhaps may be explained partly from the fact that they are usually short. Why long lists are usually published in the second volume and always omitted in the third requires another explanation.

GENERAL RESULTS.—While one might hold that a general work should treat all of the data alike, and that, when it repeats one set of lists for the third time, it should collect another set once, it is not certain that it should give local lists at all. As regards details, local lists decline in value as the distance increases from the place where they were made. As regards species, the lists from Illinois and Germany are quite different. A student in one place does not need to know the specific name of every insect taken on flowers in the other, but only the different kinds. Of course in giving the general groups errors may easily be made. "Hymenoptera" is used for the three groups, long-tongued bees, short-tongued bees, and other Hymenoptera, for any two of them, or for any one of them exclusively. Bees and the other Hymenoptera do not belong to the same ecological class. Of 437 entomophilous flowers bees were found on 95.4 per cent, while flies were found on 60.4 per cent, and the other Hymenoptera on only 43.0 per cent. Table I shows that the visits of bees range from 33.3 to 60.6 per cent, while the visits of other Hymenoptera range from 1.6 to 16.9. In DAVIS' *Handbook of flower pollination* (1:165), "hymenopterid flowers" is a translation of "Immenblumen," used by KNUTH in referring to a statement in which LOEW wrote "Bienenblumen."

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