INSECT FOOD HABITS AND VEGETATION.

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INTRODUCTION.

The object of this paper is to call attention to the types of insect food habits which appear to be associated with certain types of vegetation. For the past three years, what might be called "insect surveys" have been made in different parts of New Jersey, primarily for the purpose of arriving at the relative importance of the food-habit types in various localities. In all cases an effort was made to obtain a fair sample of the species present and in order to achieve this end, all collecting methods were employed and the areas under consideration were visited, usually, at weekly intervals throughout the insect seasons. Whereas such methods are not exhaustive it is believed that a fair "sample" was obtained during each survey. The collections were all made by the same men, the same methods were employed throughout and the areas were collected over with the same degree of thoroughness, thereby making the results more comparable than if different methods and collectors had been employed in each case.

The types of food habits were based mainly on the predominating larval habits of the family and the results therefore are general, due to the absence of exact knowledge for many of the species concerned. Any classification of this sort will of necessity lack exactness, but the present state of our knowledge will not permit any better or quicker method. Under this plan each species was placed in accordance with its food habits, if known, and in accordance with its family food habits if its own habits were not known. Dr. L. O. Howard, in his paper on "The Economic Status of Insects as a Class," (Smith. Rept. 1898, pp. 551-569), published some twenty years ago, called attention to the difficulty of classifying insects in accordance with their injurious or beneficial habits, other than by summarizing their activities by families and the same difficulty will persist until the habits of many individual species are better known. In addition, the percentages showing the comparative

importance of the various types of food habits were founded on the species present, regardless of the number of individuals of each species. In some ways this might be regarded as a serious error. On the other hand, the fact that various species of insects exist indicates that they are adapted to their surroundings, including natural enemies, weather, diseases, etc., and if a species is plentiful or rare, such conditions are usually normal. Various species maintain themselves in certain numerical ratios with respect to factors or combinations of factors tending to reduce their numbers and also bear certain relationships to associations of plants. These relationships are usually normal and are part of the so-called natural balance except where the balance has been overthrown by the destruction of natural plant associations and the interposition of large numbers of plants belonging to a single species, or except where it has been temporarily destroyed by an unusual increase in the numbers of certain species of insects.

As natural conditions prevailed in the surveyed places, the numerical ratios can be considered as constant and the percentages showing the importance of the various types of food habits can be taken as indicative of conditions in the surveyed areas or other areas where plant associations, temperature, moisture, etc., are similar. It is not supposed that the percentages will be taken literally. They simply show the trend and the comparative importance of the food habit types in a general way. They should be considered as averages. As is well known, the accuracy of any average depends in part on the number of items on which the average is founded. The larger the number of items, the more accurate becomes the average. The absence of bias also increases the accuracy of the average. Absolute accuracy is not possible of attainment in a matter of this kind. It is realized that a much better picture of the relationships of the food habit types could have been drawn had figures on the numerical abundance of the species been available. Having such figures some weight could be assigned to each species and its importance in the general scheme of things partly arrived at. On the other hand, even though such figures were available, the fact that a certain species was present in large numbers would not be a true index as to its importance. Relative damage to plants and its relation to other insects would have to be considered. It

would be exceedingly difficult to assign to any one species the exact importance which it bears to the whole community of plants and insects.

It has been suggested that actual counts of the numbers of the various species should have been made in different parts of the surveyed areas and such figures applied to the entire areas. The physical difficulties of such a plan are obvious. Collecting varies from day to day and even from hour to hour and insects are not equally distributed among the plants of any area. Moreover the opportunity for errors would be very great if such a plan were followed. The assumption that the numerical ratios are constant within certain limits, where natural conditions prevail, simplifies the matter considerably. By natural conditions, it is meant that the vegetation was relatively unchanged by the hand of man. An outbreak of a certain species under such natural conditions would not in most cases affect the percentages given, in view of the fact that each species, regardless of its abundance or damage, is given the same weight. It is conceivable, of course, that a certain species might multiply to such an extent as to seriously injure its host and thereby start a train of events some of which might seriously affect many other species, thereby changing the ratio of the food habit types, but even if this happened, nature would restore the balance in due time. Moreover, numerical abundance varies from time to time and depends upon variable factors and figures or estimates secured during one season might not be applicable another season. Prof. Charles T. Brues, in his recent article on "Choice of Food and Numerical Abundance Among Insects," (Jour. Econ. Ent., vol. 16, pp. 46-51), states that "the numerical abundance of a great many species of insects, perhaps of nearly all, depends to a very limited extent upon their powers of reproduction and almost entirely upon the factors which tend to limit these powers. Among these, the prevalence of disease, of insect parasites and the extent of the available food supply are the factors that determine how far any species may utilize its latent powers for reproduction and multiplication. All three factors are highly variable and to one or the several in combination may usually be traced the numerical abundance of any particular species."

THE SURVEYED AREAS.

At Monmouth Junction, N. J., the surveyed area was made up of about fifteen acres of moist woods on the Piedmont Plain of New Jersey. The ground was moist with many wet spots, but seldom became swampy. Among the trees, the red maple was the dominant species. This together with the oaks (*Q. palustris, rubra, alba*) contributed over half the trees in the woods, the balance consisting of ironwood, sweet gum and beech, with scattering clumps of gray birch in various stages of decay. A rich fungous flora, consisting mainly of polypores, flourished on the many trees and stumps in various stages of decay and the moist forest floor supported numerous species of gill fungi. Adjoining the woods was the thicket, about seven acres of which were included in the survey. In this area the fungous flora was negligible. Many of the characteristic plants of the tree and shrub groups in the woods held important places in the thicket and in addition, the herbaceous flora was large and complicated. It began with a spring flora, was followed by a less well-defined early and late summer series and ended with a distinct and showy autumn group.

The surveyed area at Lakehurst, N. J., was located in the "pine barrens" and consisted of about ten acres of dry woods and about four acres of adjoining open territory. The trees in the woods were almost entirely oaks and pines, with about two-thirds of the individuals pitch pine (*Pinus rigida*). The other third was made up of post oak, black-jack oak and chestnut oak, with a sprinkling of yellow pine and sassafras. The dominant shrub in the woods was the scrub oak. Others were clumps of scrub chestnut-oak, young pines and oaks, dangleberry and low blueberry. Herbaceous plants were few in number and inconspicuous. The open area was devoid of trees and contained such plants as the beach plum, blueberry, bearberry, patches of sweet fern, occasional plants of bayberry, large patches of dwarf sumac and many bare, sandy spots. Among the herbaceous plants were pine barren heather, sandwort, ipecac, toadflax, prickly pear cactus, horse-mint, etc.

The surveyed area at Morgan, N. J., consisted of about five acres of salt marsh located on the upper New Jersey coast along the Cheesequake creek and covered mostly by *Spartina*

patens and *Juncus gerardi.* This marsh was above mean high tide, but was occasionally covered by spring and fall tides and by winter and storm tides.

TYPES OF FOOD HABITS.

The following table (I) shows the types of food habits present in the various areas and their relative importance, the percentages being based on the species present regardless of numerical abundance.

TABLE I.

	Species	Phytophagous %	Saprophagous % *	Harpactophagous %	Parasitic %	Pollen Feeders %	Misc. %
Moist woods on Piedmont plain. Monmouth Jc.....	415	37	35	20	5	3	
Thicket, Piedmont plain. Monmouth Jc.	273	63	9	19	7	2	
Dry woods in "pine barrens" Lakehurst	381	45	21	18	14	2	
Open area in "pine barrens" Lakehurst	246	41	10	24	18	7	
Salt marsh, Morgan..	210	39	21	26	13	1	

TABLE II.

Western Arctic Coast of N. A.....	400	47	27	14	10	2	
State of N. J.....	10,500	49	19	16	12	2	2

According to Table I, the percentages of phytophagous and saprophagous species in the moist woods were almost similar and this is in accordance with what one would expect, knowing the conditions which included the presence of much decaying vegetation. The adjoining thicket on the other hand showed a small percentage of saprophagous species and a very

* J. Percy Baumberger, on the basis of experiments and "the general lack of nutritive value (for insects) of many" substrata assumes that the food of insects permanently inhabiting "substrata of a fermenting or delaying nature is the micro-organisms" (fungi and bacteria) found in such places, "and to a less extent the substratum." In view of this interpretation of the food of scavengers, he suggests that all insects which have in the past been termed scavengers, coprophages, etc., be included under the term Mycetophages. (Jour. Exp. Zool. Vol. 28, 1919, pp. 1–81.)

large percentage of phytophagous ones. This, too, appears to be natural in view of the absence of conditions which would support saprophagous species and because of the presence of a large herbaceous flora, plenty of sunlight and higher temperatures, all of which would account for the larger percentage of phytophagous species. In both the thicket and woods, the remaining percentages are approximately similar showing that the other types of food habits were about of equal importance with respect to the species present. This, too, might be expected in view of the fact that both areas were adjoining and generally similar although differing in details.

Almost the same thing holds true of the "pine barren" woods and its adjoining open area. The percentages of phytophagous forms were almost similar in each. The woods with some dead timber and decaying vegetation showed more saprophagous species than the open area. The predaceous and parasitic species were also about equal in each, the actual difference shown in the table not being large enough to be of any significance.

Comparing the moist woods, dry woods and salt marsh with each other, it is found that the percentages of phytophagous species do not vary greatly and that only in the moist woods is there a decided increase in saprophagous species. The percentages dealing with predaceous food habits show comparatively little variation, being highest for the salt marsh and lowest for the dry woods. Scanning the "parasitic" percentages, it is found that the lowest figure is for the moist woods and the highest for the dry woods, if the thicket and open area are left out of consideration. These figures do not appear to be as consistent as the others and it is not known why comparatively fewer parasitic species should occur in the moist woods area, although a small percentage is not inconsistent with a "balance" when nothing is known of the numerical abundance of the species.

As a matter of interest the food habits of the 10,500 species of insects recorded from New Jersey and the some 400 species reported from different sections along the Western Arctic Coast of America, (Rept. Canad. Arc. Exped., vol. III, Insects, parts A to K), have been tabulated and these percentages which are shown in table II are strikingly similar and seem to indicate that the ratios between the various types of food

habits are approximately identical or vary but little when large areas embracing different types of vegetation are considered *in toto* and when the numerical ratios between the species and the factors tending to reduce their numbers are considered as constant, or at the most fluctuating within limits which do not allow any serious disturbance of the "natural balance."

The percentages shown in table I for different portions of New Jersey appear to indicate that the ratios between the various types of insect food habits, (based on the species present, with the numerical ratios between the species and the factors tending to reduce their numbers considered as approximately constant) vary in accordance with the type of vegetation when relatively small areas each with a uniform type of vegetation are considered.