ECOLOGY AND PHENOLOGY OF THE SPRING AND SUMMER NECTAR AND POLLEN PLANTS OF THE MANHATTAN, KANSAS AREA

by

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INTRODUCTION

The keeping of bees is almost as old as recorded history and through the years, man has developed various methods of caring for them. Throughout the world today there are numerous types of hives for keeping bees, from the mud hives of Palestine, the log hives of India and Africa, the skeps of Holland, the gums of Tennessee, to the modern standard hives of America, England, France, Germany, and the rest of the continent. Along with these hives in use there are varities of methods for handling and studying bees.

In general, there are three main forms of manipulations or systems of beekeeping. These are the let-alone-system, semi-scientific system, and the scientific system.

The let-alone-system is the simplest of the three and involves very little work or contact with the bees. In this form, the beekeeper, through fright of being stung, permits the bees to care for themselves in logs, nail kegs, pots, or boxes once he has hived the swarm. At the end of each active season, the bees are killed by the use of fire or some chemical and the honey is taken. If the honey is merely taken without the destruction of the bees, the colony may die out during the winter due to a lack of stores or if this takes place in the tropics, the bees may abscond because of the disturbance. The hive may be in use again the following season when another swarm occupies the box.

This type of beekeeping involves no study of the internal functions of a colony but may be accompanied by some casual field

observations. The ideas of the beekeeper are based chiefly on fiction, folklore, and superstition. The amount of honey obtained each year is small.

The semi-scientific system involves the use of semi-standard or standard equipment, leaving the activities of the colony up to the bees. The only activity that is interfered with is that of honey production. A sufficient number of supers are put on the colony at the beginning of the blooming period of the major nectar plant, and removed at the end of the season. During some portion of the season the lid of the hive may be pried open and a hurried glance shows the amount of honey stored by the bees. Swarming is never controlled and the beekeeper only has a bare knowledge of some few nectar producing plants of the area. This is often erroneous.

The ideas of the beekeeper are mingled with fact and fiction, most of them having been obtained through conversation with other beekeepers of like caliber. Some is gleaned out of magazine articles of both scientific and non-scientific basis and these are distorted due to a lack of scientific study. In general, he is a hinderance to himself and every one concerned.

The amount of honey obtained is variable with the seasonal changes of each year and these climatic factors affect the flora of the area as well as the colony. The entire operation is hazy and a burdensome affair for the owner.

The third system is the best form of keeping bees. This affords a great amount of pleasure as well as mental and physical

stimulation for the beekeeper. It should be used, by those who have adopted this system, for the improvement of the unfortunate.

This form involves years of field experience in scientifically manipulating and studying bees as to the internal activity of the colony and the activity in the field. Observations on the phenology of the nectar and pollen plants of the region are recorded for reference in order to present a definite monthly and annual schedule of events. This guide helps in proper colony manipulation during each month of the year.

Of slightly less importance is a thorough knowledge of the meteriological and ecological factors involved in the growth of various floral species of major and minor importance within the region in which the beekeeper operates. By having all this information available, the proper location for maximum nectar production can be selected. The colonies of a scientific beekeeper are observed regularly and the equipment used is standard with all hive parts properly cleaned for easy manipulation. The amount of honey obtained each year is above the average for the entire area.

Since all beekeepers are not so efficient as the scientific one, who has learned the behavior of bees thru years of experience and under proper guidance, some form of phenological literature should be made available for all to use. It should be based on careful field observations for all beekeeping regions of the State of Kansas and presented in simple language for the layman. Such a presentation of facts would be a definite aid to the beekeepers. This subject has been chosen for a thesis in order to try and fulfill a part of that need.

Beekeepers of this area of Kansas as well as those of other areas miss a great amount of bee pasture for two main reasons. The first, is that they do not know the phenology of the nectar and pollen plants or the potential value of each in their own operational zones; and secondly, they either fail to locate their apiaries in proper sites or do not adjust their colony manipulations to the blooming periods of the different plants within the region.

Two of the primary colony requirements, not only for good wintering but also for obtaining the maximum honey crops are, an abundance of some major nectar producing plant in the near vicinity of the apiary and strong populous colonies. The first requirement can be obtained by conducting a thorough field study throughout a year and drawing up a phenological chart for the area. The second requirement is dependent upon the first as stated by Root (15, p. 116). If the colonies have gone into the winter with a minimum or less of honey and pollen, especially the latter, they must be able to obtain the necessary amount from the field during the early spring. In this region it can only be accomplished if the trees producing these supplies are in the vicinity of the apiary. It would be absurd to place an apiary in the center of a section of grassland, but unwise as it may be some manage their bees almost as badly. In short, pollen as well as nectar is vitally important in increasing a colony's strength before the honey flow begins. Further, a knowledge of the phenology of an area will help to determine whether the colonies need any and how much external stimulation until the flowers are

present furnishing stores with which they can maintain themselves. By adjusting the colony manipulations during the early spring months in conjunction with the sources of nectar and pollen available, a surplus should be obtained rather than have the colony build up on the nectar flow and lose a crop of honey. Theoretically, this should be true if all factors in regards to the internal condition of a colony are proper. This again is dependent upon good beekeeping methods.

Furthermore, the statement has often been made by some beekeeper that a crop of honey was obtained but the source was unknown. Such a remark is the result of not knowing the phenology of the nectar and pollen plants of the area. This untraceable crop of honey may have been obtained from some insignificant plant, tree, shrub, herb, or vine growing in a nearby timber or it may even have been gathered from a small plant growing along the bed of a streamlet running through a neighboring pasture. Wherever it may have been gathered, in all probability the surplus could have been doubled by coordinating proper colony manipulation with the period of blooming if, first, the plant had been known to exist where it did; secondly, whether it was visited by bees; thirdly, if it produced any quantity of nectar and how much; and last but the most important, when it bloomed and for how long a period.

Phillips (12, p. 301) has this to say,

> To the beekeeper who studies his locality properly, one of the most difficult and important problems is to determine the sources from which his bees gather important amounts of nectar and pollen and to schedule the usual blooming dates of

these plant species. The books and journals devoted to beekeeping give considerable information regarding honey-plants, but to determine which ones are of greatest importance in any given place and properly to identify those on which bees work is sometimes difficult for one who is not a botanist. In localities where only one or two species yield surplus, this problem is relatively easy.

He continues (12, p. 337),

> Those plants which, because of scarcity or limited secretion of nectar, fail to give the beekeeper a surplus are nevertheless, of marked value and are worthy of more consideration than they usually receive. The amount of honey consumed by an average colony of bees in a year has been variously estimated as 200 to 600 pounds. This will, of course, vary according to the locality, strength of colony and other factors. Accepting even the lowest figures, it is evident that a moderate sized apiary obtains tons of sugar from the flowers in the surrounding territory. While nectar comes in abundantly enough at times to produce a surplus, the beekeeper does not leave in the hives enough at the close of a surplus honey-flow enough to feed the bees until another major honey-flow, except possibly at the close of the season. The bees are almost constantly gathering nectar from the minor sources during the summer and the aggregate from these plants is enormous. If, for example, nectar were obtained in the North from white clover only, at the close of the honey-flow the beekeeper would be compelled to leave about 200 pounds for the bees, and there is rarely enough honey from white clover to permit this. This indicates that the beekeeper is debtor to the minor sources for much more than he is accustomed to believe.

However, a study of the blooming dates of nectar and pollen plants would be incomplete without a brief description of the climatic and ecological factors of these counties. These play an important part in this phase of beekeeping. Often the plant growth may be well above normal but under certain climatic and ecological conditions the amount of nectar secreted may be greatly reduced. The reaction of these various factors on the nectar secretion of the plant are not clearly understood. The problem of nectar secretion is subject to plant physiological factors, ecological factors, soil factors, and climatic factors. Under

normal conditions these factors will not be a total hinderance in obtaining the maximum surplus possible, if the phenology of the region is known. Migratory beekeepers are greatly in need of this information since they often move into an area that has not been studied for beekeeping.

The region being dealt with in this thesis includes portions of the Kansas River, Big Blue River, Kaw River, Wildcat Creek, Vermillion River, and the Mill Creek water sheds. The counties included are Riley, Pottawatomie, and Wabaunsee. Field trips have been carried on for two years covering the hilly tracts, plateaus, plains, woods, and crop growing areas of these counties. This is by no means a total list of the flora visited by bees for that would require years of study. However, it contains a large portion of the flora found scattered over the entire region. Various plants are to be found in greater concentrations in specific areas. Field observations have shown that vegetation of the immediate counties bordering the three studied, have almost the same identical flora and could be included in this paper. Because of insufficient time spent in each, they have not been included.

AIMS AND METHODS OF THIS STUDY

The purpose of this study is to prepare a phenological chart of the blooming periods of all the nectar and pollen plants of this part of Kansas. Three counties were included in this study namely, Riley, Pottawatomie, and Wabaunsee. An analysis of the

methods of beekeeping brought out the fact that this region had no definite list of nectar and pollen plants. The main sources of nectar, such as yellow sweet clover and white sweet clover, are known by the majority of beekeepers, if not by all of them. However, the majority do not know the flora that contribute so much to the total colony production or that help in rearing brood. A knowledge of the blooming periods of the flowers aiding in beekeeping would help apiarists in carrying on their manipulations throughout the year.

Furthermore, such a list would benefit beekeepers throughout other parts of the United States as well. A list of the nectar plants would enable a further study of the sugar concentration of the nectar secreted by each and an analysis of the attraction of bees to one rather than another.

This study consisted in field observations, collection of plants, and the identification of each. Field observations can be divided into the recording of the first and last blooming date, the type of stores obtained by the honeybees, the amount of activity present on the flowers through various portions of the day, and the environment in which each specific nectar and pollen producing plant grew. Collection consisted of taking either flowering or fruiting parts of the plants, preserving them in presses and recording the environment in which they were found. Identification consisted in the use of taxonomic keys for flowering plants, trees, herbs, and woods. In certain instances horticultural varieties were identified with the assistance of

an authority on such plants.

In the beginning an attempt was made to record the periods of greatest bee activity but this proved to be too time consuming and was given up. Sugar concentrations of the nectar of some of the major nectar plants were obtained by means of a refractometer. A record was kept of the daily weather factors for Manhattan and from this and a less complete phonological chart for 1948, field observations were conducted successfully on consecutive days of the week. This work was carried on for two and a half years through out each of the counties discussed.

Weather data was obtained from the Report of the Kansas State Board of Agriculture by Flora (2). Soils and drainage data was taken from a reprint by Fly (3). The distribution of each plant was checked with that shown by Gates (4) and the scientific name for each was again checked with the same source. Some of the names used by Rydeberg (16) and Robinson (14) did not check with that of Gates. As a final check the flowers were checked with the works of Lovell (9) and Pellett (11). Several were not listed by either and others did not agree with the reports of both. No effort was made to change the findings but were described as they had been observed during field trips.

To date there has been no complete study of all the nectar and pollen producing plants of any area of Kansas. Literature has numerous accounts of the use bees make of individual important plants but not a combined study or chart of both the major,

minor, and unimportant ones. There are two papers dealing with nectar and pollen plants of Kansas but these, too, are brief and deal only with the major ones. One of these is by Merrill (10) and the other is my Small (18). To obtain a complete list of the nectar and pollen plants of this area as well as those of the entire State of Kansas, a full time effort will have to be made and continued for some five years. Such a period of time would enable one to establish with accuracy the average period of blooming.

SOILS AND VEGETATION OF THE REGION

The three counties dealt with in this thesis are within the Bluestem or Limestone Region of Kansas, although some portions of other regions shown on Fig. 1, are included in each of the counties dealt with in this paper. This entire region is noted throughout the state for its fine grasslands on which the cattle growers depend.

Another name for this region is the Flint Hills, having originated from the discovery of great quantities of flinty or cherty limestone deposits beneath the surface of the soil. In general, the soil of this region is high in lime content and separate the eastern Kansas prairies region having an acedic chemical content of the soil from the western Kansas soil types having an acedic, neutral, or basic mineral content.

The eastern two-thirds of Riley county is made up of the Bluestem Region while the western third of the county is composed

of the central Kansas prairies region. The portion of the county along the Big Blue River and Kansas River is included in the river flood plains and low terraces (Fig. 1).

Pottawatomie county is almost equally divided into two soil regions, the western half composed of the Bluestem Region and the eastern half the Loess-drift Hill Region. This eastern portion is given to truck farming, fruit growing, small grain, hay, and row crop agricultural methods (Fig. 1).

Practically two-thirds of Wabaunsee county is in the Bluestem Region. A small northeastern section of the county extends into the Loess-drift Hill Region, the extreme southwestern corner extends into the East Central Prairies Section, and the extreme southeastern corner of the county extends into the Central Kansas Prairies Section (Fig. 1).

This region is hilly to rolling and has numerous plains, valleys, and steep breaks along its streams. Due to a great amount of erosion of soil on the hillsides and hilltops, rocks or rock ledgings have been exposed to the surface. This makes agricultural practices almost impossible. In his paper on Kansas resources, Fly (3, p. 52) states,

> Soils suitable for cultivation include those on the smoother slopes on the high divides, which have ten inches or more of dark brown to nearly black granular silty clay loams over heavy dark clay or clay-pan like subsoils. Soils with very thin topsoils over light brownish clays occupy some of the lower divides adjacent to flinty limestone outcrops, but they are so shallow and hard to till that their cropland use is limited. The best croplands other than the stream valleys are the deep, dark brownish gray to nearly black silt loams and silty clay loam to silty clay subsoils on the gently rolling limestone uplands and below limestone outcrops. Along the stream valleys the soils are dark, deep

silt loams and silty clay loams which are fertile and produce abundantly were well drained. Soils farthest from the stream channel in some of the wider bottoms, however, are nearly black heavy plastic clays which drain slowly, and reequently are too wet for early seeding. They produce well in favorable seasons.

The amount of subsoil moisture is limited in many areas but in the limestone hills many of the streams are fed by fine springs or seepages from between fissures in the limestone bedrock. Wherever the moisture content of the subsoil is high, vegetation does well. Water is found to be lodged in subterranean pockets or in underground streams, and the root systems of many forms of vegetation penetrates deeply to obtain moisture. The streams, rivers, ponds, lakes, and wells supply the greater portion of moisture for animal life as well as plant growth.

Vegetation, therefore, due to the location of the chief water supplies, is to be found growing densely along the stream banks and hillsides where the moisture content of the subsoil is high. Excluding the clovers and prairie growing plants, the chief nectar and pollen producing trees, shrubs, and herbs are to be found in these areas. Some of the common ones are the cottonwoods, boxelders, maples, elms, willows, redbuds, horse-chestnuts, basswoods, mints, verbenas, wild plums, buckbrush, and others. None of these are considered major nectar sources. However, the majority of them are the major pollen producers and without them bees would not be able to make use of the clovers, which are the major nectar producers of this area. These dense growths of vegetation aid in the conservation of moisture and the replenishment of soil nutrients by the carpeting of the ground

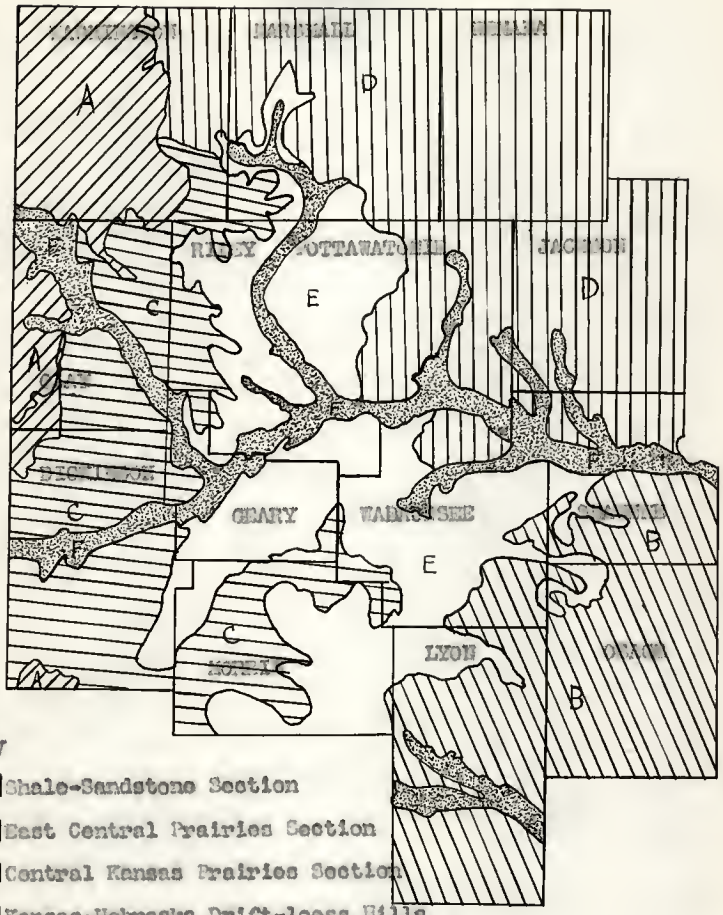


Fig. 1 Soil types of the region

Source: Fly, Claude L. (3)

with their annual leaf growths.

On the open prairies, pastures, plains, and roadways are to be found several of the minor nector and pollen plants which contribute to the storage of winter supplies. These are the sources of bee supplies, which are so often neglected as to their value, as to be totally unheard of or used. They are to a great extent drought resistent and therefore require smaller amounts of moisture to grow and produce bee stores. Besides, they are largely the annuals and perennials which grow from rootstocks, seeds, or their vegetative growths of the previous season. Some of these are buckbrush, ironweed, hoary vervain, sumac, lead plant, and others.

A complete field survey shows that this area is abundantly supplied with nector and pollen producing plants, trees, lianas, shrubs, and herbs for beekeeping and there should not be any reason for beekeepers to sustain heavy winter losses and minor honey crops. The error lies with the beekeepers and their manipulation of the colonies within their possession - not in the bees.

DRAINAGE AND TOPOGRAPHY OF THE REGION

This area, being chiefly composed of large flat plains along the many river systems and rolling to hilly country extending from these stream valleys, has a great amount of erosion. The recorded elevation for the counties has been taken for a few points, but from field trips in each of them once can assume with

fair certainity that these readings are for the higher points or merely for the location at which a weather station is established. However, the points recorded are as follows; for Riley county, there are two points, one at Randolph having an elevation of 1,052 feet and the other taken at Manhattan, having an elevation of 1,073 feet. There is disagreement on the latter figure as recorded on a recent map published by the Kansas Highway Commission and the Report of the Kansas State Board of Agriculture dealing with the climate of Kansas. For Wabaunsee county, there are three points having the elevation recorded as follows; Alma 1,080 feet, Harveyville 1,200 feet, and Eskridge 1,412 feet which is also the highest point in the three counties being considered. There are two points recorded for Pottawatomie county, namely, Emmett 1,024 feet and Westmoreland with 1,270 feet. Certain plains areas of all three counties are lower than these figures, for of the seven points mentioned, only Randolph and Manhatten are situated in a river valley; the former on the Big Blue River and the latter on the Kansas River. This would lead one to assume that the lowest points probably have an elevation of around a thousand feet.

Because of this variation in elevation many of the streams have cut deep channels, which are narrow in width and cannot adequately carry the great amount of water drained off the surrounding hills from heavy spring and fall rains. In his report Fly (3, p. 51) states,

Grades of the streams rising in the Bluestem Hills are as

> much as twenty feet per mile, much steeper than their grades after they leave the hills, with the result that heavy rains are followed by flooding on the lower, more gently rolling prairies to the east and south.

Because of this heavy drainage, soil conservation and water conservation methods will have to be adopted extensively in order to maintain the productivity of the higher agricultural areas. Erosion is gradually denuding the hills and gentle slopes of their rich topsoil, only to bring to the surface clay pan soils, alkali spots, and rocks.

The drainage system of each of these counties is tremendous being made up of numerous small streamlets, creeks, and some rivers. This probably is due to the hilly nature of the greater portion of the region.

Of all the principal drainage systems, that of the Kaw River is the largest. This river is formed by the union of the Kansas River flowing up through the south-east corner of Riley county with that of the Big Blue River flowing down from the north through the central portion of the same county. It is into this stream that the principal individual drainage systems within each county flow.

The Big Blue River forms the eastern county line for Riley county and western county line for Pottawatomie county. The northern part of Riley county is drained by Fancy Creek with its tributaries and several other minor streams, all of them flowing into the Big Blue River. The central portion of the county is drained by Wildcat Creek with its tributaries which flows into the Kansas River from the northwest. The Kansas River

flows through the extreme south and southeasterly portion of Riley county uniting with the Big Blue River to form the Kaw River which continues in an easterly direction through the entire southern portion of Pottawatomie county and entire northern portion of Wabaunsee county. Flowing between these two counties it forms the county lines for both (Fig. 2).

The west central and central portions of Pottawatomie county are drained by Rock Creek with its tributaries; and the northeastern, east central, and southeastern portions of the county drained by the Red Vermillion River system and Cross Creek with its tributaries. All of these drainage systems empty their water into the Kaw River (Fig. 2).

The extreme northerly portion of Wabaunsee county is flat and therefore has no large waterways, though the area is drained by small streams. The greater portion of the southwestern, central, and northeastern portions of the county are drained by the Mill Creek system, which flows into the Kaw River at the northeastern corner of the county. The eastern, southeastern, and extreme southern portions are drained by the upper branches of the Neosho River, Osage River, Dragon Creek, and the Wakarusa River systems (Fig. 2).

These various drainage systems carry off the excessive amount of moisture which falls in the form of rain, hail, or snow and would prove harmful to vegetation if left to stand for long periods of time. Floods, in general, do not cause excessive damage to vegetation other than agricultural crops, but they do

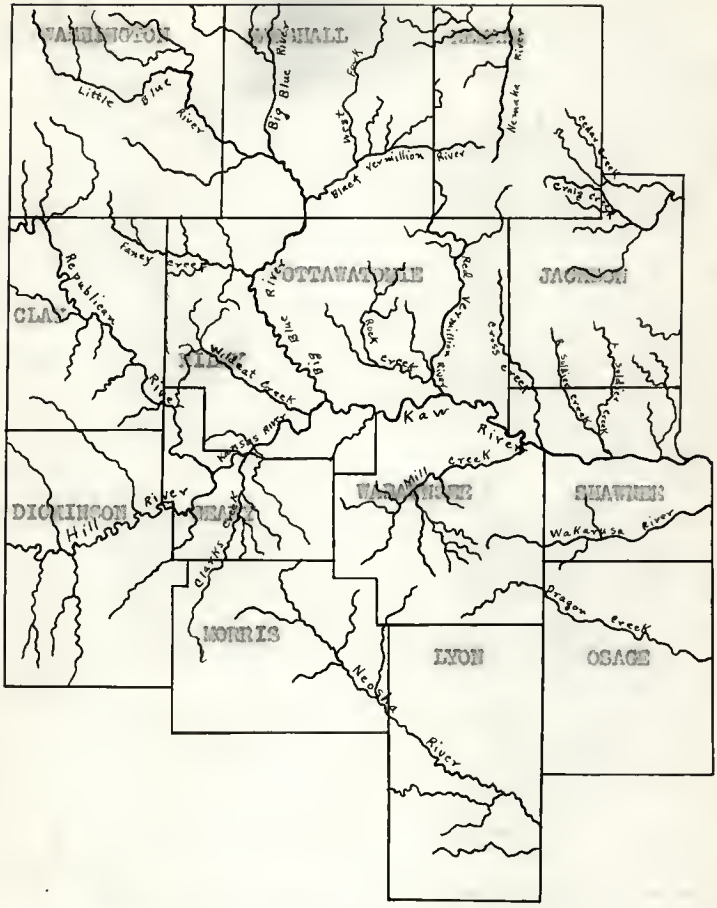


Fig. 2. Drainage of the region.

Source: Fly, Claude L. (3)

cause some damage through the distribution of unwanted weeds or plants. Often these plants are an aid to beekeeping by supplying amounts of nectar and pollen. An example of this kind may be seen on a farm in Wabaunsee county where boxelders and cottonwoods have spread several hundred feet downstream to establish a small flourishing grove of trees. This was due to the action of high water from heavy spring rains carrying the winged seeds downstream and replanting them. Certain nectar and pollen plants may also be spread in this manner as described by Johnson (7, p. 484) as follows,

> A neighbor beekeeper, many years ago, planted just a little golden honey plant along a small river near his home. My bees now get nearly half of their surplus from the golden honey plant that had scattered its seed all along down the river during periods of high water. Long after the clover had ceased blooming, my bees worked early and late on this golden honey plant. At first I thought the honey was from goldenrod or Spanish needle but few bees could be found on either one. We finally found that the bees were carrying from big clumps of this golden honey plant in the pastures and along the rows of fences.------ This plant now grows for miles down the river originating at the home of this old beekeeper now long since dead.

The utilization of flood waters for the increase of bee pasture would be a good thing to investigate in areas where there is a scarcity of an abundance of any one nectar and pollen plant.

SEASONAL WINDS OF THE REGION AND THE EFFECT ON BEES AND PLANTS

The three counties being studied lie in the eastern division of Kansas and as one would expect have a variation in the direction of season winds and their velocities. For this area Flora (2, p. 6) states,

These show an average hourly movement ranging from 0.2 miles at Topeka to 12.1 at Wichita and 12.9 at Dodge City, which indicates that wind movement in the south-central and western counties is approximately a third greater than in the eastern counties.

The prevailing winds during the winter months of December, January, February, and March are from the north with the velocity ranging from 0-65 miles per hour during blizzards. Any increase in the velocity, accompanied by a change in the direction toward the northwest, is an indication of an approaching cold front. Snowfalls, accompanied by strong winds, cause considerable drifting and colonies may suffer if they remain covered for long periods of time. Colonies that are covered with snow for days may suffocate due to a lack of ventilation.

Winter winds of high velocity cause little damage to vegetation other than trees, but if accompanied by freezing rains the weight of the ice on the branches, may cause them to break. Drifted snows are a benefit to small forms of vegetation acting as a blanket by keeping out the extremely low temperatures which usually follow snowfalls. Extremely low temperatures, heavy winds, and low humidity cause the greatest amount of damage to vegetation. Brambles are severely injured through the dessication of their canes, causing them to split. Young fruit trees are also killed if the sap within the phloem tubes is frozen because of the lack of a covering of thick bark. Many plants have their branches frozen back to the trunk or to the surface of the ground, but are capable of growth in the spring through the utilization of plant foods that have been stored up in the roots.

Most bee plants of this area are winter hardy and little damage is done to them.

Perhaps the greatest amount of financial loss is sustained during the spring months when most fruit growers are awaiting the blossoming of their trees. Because of the lack of wild bees and most pollinating insects during the early months of the year, bees play a very important role in the setting of fruit. Because of this reason the best weather for the best pollination of fruit blooms consists of a lack of wind, at least 50 per cent sunshine, and temperatures around 60 degrees Fahrenheit or more. Such weather conditions stimulate bees to their greatest activity during spring months. However, if the temperature is in the upper 50 degrees and the wind velocity averages 15 miles from the north, bees can be observed to be working the leeward or southerly sides of the trees leaving the blossoms on the north side unpollinated. The velocity of the wind being near the speed of flight of bees limits the activity to that area. The lack of proper pollination of fruit trees may often be traced to a period of days during which the wind velocity and the temperature were detrimental to strong bee activity. Another effect on bees is that of reducing the number of flights per day per bee because of the greater amount of energy used during windy days. Strong winds, against which bees have to struggle in their effort to obtain nectar or pollen, delay them in obtaining these stores. Furthermore, the constant waving movement of the branches forces the bees to make repeated attempts to visit each individual flower. Upon

return to the hive in an apiary location having no protective obstruction to the wind, the bees are forced to make repeated efforts to land on the entrance boards. Many beekeepers fail to realize the great effort put forth by bees during days having winds of high velocity, and fail to conserve the energy of a colony's field force by not placing a flight board from the bottom board of the hive to the ground. This flight board enables the exhausted bees to walk up to the entrances, instead of trying repeatedly to reach it against the buffeting of a strong wind. Then, too, many pollen carrying bees lose part of their stores either from the brushing action of the branches and leaves swaying in the breeze or through the direct action of the wind.

The prevailing winds during the spring months of April, May, and June are from the south bringing with them a rise in daily temperatures and an end to winter weather. The soil begins to thaw out and the sap within the roots and trunk of plants and trees begins to flow, stimulating vegetative growth. Bee activity is increased with the advent of warmer winds, more sunshine, and the blooming of the early sources of nectar and pollen. Activity is increased within the hive through the increase in egg laying by the queen. Prevailing southerly winds are a sign of the end of winter weather.

The prevailing winds during the summer months of July, August, and September are from the south, with occassional shifts to the southwest, southeast, north, northwest, or northeast. Winds from directions other than from the south or

southwest, bring many of the refreshing summer showers so badly needed to lower the high temperatures and increase the humidity. These rains aid in the maturing of many crops as well as nectar and pollen plants. In general, the early morning hours during the summer have no winds or those of extremely low velocities, but there is an increase in the velocity about the middle of the morning, reaching the maximum at about 2 o'clock in the afternoon. This period of the afternoon is also correlated with the highest daily temperatures and the lowest humidity for summer days. Flora (2, p. 6) states,

> The months of least wind are July and August, the averages for each of these months being practically the same. There is a marked variation in wind through the hours of the day, the average movement increasing near the warmest hours of the afternoon and falling off at night.

Summer winds in general do not affect the colony activity except as in the spring months. Bees lose a great amount of energy in working in the field when the wind velocity is more than 15 miles per hour. Winds of varying velocity may aid in the ventilation of the hive and help to evaporate the water content of the nectar gathered.

During the fall months of October and November the prevailing winds are from the south. However, during certain years there is a great amount of freezing weather with snowfalls. During these seasons the temperatures brought by the winds may cause an earlier cessation of all bee activity as well as plant growth. Little damage is done to pollen and nectar plants in this region during the fall months, as there are only a few

Table 1

	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Annual
Manhattan, Ks.													
Mean Maximum	39.6	44.3	56.5	67.9	76.6	86.7	93.0	91.5	83.6	71.2	56.0	42.0	67.4
Normal	29.2	32.4	44.0	55.2	64.8	75.7	80.2	78.5	70.5	58.1	44.0	32.2	55.3
Mean Minimum	18.5	21.1	31.4	42.5	52.8	62.6	67.3	65.8	57.8	45.2	31.8	22.0	43.2
Topeka, Ks.													
Mean Maximum	38.4	42.2	54.1	66.0	74.9	84.6	90.3	88.5	80.7	69.1	54.1	41.8	65.4
Normal	29.4	32.1	42.7	54.7	64.6	74.3	79.7	78.1	70.0	58.2	44.3	32.6	55.1
Mean Minimum	19.8	22.3	32.2	44.1	53.9	63.6	68.2	66.6	58.6	46.6	33.5	23.9	44.4
Wamego, Ks.													
Mean Maximum					Topeka, Ks. Readings*								
Normal	29.2	32.4	43.5	55.5	65.0	74.5	80.2	78.6	70.2	58.5	44.4	32.6	55.4
Mean Minimum					Topeka, Ks. Readings*								
Eskridge, Ks.													
Mean Maximum					Topeka, Ks. Readings*								
Normal	28.8	33.1	44.2	54.5	65.8	74.0	79.1	77.5	69.8	57.8	44.2	32.5	54.9
Mean Minimum					Topeka, Ks. Readings*								

*Readings taken at Topeka, Kansas were used for the mean maximum and mean minimum readings for Wamego, Pottawatomie county and for Eskridge, Wabaunsee county since they were not kept for these two weather stations.

Monthly mean maximum, normal, and mean minimum
Temperatures for
Riley, Shawnee, Pottawatomie, and Wabaunsee Counties

TEMPERATURE OF THE REGION AND THE EFFECTS ON BEES AND PLANTS

In order to show the great similarity between the three counties being studied, the data presented in Table 1, was taken from the Report of the Kansas State Board of Agriculture by Flora (2, p. 161). The table shows the monthly mean maximum, normal, mean minimum readings and the annual normal temperatures for this region. Topeka readings were included to show the very slight degree of difference between them and those of the other three counties. The readings for Topeka, therefore, will be recorded for the mean minimum and mean maximum temperatures and used for Wamego and Belvidge, as these temperature factors are not given in the Report of Kansas State Board of Agriculture. Each of the four weather stations listed above in the table are approximately 15 to 35 miles apart and within the 39 degree north latitude. The table reveals that the temperatures for Wabaunsee county are slightly lower than those of the other three counties but this is probably due to the higher elevation.

Daily temperatures were kept for the Manhattan region and could be used for practical purposes to represent the entire area being dealt with in this thesis. Some correlation may be seen to exist between the amount of temperature, sunshine, and bee activity. The higher temperatures accompanied by a great amount of sunshine stimulate bees to the peak of activity and aid plants in their growth through the increased amount of photosynthesis within the chlorophyll of the leaves.

The advent of continued low temperatures during the fall

months of October and November curtail the broodrearing cycle within the hive and the colony begins to form a winter clustering area. Temperatures of 57 degrees F. or lower, cause bees to maintain the cluster and bee activity in the field is limited to the hours of the day when the amount of sunlight is at the maximum and the temperature is the highest. During these months small amounts of pollen and nectar are obtained by bees, from sources that withstand the cool weather, boosting the winter stores a bit higher.

Most flowers have finished blooming and the first heavy frost kills all remaining vegetation. Since most of the vegetation has completed their reproductive efforts, the fall temperatures are a benefit rather than a harmful element as it conditions the seeds and reproductive forms for the following winter months.

During the winter months of December, January, February, and March bee activity in this area is limited to occasional cleansing flights, which are brought about by periods of warm weather when the temperature and sunlight combine to raise the internal hive temperature to a par with the outside temperature. Bees then perform the task of cleaning out the dead and voiding themselves of the accumulated feces within their digestive tract. If, however, the winter months are not broken by periods of warmer weather the accumulation of feces within the intestinal tracts causes dysentery and by spring the colony may die out. Subzero weather extending over a long period of days may cause

a colony to die out because of starvation. The reason for this being that the bees cannot move to new stores which are surrounding them, due to the extremely low rate of metabolism of bees in such temperatures.

Winter temperatures near the normal are an aid to vegetation since they retard the flow of sap and prevent growth until constant spring temperatures exist. Native nector and pollen plants, trees, and herbs are not affected by winter temperatures to any extent except during spring months when they may be delayed in growth by a few weeks. However, the cultivated varities of fruit trees are often severly damaged by freezing weather. Various brambles and grapes, both plants supplying bees with spring nectar and pollen, suffer severe damage from zero weather if constant for several days. An example of this occurred during the winter of 1947 when the temperature dipped to a -31 degrees F. and many fruit trees, grapes, and brambles were either severely damaged or killed completely. A blanket of snow eleminates much of the damage caused to plants by low freezing temperatures by acting as an insulation factor.

Spring temperatures, probably cause as much damage to fruit trees, native nector and pollen producing trees, shrubs, and herbs as well as bees during certain years, than the summer temperatures. This is because of the continual fluctation of the spring temperatures bringing warm periods only to be followed by sharp freezing weather. After the first break in the winter weather during the month of March vegetation of all types begin

to grow and sap flows up from the roots to nourish the leaf and flower buds developing on the branches. Normal monthly temperatures do not hinder this development but occassionally as late as the latter part of April a sharp freeze occurs accompanied by snow, causing the setting-back of plant growth. Leaves are killed, flowers blasted, and the plants have to start anew. This fortunately occurs irregularily. The amount of sunshine present during the spring months aids in maintaining the higher temperatures which are due to the prevailing southerly winds. The ground thaws out and flowers burst as it were from out of the ground.

Spring temperatures if normal do not affect bees to any great extent in a detrimental way, but sudden freezing weather often forces the cluster of bees to reduce the spaces covered, causing considerable amounts of brood to be chilled and die. Cool spring weather is invigorating to the bees as it is to mankind and activity is increased as the weather becomes warmer. Mild spring weather when accompanied by ample sunshine, moderate humidity, and low wind velocity is an aid to the proper pollination of all fruit trees by bees within the vicinity of the orchard.

Spring temperatures enable bees to gather nectar and pollen to replenish the supplies used up during the winter months and to maintain the needed stores for continuous brood-rearing. The prime duty of bees during this period of each year is that of pollination and if temperatures are such that the bees are confined to the hive, fruit setting in orchards is poor.

From Table 1, it can be seen that during the months of

March, April, May, and June the rise in temperature is gradual with a variation of a mean minimum reading of 32.4 degrees F. in March to a mean maximum of 84.6 degrees F. in June. The normal temperature range is from 43.7 degrees F. in March to 74.3 degrees F. in June. These figures are taken from the Topeka readings.

Summer temperatures for this area are more constant, ranging from a mean minimum of 62.6 degrees F. during the month of June to a mean maximum of 93 degrees F. for July. In general, the monthly temperatures for July and August are very similar, while there is a drop of five to eight degrees during the month of September.

During the summers, the early mornings are fairly cool with the temperature reaching a peak around mid-afternoon. The effect on plants is varied and should be considered with the amount of humidity present. The higher the temperature with the minimum percentage of humidity in the air, the greater will be the evaporation rate of moisture from the leaf surfaces of plants. If the soil moisture content is too low so that the amount of moisture taken up by the plant through its root system is less than the amount of moisture evaporated from its leaf surface, the plant will stop growing, slowly wilt, and die. Hot dry periods broken regularily by rains are highly conducive to the growth of plants and the ripening of all types of fruit.

High temperatures with maximum sunshine reduces bees activity during the mid-afternoon hours. It is a form of estivation

and activity is resumed later in the afternoon as the temperature begins to drop, the humidity rises, and the amount of solar radiation is decreased with the lowering of the sun. During these excessively hot periods of the day, colonies carry on a system of air conditioning. Water is carried into the hive in large quantities and fanning causes a circulation of the air within the hive evaporates the water, thereby cooling the interior of the hive. This must be carried on under conditions where shade is lacking for the wax will not tolerate temperatures much over 120 degrees F. and melting of the combs may occur. Root (15, p. 668) has incorporated the following information.

> When this colony was opened on a hot day in midsummer, it was noted that drops of some liquid were deposited on the frames, much in the manner of nectar when it is being brought to the hive during the rush of an exceedingly heavy honey flow. There was at this time a complete dearth of nectar. In tasting this liquid, it was found to be water, evidently brought to the hive to be evaporated and thus to reduce the temperature within the hive, since the evaporation of water causes the absorption of considerable amounts of heat.

An effect of temperature on plants, though not harmful, is that of increasing the sugar concentration of the nectar in flowers. This in a way affects bees. During the summer of 1948 field observations were carried on in the vicinity of Manhattan, Kansas, in an effort to obtain sugar concentrations of the nectar of various flowers through the use of a refractometer. As an illustration three flowers have been chosen from the list studied, these being buckbrush (Symphoricarpos orbiculatus), ironweed (Vernonia interior), and horehound (Marrubium vulgare). The data obtained will be given in the following table.

Effect of temperature and relative humidity on the sugar concentration of the nectar of buckbrush, ironweed, and horehound.

Table 2.

Date	Time	Plant	Temp.	R. H.	Sugar Concentration per cent
July 26	10:20	Buckbrush	83°F.	52	42.2
July 26	10:40	Ironweed	83°F.	52	26.5
July 26	11:10	Horehound	83°F.	52	21.5
July 26	1:45	Buckbrush	92°F.	35	44.0
July 26	2:00	Ironweed	92°F.	32	31.2
July 26	2:25	Horehound	93°F.	32	25.0

From the above table a variation can be seen in the sugar concentration of the nectar of the same three plants all growing on the same hillside. The plants were a couple hundred feet apart with the buckbrush growing either under trees or in the open, the ironweed growing exclusively in the sunlight, and the horehound exclusively beneath trees. There may be several plant ecological factors such as sunlight, soil moisture, humidity, temperature, mineral content of the ground, as well as plant physiological factors involved in the variations.

RELATIVE HUMIDITY OF THE REGION AND THE EFFECTS ON BEES AND PLANTS

From Table 3 it can be seen that this region has a rather low relative humidity which is a benefit to man as well as to plants. According to Flora (2, p. 7) the average relative humidity range during the month of July is from 35 per cent - 40 per cent in the western part of the State of Kansas and 45

Average daily relative humidity for,
the Topeka, Kansas region*

Table 3

Time	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
12:30 a.m.	77.0	74.1	73.0	70.4	73.2	79.3	71.4	74.9	72.4	70.9	73.7	76.7
6:30 a.m.	79.6	79.1	78.0	78.4	80.1	82.7	77.4	82.0	79.9	77.3	77.4	80.2
12:30 p.m.	64.0	60.3	56.6	53.4	52.1	56.9	47.0	53.6	49.7	50.1	58.0	66.1
6:30 p.m.	68.0	63.3	58.2	53.2	55.7	56.5	46.0	52.3	52.0	51.6	57.6	67.4

*Due to a lack of daily relative humidity readings for the counties studied, the readings for the Topeka, Kansas weather station will be used.

per cent - 80 per cent in the eastern. The winter averages are somewhat higher.

Because of this factor the evaporation rate is rapid and dirt roads and fields dry out within a few hours after heavy rains. However, too rapid an evaporation may be detrimental to plants if the amount of soil moisture is low.

Humidity of the air seems to act as a filter for light rays by absorbing the heat produced from them. This climatic factor aids in reducing the evaporation rate of moisture within vegetation and insects. During certain years, dysentery and mold are present within hives because of the excessive humidity of winter and spring months. High relative humidity therefore, is detrimental to bees and may be to certain plants which require ample sunlight and dry air for growth. This region of the State of Kansas because of the rather low relative humidity is favorable for bees and plant growth throughout the winter, spring, summer, and fall months.

GROWING SEASON AND SUNSHINE OF THE REGION AND THE EFFECT ON BEES AND PLANTS

A fairly good picture of this growth factor for all living organisms can be seen from a comparison of the data shown by Fig. 3, 4, 5, 6, and Table 4.

Of all the climate factors discussed so far, none has shown such a variation for each county as the data recorded in Table 4. The fact that Wabaunsee county has the greatest number of frost free dates of the three counties, can be explained because of

Average number of days in growing season for this region and average dates of first spring and last fall frosts one year in ten.

Table 4.

Counties	No. of days	Date of first spring frost one year in ten	Date of last fall frost one year in ten
Riley	172	April 23	October 12
Pottawatomie	183	April 18	October 18
Wabaunsee	187	April 14	October 18

the more southerly position that it occupies. However, Riley and Pottawatomie counties are parallel to each other and yet the variation is rather remarkable. No reasons can be offered to explain this.

The length of the growing season of any region determines to a great extent the amount and types of crops that can be raised within it. In like manner it would seem logical to conclude that it may also curtail the growth of various wild types of vegetation which offer supplies of nectar and pollen to bees. Assuming the foregoing, may also enable one to conclude that with the retarding of plant growth, the nectar or pollen supplies of plants living in the fall may also be stopped. In a region having a short growing season, the number of species of various plants will be less than that found in a region having a longer growing period. Kansas, because of its central position in the United States, has extremes in its weather but also has a large variation in vegetative growth because of the overlapping of Northern types of plants and also some forms found chiefly south of the state. The first and last killing frosts, one year in ten, can be seen in Fig. 3 and 4.

These counties lie within the zone of Kansas having approximately 145 days of sunshine and 92 days of cloudiness. Fig. 5 and 6 show these variations.

Sunshine is perhaps the most important factor in the growth of all forms of vegetation. The amount of this factor along with the moisture content of the soil determines the quantity

Average number days clear, partly cloudy, cloudy for Topeka, Kans.*

Table 5

Type of day	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Annual
Clear	11	10	10	10	10	11	15	14	14	16	13	11	145
Partly cloudy	10	9	11	11	13	13	12	12	10	8	8	9	126
Cloudy	10	9	10	9	8	6	4	5	6	7	9	11	94

*These data are derived from the readings for the weather station at Topeka, Kansas, due to a lack of those readings for the counties studied. The number of clear days are greatest during the summer and cloudy days the most numerous during the winter months.

of nectar secreted by many plants. Laude (8, p. 300) states,

> Light is important in crop production mainly for two reasons. Only in the presence of light do plants manufacture carbohydrates which are used in building roots, stems, leaves, and grain. The longer the light is supplied the more opportunity crops have to work. The length of summer days increases with latitude and consequently the number of hours in a summer month during which plants do photosynthetic work is greater in the northern than in the southern part of the United States. The days in late June are about an hour longer in Kansas than in Florida or southern Texas.
>
> Moderately intense light is needed for maximum rate of carbohydrate manufacture. Kansas has a large proportion of bright sunny days which are conducive to the best growth of crops. Most plants when shaded make little if any growth.

Although the above statement was made concerning crops, it can be applied to wild or domesticated nectar and pollen trees, shrubs, lianas, and herbs.

The effect of sunshine on bees is great, for the amount of activity within the field is proportional to the percentage of sunshine. Cloudy days during the fall, winter, and spring months usually are accompanied by cool temperatures which confine bees to the hive or at least reduce their activity. Sunshine striking the sides of the hive increases the internal temperature of the hive stimulating the colony to activity. This action of the sun is especially beneficial to colonies during the winter months, enabling the cluster of bees to move over to new stores. This is brought about by the increased internal temperature from the action of the sun's rays penetrating into the cluster itself.

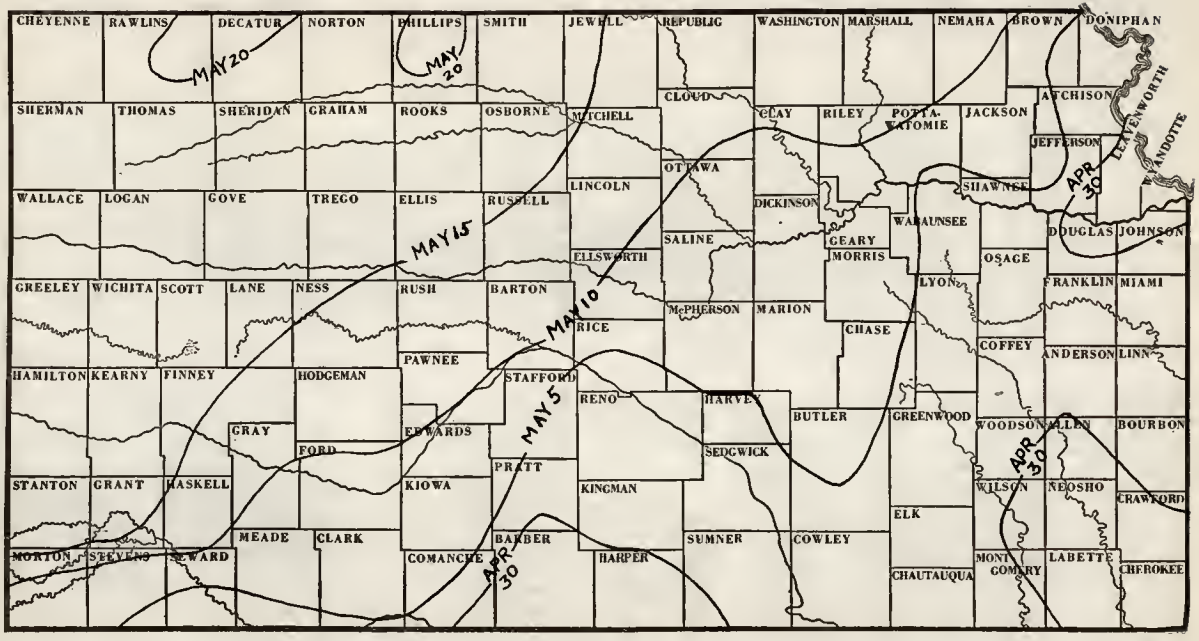


Fig. 3. Dates in spring after which a killing frost is likely one year in ten

Source: S. D. Flora (2).

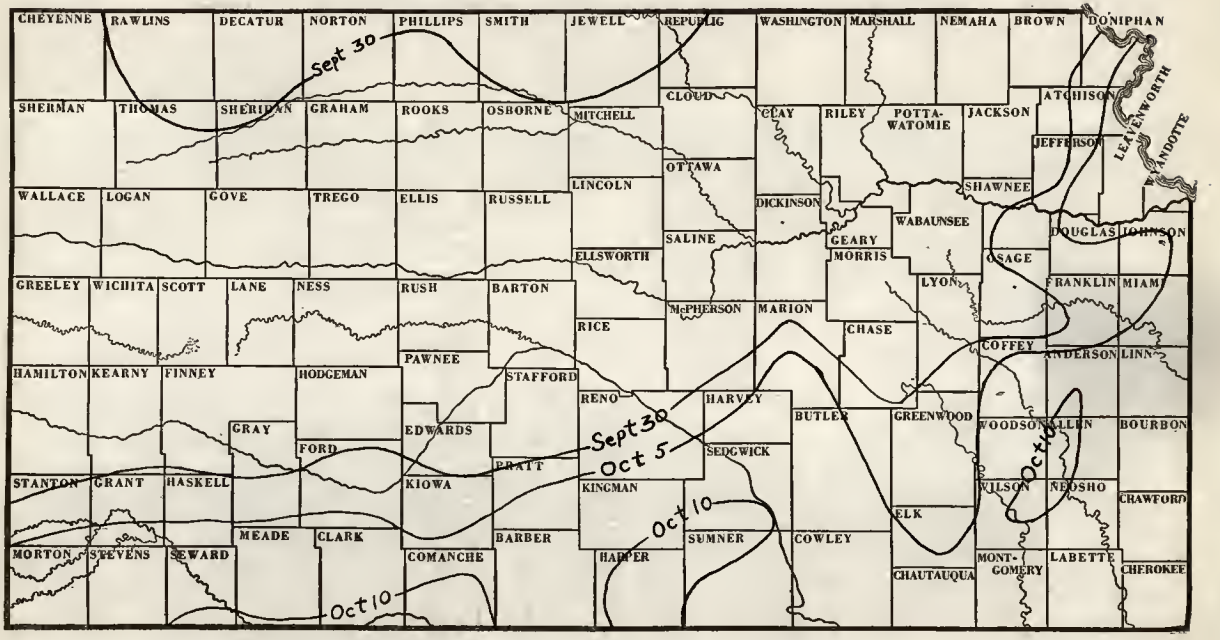


Fig. 4. Dates in fall before which a killing frost is likely one year in ten

Source: S. D. Flora (2).

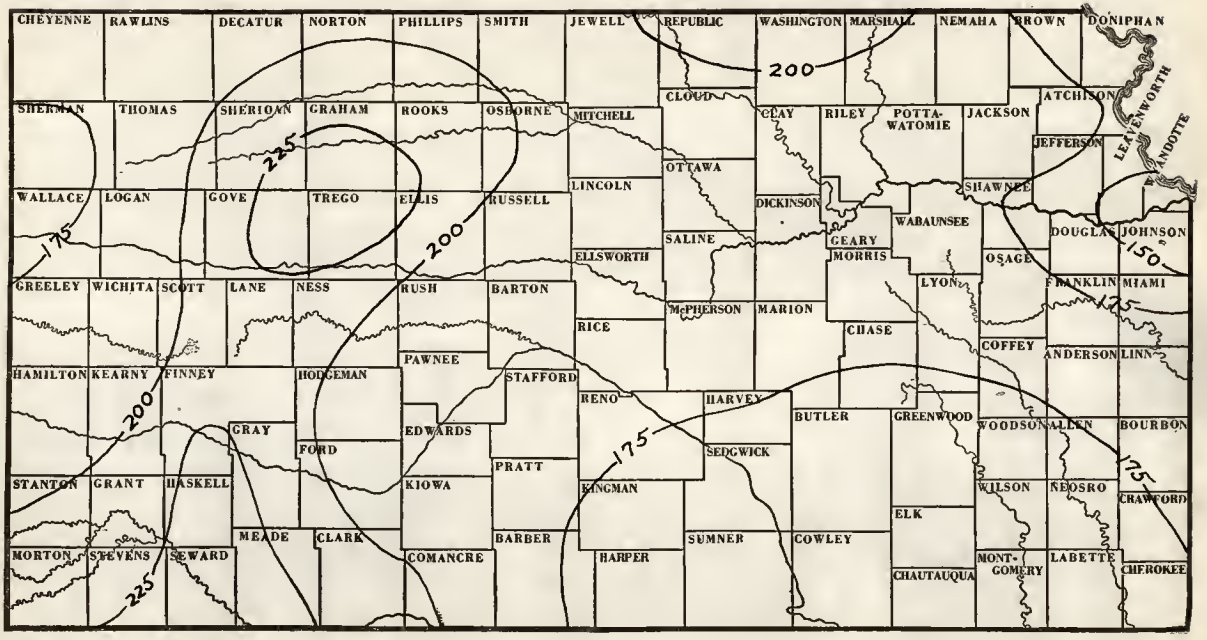


Fig. 5. Average annual number of clear days for Kansas

Source: S. D. Flora (2).

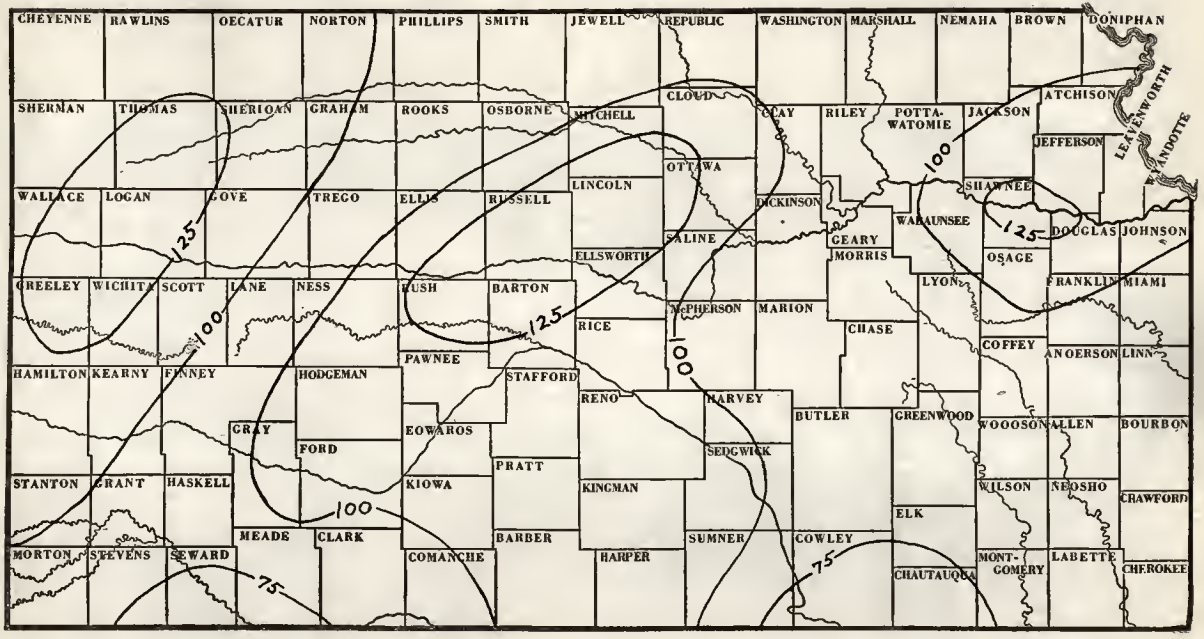


Fig. 6. Average annual number of partly cloudy days for Kansas

Source: S. D. Flora (2).

PRECIPITATION OF THE REGION AND THE EFFECT ON BEES AND PLANTS

This region of Kansas according to Flora (2, p. 26) has a normal annual precipitation of 30 - 35 inches which is almost twice that of western counties. In regards to this, Flora (2, p. 2) states,

> In the distribution of precipitation through the year, Kansas is especially fortunate. From 70 to 77 percent of the annual total falls during the six crop growing months, April to September, when it is most needed. The eastern third has an average of 26.04 inches for those months, which is greater than the average for other states, except a few along the Gulf Coast.

The above statement clearly indicates that the conditions for vegetative growth are ideal in this region of the state and this is also borne out as one enters Kansas from the East and leaves it in the West.

The average winter precipitation for the months of December, January, February, and March are given in the following.

Average precipitation during winter months.

Table 6

Counties	: December	: January	: February	: March
Riley	0.95	0.91	1.37	1.90
Pottawatomie	0.86	0.71	1.22	1.62
Wabaunsee	0.90	0.75	1.05	1.60

Of the three counties being studied Wabaunsee has the greatest amount of precipitation and the only explanation for this may be that it has the highest elevation of the three. The precipitation during the months of December, January, and

February is usually in the form of snow or sleet. However, during certain years when winter weather is delayed, due to climatic factors, the precipitation for December is in the form of rains. Rains and snowfalls comprise the principle forms of moisture during the month of March, with the majority being snow.

Rains during winter months do not aid vegetation beyond the addition of moisture to the soil and occassionally acting as an insulation factor for plants when freezing temperatures cause it to form an icy covering over everything. However, snowfall if heavy, without an accompaning wind, forms a perfect blanket of protection for all types of low vegetation, especially clovers, by keeping out the below freezing or zero temperatures which generally follow a snowstorm. Snows also reduce the amount of heaving of the soil caused by periodic thaws and freezes. Many forms of vegetation, especially when in the seedling stage during the fall months, are killed by this soil action due to winter weather. Alfalfa and clovers are examples of vegetation that die out during the winter because of it.

The average precipitation for the spring months of April, May, and June are given in the accompanying table.

Average monthly precipitation during the spring months.

Table 7

Counties	April	May	June
Riley	2.88	4.77	4.80
Pottawatomie	2.66	4.43	4.61
Wabaunsee	2.89	4.50	4.70

The precipitation for the entire year is heaviest during the spring months and the greatest percentage of it falls during June. The majority of this is rain coming in the form of heavy downpours which cause a great amount of erosion. Following some of these spring cloudbursts level fields having a slight slope to them may be seen to have numerous small to medium sized ruts cut out by the action of the water. Every spring in this region as well as others of Kansas, rich topsoil is washed away by the hundreds of tons due to uncontrolled run off of large amounts of water. It is this action of the precipitation of spring months together with the blind complacency of farmers and landowners that eventually will cause the vegetation requiring rich soils for growth to give place to those forms of vegetation that tolerate and thrive on poor soils.

However, the precipitation of spring months in highly beneficial to all forms of vegetation through the stimulation of growth if accompanied by normal temperatures. The effect on nectar and pollen plants is more complex. Following rains, the flow of nectar from the nectaries of the plants is increased due to the absorption by the plants of greater amounts of moisture from the soil. This increased amount of water within the tissues of the plants reduces the sugar concentration within the nectar. The end result is that bees gathering this nectar will have to consume a greater amount of honey in order to ripen a given amount than if the nectar was gathered during a

dry period or prior to a rain. Concerning this action Root (15, p. 655) writes,

> This elimination of water from nectar not only influences the humidity within the hive but causes a large amount of work for the bees. The work which the bees are called upon to do varies according to the outer temperature, since in cool weather the relative humidity of the outer air is usually higher, making evaporation more difficult, and furthermore the temperature of the hive must then be kept relatively higher than that of the outer air. Some nectars have a water content as high as 80 per cent. If this is the case to obtain 100 pounds of honey, which would contain about 20 pounds of water in the final product, the original nectar would weigh 400 pounds, which would consist of 80 pounds of sugar and 320 pounds of water. Of this vast amount of water, 300 pounds must be eliminated before the honey is ripe.
>
> To transform water into water vapor requires a large amount of heat, namely, 539.0 degrees centigrade small calories per gram of water, or enough to raise the temperature of the gram of water 539.0 degrees centigrade. To evaporate the 300 pounds of water mentioned above would then require 72,923.664 large calories. On the assumption that the sole source of these heat calories is the food of the bees, it would require the consumption of over 40 pounds of honey to evaporate this water. It is evident that the bees must under some circumstances consume large amounts of honey to obtain the energy necessary for the evaporation of the excess water in the nectar. This in time causes the necessity for gathering more nectar to take the place of the honey consumed in this process. If it were not true that the external heat assists the bees in this elimination of water, the honey crop would in some cases be greatly reduced.

Spring rains have some effect on colonies beside s that quoted above, namely reducing field activity by confining them to the hives during the periods of rains. It is during these adverse conditions that honey stores are heavily drawn upon for the maintainence of broodrearing. Damage may be severe from spring rains, even destroying an apiary, if the beekeeper has not kept the hives out of flash flood areas or along the

banks of streams known to flood. Rains during the month of June, a little prior to the blooming or during the blooming of yellow and white sweet clovers, cause a heavy nectar flow from them.

If during the late spring, a sudden cold spell should materialize accompanied by snow, vegetative growth is set back and colony activity is reduced for a while through the lessened usage of stores within the hive. It is during these changes in weather that many weak colonies die because of spring dwindling or starvation from a lack of stores, which were used for earlier broodrearing. The most important factor necessary for the maintenance of broodrearing during the spring is pollen. A lack of this food and the inability to obtain more from field sources because of cold weather, forces bees to curtail broodrearing until favorable weather returns.

The greatest amount of precipitation during the summer months occurs in August with an average of 4.00 inches for the three counties. The following table shows the monthly average for each of the counties.

Average monthly precipitation during summer months.

Table 8

Counties	: July	: August	: September
Riley	3.73	4.24	3.93
Pottawatomie	3.50	4.00	3.93
Wabaunsee	3.35	4.04	4.00

The rains during these months bring relief from the sweltering heat that usually is present during July and August. Many of the rains come in the form of downpours causing erosion but they aid in the pollination of corn if the moisture falls while the corn is tasseling. Dry hot weather has a tendency to desiccate the silks before proper pollination has occurred. Summer rains increase the amounts of nectar and pollen available to bees by aiding plant growth and increasing the flow of nectar from the plants. The humidity of the air is increased, thereby, decreasing the rate of evaporation of moisture from plants.

As the season progresses toward the fall months of October and November, the amount of precipitation also decreases. Except for summer months of July and August, Wabaunsee county has the highest amount of precipitation of the three. During these two, Riley county has the greatest amount but the reason for this cannot be explained. The following is the table for the fall months of the year.

Average precipitation during fall months.

Table 9

Counties	October	November
Riley	2.85	1.77
Pottawatomie	2.48	1.80
Wabaunsee	2.72	2.16

From the table it can be seen that the month of October has the highest rainfall with the highest average recorded for

Wabaunsee county. As previously stated, the higher elevation of the county probably has a great effect upon this factor.

The greatest effect to vegetation is that of replenishing the soil with moisture and affording the living vegetation a chance to fulfill their reproduction cycles before winter. Fall sown alfalfa and sweet clovers need these rains for proper growth enabling them to send their roots down below the frost line and thereby enabling better survival during the winter. There is little effect on colonies of bees other than to confine them to the hives during the early mornings and evenings because of the cooler temperatures. In short, fall precipitation accompanied by cooler temperatures condition the colonies prior to onset of winter.

NECTAR AND POLLEN SOURCES OF THE REGION

In discussing the individual pollen and nectar plants they will be treated chronologically. Various sources of literature have been consulted in an effort to use the proper taxonomic nomenclature. Both Rydberg's and Gray's Manuals were used for identification of the species, and the locale and the scientific name for each was checked with Gates (3), (4), and (5). Additional descriptions of the families were obtained from Pool (13).

The records of bee supplies furnished by each were checked in Root (15), Phillips (12), Pellett (11), and Lovell (9). However, there are no reports of some of these flowers furnishing bee food but personal field observations have established

Phenological chart of the nectar and pollen plants of this Region listed chronologically as to their blooming dates. (N Plant supplies nectar; P plant supplies pollen;* major importance of each flower: H.D. honeydew).

Table 10

Common name	Scientific name	1948 blooming	1949 blooming: to July 10	N	P
Soft Maple	Acer saccharinum	March 20 - April 4	March 3 - March 26	N	P*
American Elm	Ulmus americana	March 17 - April 5	March 22 - April 6		P*
Red or Slippery Elm	Ulmus fulva	March 17 - April 5	March 22 - April 6		P*
Crocus	Crocus sp.	No record	March 25 - April 1		P
Shepherd's Purse	Capsella bursapastoris	No record	April 1 - May 20	N	P
Golden Bell	Forsythia viridissima	No record	April 3 - April 25	N	P
Apricots	Prunus armeniaca	April 7 - April 15	April 7 - April 15	N	P
Dandelion	Taraxacum palustre var. vulgare	April 15 - June 30	April 15 - June 10	N*	P
Nanking Cherry	Prunus tomentose	No record	April 8 - April 17	N*	P
Cottonwood	Populus deltoides Marshall	April 2 - April 7	April 8 - April 21	H.D.	P*
Box Elders	Acer negundo	April 4 - April 14	April 13 - April 23	N	P
Yellow Weeping Willow	Salix vitellina	No record	April 9 - April 18	N*	P
Sandbar Willow	Salix linearfolia	No record	April 9 - April 18	N*	P
Choke Cherry	Prunus virginiana L.	April 10 - April 16	April 16 - April 23	N*	P

Table 10 (cont.)

Common name	Scientific name	1948 blooming	1949 blooming to July 10	H	P
Sour Cherry	Prunus cerasus L.	April 10 - April 22	April 22 - April 26	H*	P
Wild Plum	Prunus americana Marsh.	April 10 - April 22	April 17 - April 20	H*	P
Peach	Prunus persica	April 15 - April 22	April 22 - April 26	H*	P
Hard Maple	Acer saccharum	No record	April 12 - April 19	H*	P
Green Ash	Fraxinus lanceolata	No record	April 12 - April 17	H*	P
Wahoo	Euonymus atropurpureus	No record	April 17 - May 3	H	P
Aromatic Sumac	Rhus cronata	No record	April 22 - May 12	H*	P
Japanese Barberry	Berberis thunbergii	No record	April 21 - May 5	H*	P
Japanese Quince	Cydonia japonica	April 18 - April 24	April 23 - April 30		P
Redbuds	Cercis canadensis	April 14 - April 26	April 17 - May 2	H	P
Gooseberries	Grossularia missouriensis (R)	April 19 - April 25	April 14 - May 5	H	P
Black Currant	Ribes nigrum	No record	April 16 - May 2	H	P
Pears	Pyrus sp.	April 7 - April 14	April 20 - April 28	H	P
Yellow Mustard	Brassica campestris	April 29 - May 14	April 24 - May 5	H	P
Lilac	Syringa vulgaris L.	April 17 - April 27	April 22 - May 7	H	
White Oak	Quercus alba	No record	April 26 - May 7		P

Table 10 (cont).

Common name	Scientific name	1948 blooming	1949 blooming to July 10	N	P
Red Oak	Quercus borealis maxima(Marsh)	No record	April 26 - May 7		P
Burr Oak	Quercus	No record	April 26 - May 7		P
Black Walnut	Juglans nigra L.	May 10 - May 19	April 26 - May 20		P
Black Locust	Robinia pseudoacacia	April 30 - May 15	May 8 - May 20	N*	P
Japanese Honeysuckle	Lonicera japonica	No record	May 5 - May 30	N	P
Paw Paw	Asimina triloba	No record	May 2 - May 8	N	P
Honey Locust	Gledetsia triacanthos	May 12 - May 20	May 10 - May 20	N*	P
White Clover	Trifolium repens	May 9 - August 5	May 10 - July 10	N*	P
Yellow Sweet Clover	Melilotus officinalis	May 10 - July 25	May 12 - June 30	N*	P
Russian Olive	Elaeagnus angustifolia	May 12 - May 20	May 15 - May 30	N*	P
Ohio Buckeye	Aesculus glabra Willd.	May 9 - May 16	May 7 - May 25	N	P
Carolina Buckthorn	Rhamnus caroliniana	No record	May 10 - June 20	N*	P
Kentucky Coffeetree	Gymnocladus dioica (L.) K. Koch	No record	May 24 - June 2	N*	P
Alfalfa	Medicago savita	May 16 - August 31	May 19 - July 10	N*	P
Wild Grape	Vitis vulpina	No record	May 20 - May 25	N	P

Table 10 (cont).

Common name	Scientific name	1948 blooming	1949 blooming to July 10	N	P
Concord Grape	Vitis labrusca	No record	May 20 - May 25	N	P
Prairie Rose	Rosa suffulta Greene	May 13 - May 31	May 26 - June 26		P
Evening Primrose(Yellow)	Oenothera biennis L.	May 18 - May 31	June 2 - June 21		P
White Evening Primrose	Oenothera speciosa Nutt.	May 18 - May 31	June 2 - June 21		P
Mock Orange	Philadelphus sp.	No record	May 25 - June 5		P
Catalpa	Catalpa speciosa	May 19 - June 5	May 26 - June 20	N*	P
Sage (Blue Mint)	Salvia reflexa	June 2 - August 14	May 26 - July 10	N*	P
Horehound	Marrubium vulgare L.	May 25 - October 5	May 20 - July 10	N*	P
Queen Ann's Lace	Daucus carota	No record	May 26 - June 28	O	O
Smooth Sumac	Rhus glabra	May 30 - June 5	June 9 - June 19	N	P
Lead Plant	Amorpha canescens Pursh.	No record	June 12 - June 30	N	P
Tamarix	Tamarix gallica L.	May 19 - June 21	June 4 - June 28	N	
Elderberry	Sambucus canadensis L.	No record	June 2 - July 10	O	O
White Sweet Clover	Melilotus Alba	June 1 - July 30	June 1 - July 10	N*	P
Wild Alfalfa	Psoralea floribunda	May 18 - May 31	June 7 - July 3	O	O
Showy Milkweed	Asclepias speciosa Torr.	No record	June 6 - July 10	N	P
Kansas Milkweed	Asclepias kansana	No record	June 6 - July 10	N	P

Table 10 (cont).

Common name	Scientific name	1948 blooming	1949 blooming to July 10	N	P
Sensitive Brier	Leptoglottis nuttallii	No record	June 6 - June 28	O	O
Hackberry	Celtis occidentalis L.	June 5 - June 17	June 1 - June 12	N	P*
Wild Four O'clock	Mirabilis nyctaginea (Michx)	No record	May 25 - June 5	O	O
Tree of Heaven	Ailantus attissima Swingle	No record	June 6 - June 20	N*	P
Basswood	Tilia americana	July 1 - July 7	June 8 - June 28	N*	P
Blackberry	Rubus ostryifolius Bydb.	May 25 - June 3	June 1 - June 15	N	P
Black Raspberry	Rubus occidentalis L.	May 25 - June 3	June 1 - June 15	N	P
Wood Sage	Teucrium canadense	July 1 - July 24	June 24 - July 10	N*	P
Catnip	Nepeta cataria	June 28 - July 13	June 25 - July 10	N*	P
Corn	Zea Maye	July 20 - August 28	June 25 - July 10		P
Hoary Vervain	Verbenus stricta	July 11 - July 31	July 1 - July 10	N	
Buckbrush	Symphoricarpus orbiculatus	July 15 - August 14	July 10 -	N*	P
Pitcher Sage	Salvia pitcheri	July 7 - July 15	After July 10	N	P
Cucumber	Garden cucumbers	June 12 - June 30	June 25 - July 10	N	P
Blue Vine	Gonolobus laevis	July 7 August 25	After July 10	N*	P
Ironwood	Vernonia interior & Vernonia fasiculator	July 15 - August 17	After July 10	N*	P

Table 10 (cont).

Common name	Scientific name	1948 blooming	1949 blooming to July 10	N	P
Red Clover	Trifolium pratense L.	June 25 - July 15	July 1 - July 10	O	O
Snow-on-the-Mountain	Euphorbia marginata	July 28 - August 15	After July 10	O	O
Swamp Milkweed	Asclepias syncomata	August 3 - August 15	After July 10	N*	
Cocklebur	Xanthium pennsylvanicum	August 16 - August 31	After July 10		P
Goldenrod	Solidago glaeberrima	August 1 - September 15	After July 10	N	P*
Smartweed	Persicaria longistyla Persicaria pennsylvanicum	August 3 - September 27	After July 10	N*	P
Giant Ragweed	Ambrosia trifida	August 15 - September 22	After July 10		P
Sunflowers	Helianthus annuus L.	August 13 - September 15	After July 10	N	P
Swamp Verbena	Blyla lanceolata R.	August 1 - October 6	After July 10	N*	P
Broomweed	Amphiachyris dracunculoides	September 7- October 16	After July 10	N	P
		October 12 - December 29	After July 10	N	P

Table 11 Blooming period of nectar and pollen plants 1943

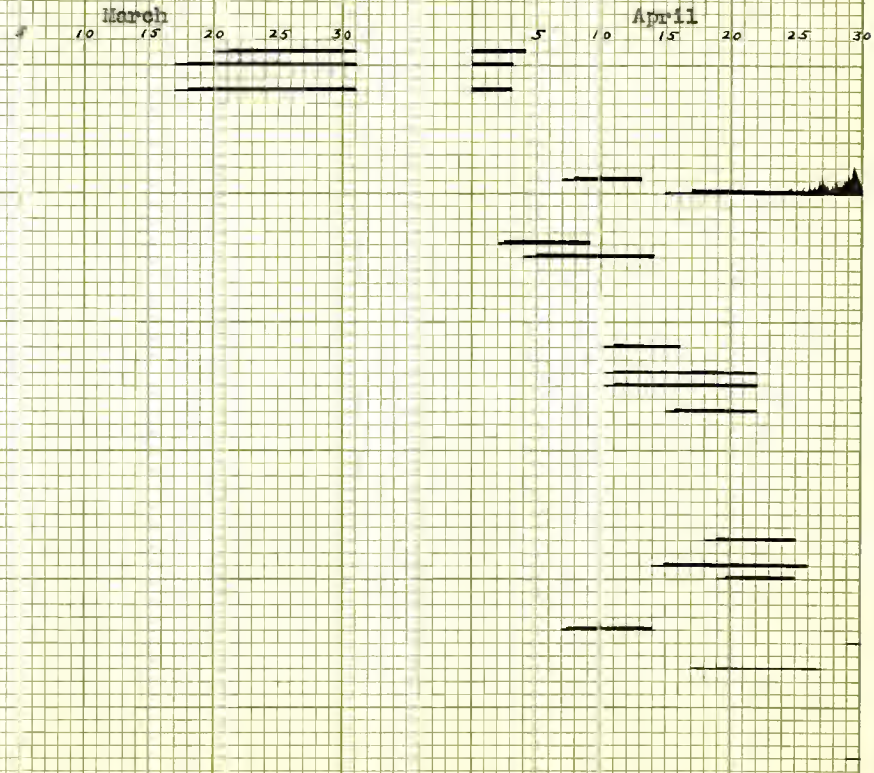


Table 11(cont.) Blooming period of nector and pollen plants 1968

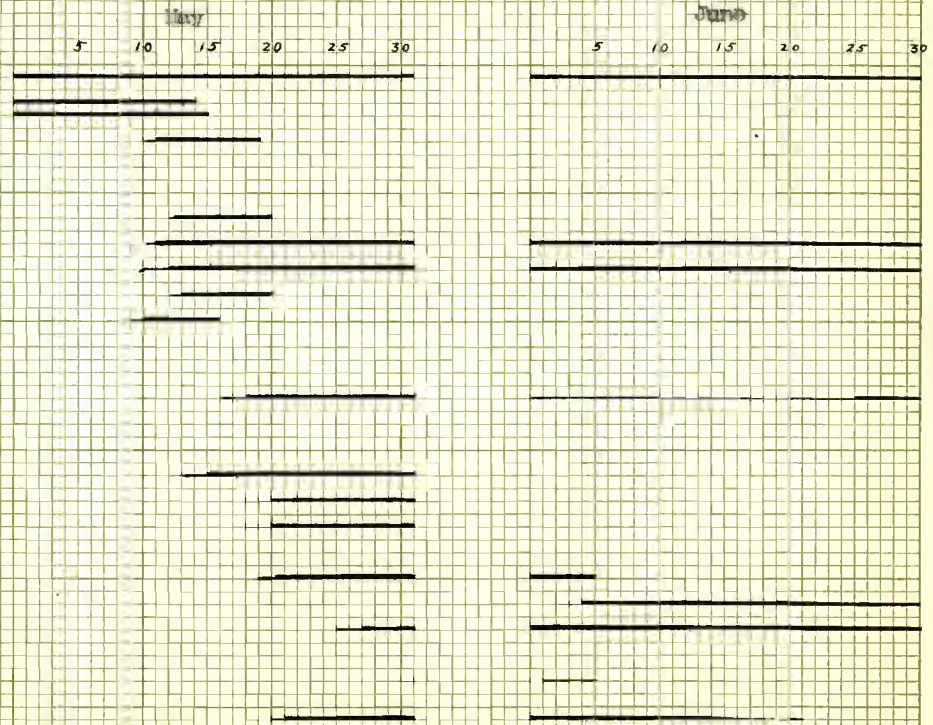


Table 11 (cont.) Blooming period of nectar and pollen plants 1949

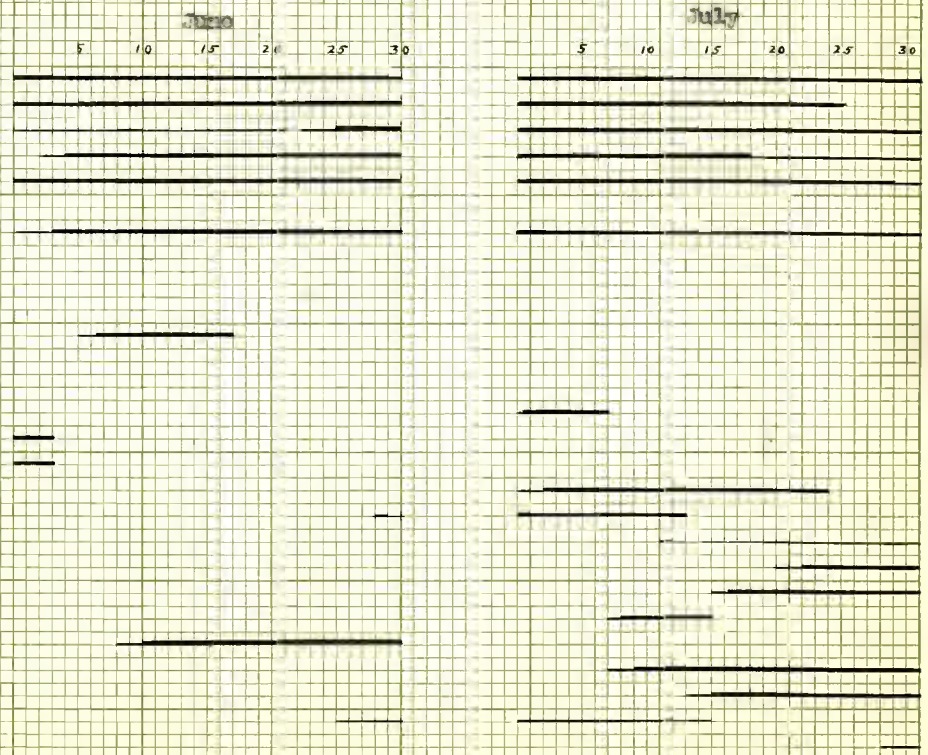


Table 11 (cont.) Blooming period of nectar and pollen plants 1949

Table 12 Blooming period of nectar and pollen plants 1940

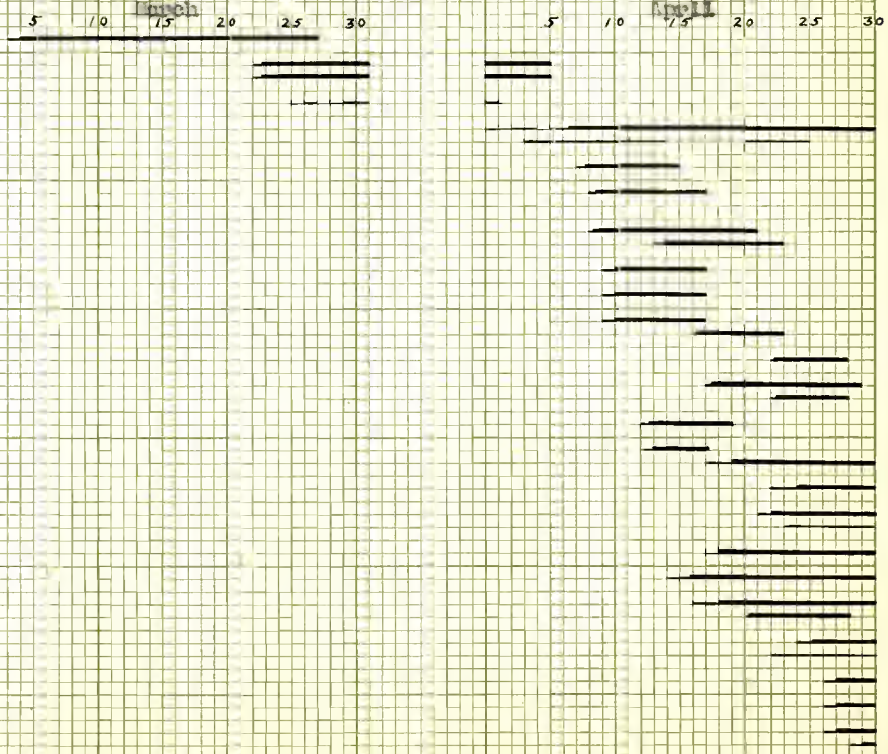


Table 12 (cont.) Blooming period of nector and pollen plants 1949

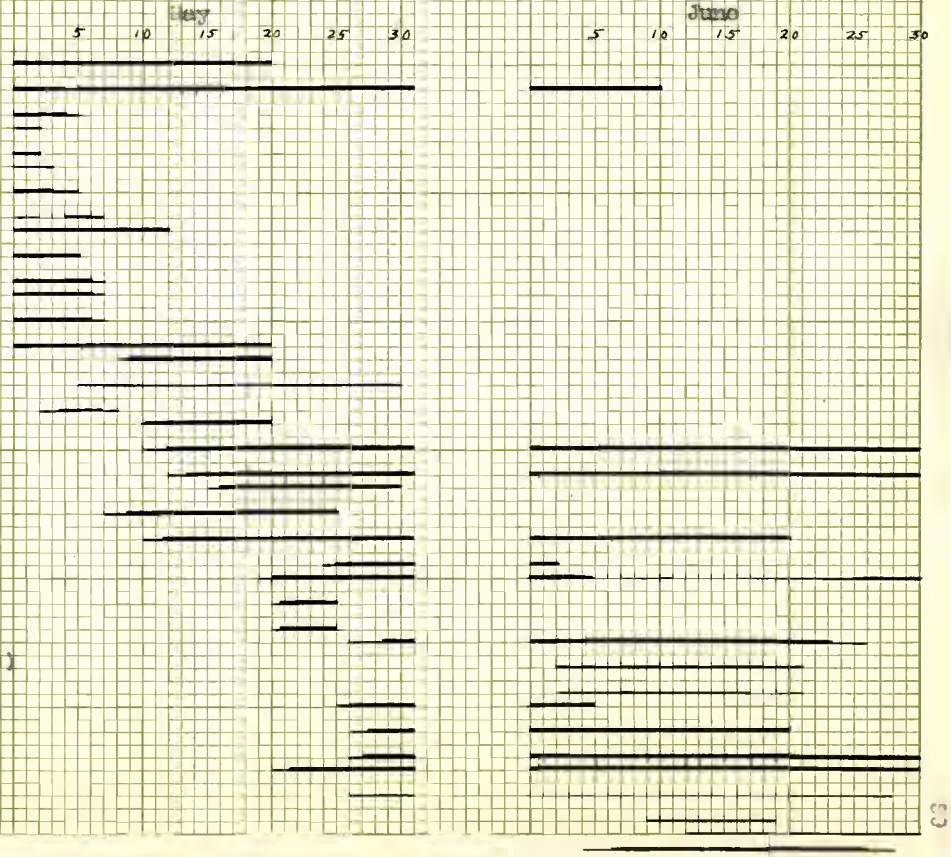
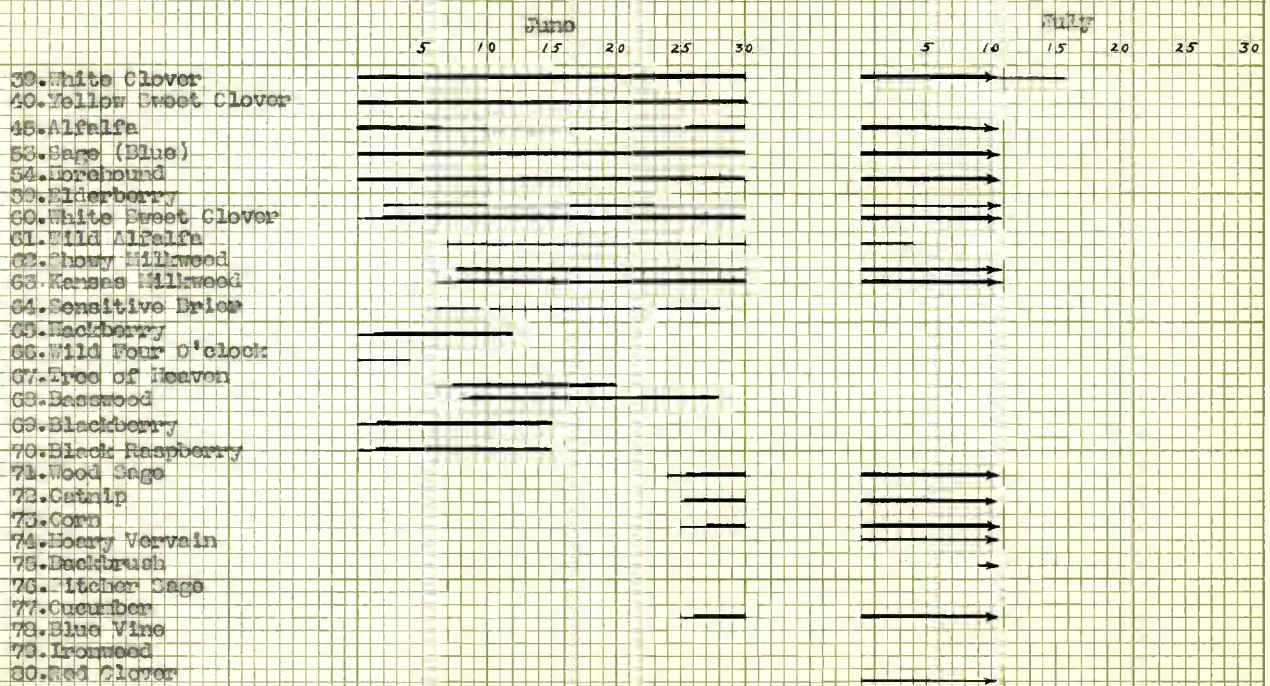


Table 12 (cont.) Blooming period of nector and pollen plants 1949



the fact that they do furnish some. The quantity of nectar or pollen stored from each has not been determined and no attempt will be made to bring this out. The amount of bee activity observed on each flower can be used in determining the attraction of the bees to the flower and a correlation may be drawn as to the value of the source. All references to bees are to be taken as meaning the honeybees (Apis mellifera) unless otherwise stated.

Description and phenological data of nectar and pollen plants of this region

In order to obtain a complete picture of this study, each nectar and pollen plant has been listed chronologically according to the specific blooming date of each in Tables 10, 11, and 12, beginning with the first blooming plant in the spring. The following pages contain the species observed, their common names, scientific nomenclature, dates of blooming for 1948 and 1949, distribution, and stores that each furnished. Observations were not carried on during 1949 after the tenth of July. The flowers have been listed but the blooming dates have not.

Maples - (Acer saccharinum and Acer saccharum) Family Aceraceae

Both the soft and the sugar maple are found in this region though the soft maple is growing in greatest numbers.

The soft maple is the first source of nectar and pollen for bees, blooming during the early part of March, while the hard or sugar maple blooms during April. The blooming period of the former is from the second to last week of March and the

latter is from the second to the third week of April. The blooming period is dependent upon the prevailing weather during the late winter months.

There are various reports in the bee literature concerning the value of these trees to the beekeeping industry. Pellett (11, p. 240-241) cites reports from different parts of the United States where it is considered to be a good yielder of nectar. However, Phillips (12, p. 408), Lovell (9, p. 155), and Root (15, p. 473) seem to disagree with this, but state that it is especially valuable for the pollen that bees obtain for brood rearing. In this region the soft maple supplies both pollen and nectar. During the spring of 1947 and 1948, colonies were observed to have gained enough surplus from maples to fill empty frames which were in the hives from the previous fall. As has been stated by some, the early blooming does not afford bees an opportunity to collect any great amount of nectar, but in this region, if these trees were not present many beekeepers would get very little honey from the sweet clovers. The adverse weather of the spring of 1948 afforded the bees but a few days to work on the blossoms and less than the usual amount of nectar was obtained. Large quantities of pollen were stored during the few days that they were able to visit the flowers.

In this region they are to be found growing along streams, within city limits, and rural areas, generally in places where the soil has an ample supply of submoisture.

Elm - (Ulmus americana),and (Celtis occidentalis L.) Family Ulmaceae

The American and red elms exist in large numbers thoughout this region being found chiefly along streams, in urban districts, and rural areas.

These trees do not secrete any nectar but bees collect large quantities of pollen from them. The blooming period extends from the first to the last week in March. The weather usually is more settled when the elms are blooming, thereby enabling bees to visit them from mid-mornings to late afternoons. The pollen is used by bees for early broodrearing.

There are several species of hackberry trees in this region but the above mentioned species was only observed. This tree blooms later in the season, flowering about the fifth of June and furnishes some nectar and a great amount of pollen for a period of about two weeks.

Crocus - (Crocus sp.) Family Iridaceae

The common varieties of crocus are not listed as pollen or nectar plants. This is probably because of the small numbers of them in any one area. They bloom early in spring around the third week in March and if in large enough numbers, provide some pollen for bees.

Pool (13, p. 312) mentions three genera in his book consisting of the Iris, Crocus, and Gladiolus. The species of the crocus observed was not determined. Neither Pellett (11) nor Lovell (9) mention this plant in their books.

Shepherd's Purse (Capsella bursa-pastoris(L.) Medic) Family Brassicaceae

According to Gates (4, p. 11) it was introduced many years ago and now is becoming a weed.

This plant grows in thick patches in waste places, fields, along roads, and in lawns, having a small white flower. No record was kept of the blooming date in 1940; but during the spring of 1940. It blooms from the first week in April to the third week in May.

Bees were observed working it after it had been in bloom for a week, collecting nectar as well as a greyish colored pollen. Whether it plays an important part in beekeeping was not ascertained. Neither Lovell (9) nor Pellett (11) mention it in their books on nectar and pollen plants.

Golden Bell - (Forsythia viridissima Lindl.) Family Oleaceae

According to Gates (4) this cultivated plant has escaped in Washington and Shawnee counties. In this region, it is found growing in cultivation.

It bloomed from the first to the third week in April, furnishing very little, if any, bee stores. On a few occasions individual bees were observed gathering nectar or carrying small amounts of a yellow colored pollen. Neither Pellett (11) nor Lovell (9) mention this plant in their books on honey and pollen plants.

Apricots - (Prunus armeniaca) Family Prunaceae

This tree is the first member of the fruit trees to bloom

in the spring, furnishing both pollen and nectar. An odd thing occurred in the observations kept for it. When the records for the 1948 season were combined with those for 1949 in table form, it was noticed that these trees bloomed on the same date for both years. The 1949 blooming period lasted from April 7 - April 15 which was two days longer than that recorded for the previous year.

Bees work the blossoms when the percentage of sunlight and the amount of temperature was at the maximum. During the spring of 1948, weather conditions reduced the amount of pollination since it was confined to the southern portion of the trees. These trees are found under cultivation throughout this region.

Dandelion - (Taraxacum palustre vulgare Lam.) Family Lactuaceae

This obnoxious weed has resisted all efforts to eradicate. It is spread by the wind and small children who think it fun to blow the parachuted seeds off the flower stalk.

However, it is one of the important nectar and pollen plants of this region as well as many others. The surpluses mentioned by Pellett (11, p. 134) and Lovell (9, p. 120) for the species (Taraxacum officinale) have not been obtained in this region. However, as Lovell has mentioned in the above citation, comb made during its flow is colored yellow from the pollen mixed in the honey.

It is found almost everywhere but chiefly along travelled thoroughfares, all over urban areas, and also in rural areas.

In this region dandelions bloom for a long period but the

heaviest date of blooming have not been listed.

Nanking Cherry - (Prunus tomentose) Family Prunaceae

This small horticultural variety is not mentioned by Lovell (9) or Pellett (11), but in this region is a good source of nectar and pollen. Since it is one of the cultivated forms of plums, it is never found in very great numbers. However, if planted for bees it would provide considerable stores as well as fruit for jellies.

No record was kept on it for 1948, but during the spring of 1948 it bloomed from the first to the third week in April. Honeybees fought for each flower.

Cottonwood - (Populus deltoides Marshall) Family Salicaceae

The cottonwoods are one of the largest pollen producing trees of the early spring months, blooming for about a week around the second to the eighth of April and lasting until the twenty-first of the month. Pellett (11, p. 35) and Lovell (9, p. 48) mention these trees as furnishing honeydew, gathered from the axils of the leaves, as well as pollen. Bees work these trees from morning to evening in such numbers that it sounds practically as if a swarm was settling. These trees are also responsible for a great amount of the propolis collected by colonies.

They are to be found growing throughout this region along the banks of streams, in moist areas, and within urban districts.

Boxelders - (Acer negundo) Family Aceraceae

In this region, boxelders generally bloom at about the same time that cottonwoods and willows do. They furnish nectar in quantity and some pollen. Blooming anywhere from the first to the last week in April. Colmatic conditions cause a variation in the date and length of blooming. Pellett, (11, p. 72) states that aphids feeding on the leaves often produce honeydew.

Boxelders are generally found growing along stream banks, in moist areas, urban districts and rural areas. They grow very rapidly and bloom profusely about the third year of growth.

Willows Family Salicaceae

This group is made up of small to large trees and in this region there are three species that have been observed to furnish pollen as well as nectar. These are the yellow weeping willow (Salix vitellina), common weeping willow (Salix babylonica), and the sandbar willow (Salix linearfolia).

The first two mentioned are chiefly found in cultivation while the latter grows along the Big Blue River, Kansas and Kaw Rivers, as well as many of the creeks and streams.

All three bloom about the same time from the first to the third week in April.

Plums - Family Prunaceae

The following species of plums have been observed; wild plums (Prunus americana Marsh), apricots (Prunus armeniaca L.), sour cherries (Prunus cerasus L.), peaches (Prunus persica

Datsch.), and chokecherries (Prunus virginiana L.). The apricot has been described previously. Besides the above, are several horticultural varieties which have not been identified and also furnish bees with stores. These trees generally bloom at the same time from around the second to the last week in April

These trees furnish bees with a great amount of pollen and nectar especially when growing over large local areas. The choke cherry and wild plum can be found growing along streams, on the hillsides, and prairie where there is rich soil and ample sub-moisture. The choke cherries are also found growing along streams and in rocky wooded sections.

Green Ash - (Fraxinus lanceolata) Family Oleadeae

This medium sized to large tree is found growing in this region along streams, in low woodlands, swampy regions, and urban districts.

The blooming period extends from the second to the third week in April and bees were observed obtaining nectar and pollen. Because of the cool windy weather of the 1949 spring bees were greatly hindered in obtaining the stores from them.

Wahoo - (Euonymus stropurpureus) Family Celastraceae

This rather tall shrub is found growing throughout this region in woods and dense vegetation along streams, and in urban districts where it is used for ornamentation.

The flowers bloom from the third week in April to the first week in May. Bees have been observed obtaining nectar and pollen from it.

Aromatic Sumac (Rhus aromata). Family Anacardiaceae

This region of Kansas forms the northwestern limit of distribution for this rather large shrub. It is found growing along rocky wooded hillsides, or along sandy areas.

The flowers bloom from the third week in April to the second week in May. Bees began working this about a week after it had begun blooming and colonies gained a surplus of 15-30 pounds of honey. The honey was of a greenish-yellow color, especially so when tilted to the light. The honey had a slight bitter taste to it. By the middle of July, most of the honey had been used for brood-rearing. Neither Pellett (11) nor Lovell (9) mention this plant in their books on honey and pollen plants.

Japanese Barberry - (Berberis thunbergii) Family Berberidaceae

This ornamental shrub is not found in uncultivated areas. It is used as a hedge in urban districts and therefore bees within city limits may obtain a good quantity of nectar and some pollen from it.

No record was kept of its blooming date until the spring of 1949, when attention was drawn to it by the great amount of bee activity on some of the bushes. It bloomed on the twenty first of April and continued till the fifth of May. The small yellow flowers are bellshaped. Neither Pellett (11) nor Lovell (9) mention this plant in their books on honey plants.

Japanese Quince - (Cydonia japonica)

This ornamental tree is found within urban districts.

Bees work the blossoms from early morning to late afternoon obtaining great amounts of pollen.

This tree blooms from the third to the last week of April. The flowers are orange-red or pinkish-red in color.

Redbuds - (Cercis canadensis) Family Cassiaceae

This small tree is found growing along the hillsides, stream banks, and in wooded areas having high soil moisture content. This tree, along with the plums, forms the first major nectar flow of the spring months. Bees in this region often store several pounds of surplus honey from this source.

They bloom generally from the second week in April until the first week in May. The flowers are a violet-pink and similar to that of a sweetpea.

Gooseberry - (Grossularia missouriensis R.) Family Grossulariaceae

Gooseberries may be found in this region on hillsides having rich soil and ample sub-moisture or in timbered areas along streams. The flowers are a yellowish-white to greenish-white.

The flowers bloom from the second week in April to the last week in May or the first week in June. They furnish pollen and nectar and bee activity on the flowers is heavy.

Black Currant - (Ribes nigrum) Family Grossulariaceae

This shrub is to be found only in certain local areas where it has escaped cultivation or in urban areas.

This plant is not listed by Pellett (11) p. 132),

Phillips (12, p. 404) or Lovell (9,p.120) as being a nectar and pollen plant. Pellett, however, mentions that the species (Ribes aureum) having yellow flowers, furnishes pollen and nectar, the latter being obtained by the action of some agent which splits the sides of the flowers open. The flowers of the species (Ribes nigrum) are about one-half inch in length, yellow colored, trumpet like, and very fragrant. Observation showed bees to be gathering nectar and pollen from the blossoms. The splitting of the sides of the flower were observed to have been done by a biting action of the bumble-bee (Bremus americanorum).

The flowers bloom in this region from the second week in April to the first week in May.

Pears -(Pyrus) Family Malaceae

The pears observed were the cultivated varieties of Keiffers and the common sugar pears. The ones mentioned belong to the genus Pyrus but no species name has been determined. They bloom from the first to the third week of April depending upon the season. From the two year record kept on Table 10, it can be seen that the length of blooming is avriable.

Pears furnish both nectar and pollen in quantities and when in large number greatly stimulate broodrearing. They are chiefly found in this region under cultivation.

Common Yellow Mustard - (Brassica campestris) Family Brassicaceae

This mustard with its small yellow flowers, grows throughout this region. In some localities whose wheat fields are covered

by them, bees collect a great amount of nectar and a dull grey colored pollen. Bees activity is constant from morning to evening.

According to Gates (14, p. 157) this species has escaped from cultivation. It is found over fields and waste places and blooms from the third week in April to the second week in May.

Lilac - (Syringa vulgaris L.) Family Oleaceae

In this region it is cultivated and never in very great quantities. The flowers which are sickeningly sweet smell are purple to white in color, and bloom from the second week of April to the first week in May. Bees have been observed to visit it on one of two occassions and seemed to be gathering nectar. It should not be considered important.

Oaks - (Quercus alba) (Quercus borealis) (Quercus macrocarpa) Family Fagaceae

The red oaks, white oaks, and burr oaks are small to large trees and found growing throughout this region along streams, on hillsides, and in cultivated areas where the sub-moisture content of the soil is high.

The flowers bloom from the third week in April to the first week in May. No record was kept of their blooming period during 1948, but the ones observed bloomed for approximately the same period of time.

Bees obtain large amounts of pollen, of a yellow color from

them and occassionally some honeydew secreted by Homopteran insects.

Black Walnut - (Juglans nigra L.) Family Juglandaceae

These medium to large trees can be found throughout this region, growing in woodlands or along streams where the soil is rich and contains ample moisture.

Bees obtain great amounts of pollen from them, usually from the first to the third week of May.

Black Locust - (Robinia pseudo-acacia) Family Fabaceae

In this region bees often obtain their first surplus honey from this source, because by this time colonies are strong if properly managed. The white flowers hang in clusters. During certain years the yeild is light and the flowers bloom from the first to the last week in May.

It can be found growing throughout this region of Kansas in pastures, woodlands, along streams, on hillsides, or in waste places. It is often used for windbreaks, but the main usage is for fence posts. Eastern Riley county and western Pottawatomie county have many of these trees growing out of cultivation.

Japanese Honeysuckle - (Lonicera japonica) Family caprifoliaceae

This vine having fragrant yellow and white flowers has escaped cultivation in parts of Riley county. However, it is found chiefly in urban areas or on farms where it is used for trellises.

The flowers bloom from the first week in May until the end of the month.

Because of the deep corolla, bees are not able to gather nectar. However, if some bumble bee cuts the base of the flowers, honeybees visit them for nectar and pollen. Japanese honeysuckles are of practically no value in beekeeping.

Paw Paw - (Asimina triloba) Family Annaceae

This small tree grows chiefly along heavily wooded ravines where the humus is heavy and the soil moist or along stream banks where these conditions are also to be found. Large groves of these trees are to be found in southeastern Riley county and southwestern Pottawatomie county growing along the banks of the Kaw River.

The flowers bloom for about a week during the first or second week of May. No record was kept of their blooming during the 1948 spring. Bees were observed to be deriving some pollen from them but the numbers visiting the trees were limited. Other insects such as wasps, certain solitary bees, and flies were the chief pollinators of the fruit. Neither Pellett (11) and Lovell (9) mention this plant in their books on nectar and pollen plants.

Honey Locust - (Gleditsia triacuthos) Family Cassiaceae

This medium to large tree grows in large numbers through all three counties. The branches and trunk of each tree are covered with numerous large thorns of a reddish color. They

furnish pollen and nectar, the amount varying with the years. The blooming period is rather constant ranging from the second to third week in May. The flowers are small, hanging in catkins.

They can be found growing through pastures, fence rows, hillsides, valleys, along streams, in rocky localities, and in woodlands.

White Clover - (Trifolium repens) Family Fabaceae

This small lawn clover is found growing throughout the cities and towns of this region.

It blooms from the first week in May to the second week of August. Cutting lawns extends the blooming of the plants and thereby provides a constant bee pasture. However, because of the limited acreage of this plant it does not produce a surplus such as is obtained in the northern states. The nectar stored can not be claimed to come from the white clover because of the contemporary blooming of the yellow sweet clover, which is the second major nectar source during the spring.

Bees obtain a great amount of nectar and pollen from these plants, visiting the flowers from morning to evening.

Yellow Sweetclover - (Melilotus officionalis) Family Fabaceae

This medium sized plant grows throughout this region. Since it is biennial, the amount of bloom varies with the years. It is to be found growing along all roadsides, on hillsides near roads, and in small to large acreages on farms where it is sown as green manure or for a seed crop.

The blooming period is from the second week in May to the end of June, though there may be a small amount of blooming for a longer period. There is a period of about three to five days between the time of blooming until the time that bees visit the blossoms. Nectar is obtained in large quantities and often with proper management colonies have a surplus of over a hundred pounds capped honey within two weeks after the first visit to the blossoms. Heavy rains during the end of May and through the month of June followed by sunshine, make for the maximum secretion of nectar. Bees work it from morning to evening. Some pollen is obtained but each pollen carrier also obtains a load of nectar.

Russian Olive - (Elaeagnus augustifolia) Family Elaeagnaceae

This small to medium sized tree is an introduced species. It is found within urban areas where it is used for ornamentation in parks or in private yards.

The flowers bloom from the second to the third week in May and bees swarm over the trees gathering nectar and pollen. If it was planted in large numbers such as a wood lot, the nectar obtained would make a surplus. Because of the limited numbers of trees within any given locality they may be considered an essential nectar and pollen source aiding colonies in growth prior to the honey flow from the white sweet clover.

Ohio Buckeye - (Aesculus glabra Willd) Family Aesculaceae

This small tree is found growing along the banks of the

Kansas or Kaw Rivers and also along Mill Creek in Wabaunsee county. Rich woodland soils favor its maximum growth.

Bees visit the blossoms, which bloom from the first to the second week in May, obtaining nectar and pollen. Beekeepers within the areas having a large number of these trees may obtain a small surplus if their colonies are very strong.

Carolina Buckthorn - (Rhamnus caroliniana) Family Rhamnaceae

This small tree like shrub is found according to Gates (4, p. 219) along stream banks, in thickets, or woods. Shrubs within parks were the only ones observed.

No record was kept of its blooming date for 1948, but observations during 1948 showed that it bloomed from the second week in May to the end of June. As one cluster of flowers dies new ones are developed, thereby prolonging the blooming period.

During the period of spring when it blooms, no single plant seemed to be covered with many bees at one time. Frequently, two to three bees were observed trying to visit the same blossom. This shrub should be planted extensively because of the amount of nectar and pollen furnished to bees.

Kentucky Coffeetree - (Gymnocladus dioica (L) K. Koch) Family Cassiaceae

This medium to large tree is found growing along the wooded banks of streams in this region.

The first record of its blooming period was made during the spring of 1949, when it bloomed from the third week in May

to the first week in June.

Bees obtained nectar and pollen from the blossoms, working it heavily. It is a minor nectar source. Neither Pellett (11) and Lovell (9) mention this plant in their books on nectar and pollen plants.

Alfalfa - (Medicago savita) Family Fabaceae

This agricultural plant is chiefly found in cultivated fields. In areas surrounding these fields it has escaped to a degree.

Bees obtain a large amount of nectar from the flowers but from observations conducted during the past year, pollen is only obtained when the field sources of pollen are limited or curtailed. Pollen is especially gathered during the month of August when the last major source of pollen, namely, corn has finished blooming.

Alfalfa blooms in this region to a certain degree throughout the season from the second week in May to the end of August. In local areas where it is left standing for a seed crop, the honey surplus obtained may be great.

Grapes - (Vitis vulpina)(Vitis labrusca) Family Vitaceae

The above species of grapes are the two principle varieties growing in this region that furnish bees with stores. The former is the common riverbank grape and the latter is the cultivated variety such as, Concord grapes. This second species is cultivated in large numbers through the southwestern part of

Pottawatomie county. The first species named is found growing along hilly ravines, and on the wooded banks of stream throughout this region.

The flowers bloom from the third to the last week in May and furnish bees with nectar and pollen. The amounts obtained are relatively small but are an aid to colony maintenance.

Prairie Rose - (Rosa suffulta Greene) Family Rosaceae

This low shrub is found throughout this region in waste places, along roadsides, in pastures, and on hillsides.

They bloom from the second to the last week in May, supplying pollen in varying quantities, depending upon the numbers of plants within the locality.

Primroses - (Oenothera biennis L.)(Oenothera speciosa Nutt.) Family Oenotheraceae

These two species are to be found throughout this region growing chiefly in waste places, roadsides, and prairies. They bloom from the third week in May to the first part of June or even later, depending upon the climatic conditions of the spring months.

Bees gather appreciable amount of pollen from the flowers. Neither Pellett (11) nor Lovell (9) mention these plants in their books on nectar and pollen plants.

Mock Orange - (Philadelphus sp.) Family Hydrangeaceae

This tall ornamental shrub is found exclusively in cultivation within almost every urban district.

The flowers bloom from the last week in May to the dirst week in June, supplying bees with pollen. If in large numbers it would supply ample amounts of pollen. Neither Pellett (11) nor Lovell (9) have mentioned this plant in their books on nector and pollen plants.

Catalpa - (Catalpa speciosa) Family Bignoniaceae

This medium sized tree, noted for the fine fence posts that are made from it, is found along streams, in woodlots, or in urban districts where it has been planted for shade, beauty, or fence posts.

The flowers bloom from the third week in May to the first week in June, furnishing bees with nectar and pollen. In large woodlot areas bees have been known to store moderate surplusses. However, in this region it is merely a good aid to higher colony production.

Sage - (Salvia reflexa) Family Lamiaceae

This small bushy plant, having a small blue flower is found growing throughout this region on farms, along wooded and open fields, preferring the open places. It is spread by the seeds being thrown out of the dry, open capsules when some animal or person walks through them. In some places the entire width and length of untilled fields is covered by these plants presenting to the eye a green mass.

The flowers bloom from the beginning of June to the middle of August although the major blooming period extends only to the first of July. Bees work this during the earlier morning hours

and later afternoon hours, practically abandoning it during the heat of the day. It furnishes surpluses of a clear, light pink colored honey having a mild minty flavor. Some beekeepers have been known to collect the seed by hand and then scattering it over waste areas for bee pasture. Neither Pellett (11) nor Lovell (9) have mentioned this plant in their books on nectar and pollen plants.

Horehound - (Marrubium vulgare L.) Family Lamiaceae

This species of mint is a small plant having woolly leaves. It is found growing throughout this region along hillsides, sparsely covered with trees, in waste places, or around old farm buildings.

It blooms from the third week in May to the first of October. Bees work it the most during June and July but continue to visit it until the fall, when the first heavy frost kills the plants and stops the blooming. Nectar and some small amounts of pollen are gathered from the flowers. Field observations revealed that the sugar concentration of the nectar averaged about 25 percent of the total.

Queen Ann's Lace - (Daucus carota) Family Ammiaceae

This stinking tall weed having a head of small white flowers grows throughout this region in waste places, along stream banks, or in moist timber conditions.

It blooms from the end of May to the end of June. Some beekeepers have said that bees visit it, however, no bees have

been observed working it. Insects on it included various flies, and some of the sweat bees. Pellett (11, p. 92) states that it blooms at very irregular seasons and may require a temperature of 90 degrees F. or more to secrete nectar.

Smooth Sumac - (Rhus glabra) Family anacardiaceae

This species of sumac is found growing throughout this region in dry localities, usually on the sides of open hills.

The flowers bloom from the end of May to the third week in June depending upon the climatic conditions of the year. Various solitary bees, bumble bees, butterflies, and flies were observed visiting the flowers in large numbers but few honeybees. Surpluses from these plants are unknown in this region. Bees obtain nectar and pollen from the flowers.

Lead Plant - (Amorpha canescens Pursh) Family Fabaceae

The flowers, which are borne in terminal spikes are small purple colored, blooming from the second to the last week in June. Solitary bees, wasps, and flies visit it regularily; but only on a few occassions have bees been observed working it. A beekeeper in Wabaunsee county maintains that during certain years the bees work it steadily. It furnishes nectar and pollen in very small amounts.

Tamarix - (Tamarix gallica L.) Family Tamaricaceae

This small shrub like tree is the only one species in Kansas listed by Gates (4, p. 164).

These trees are found chiefly along flood plains or salt flats.

Elderberry - (Sambucus canadensis L.) Family Caprifoliaceae

This flowering shrub, noted for the fine wine made from its fruit, is to be found growing in dry areas along roadsides, waste lots, edges of timbers, along creek banks, and in thickets.

The flowers bloom from the first week in June to the end of July. No honey bees have been observed visiting the flowers although some wasps, bumble bees, and flies do seek it. Pellett (11, p. 141) states that it furnishes pollen in localities where that item is scarce.

White Sweet Clover - (Melilotus alba) Family Lamiaceae

This plant is to be found throughout this region both as a cultivated crop and also growing wild along all roadways, in waste places, on hillsides, and along streambanks.

The flowers bloom from the first week of June until the end of July, and forms the major source of nectar in this region. The more rain that has been had during June the greater will be the flow of nectar. Bees work the blossoms from early morning until late in the afternoon. Towards the end of the season bees seem to abandon the remaining flowers as large numbers of tachinid flies make their appearance on the flowers and plant parts. There may be some distasteful characteristic about the flies that cause bees to not visit the blossoms as they had before the flies were present. Pollen is also obtained from the blossoms, though in small quantities.

Wild Alfalfa - (Psoralea floribunda) Family lamiaceae

These shrubs or herbs can be found growing over the prairies of the entire region.

The flowers bloom from the second to last week in May. Bees have been observed visiting it on a few occasions, gathering nectar and small amounts of pollen. It is of little or no importance.

Milkweed - (Asclepias speciosa Torr) and(Asclepias Kansana Vail) Family Asclepiadaceae

There are several species of milkweeds in Kansas but records have only been kept of these two, which are found growing throughout this region chiefly on the open prairies and plains.

Bees visit the flowers readily but the amount of nectar has not been determined because of the competitive sources which also furnish nectar. The blooming period lasts from the first week in June until the second week in July.

Pollen is obtained in quantities but bees are often trapped due to the clip mechanism of the flowers attaching two pollen masses to the feet of the bee. Bees ladened with these structures have great difficulty in climbing into the hive because of the smooth surfaces of these flower parts. Lovell (9, p. 168-169) states the following concerning this strange flower mechanism.

> Milkweed flowers are called pinch-trap flowers because they possess a remarkable clip-mechanism found in no other family of plants. Two club-shaped masses of pollen are attached by flexible bands to a small, dry, triangular disc placed midway between them. In this membraneous disc there is a wedge-shaped slit at one end. In its effort to obtain a foothold on the smooth flowers an insect is likely to

thrust a claw, leg, antenna, or tongue into one of the slits. If one of these organs is drawn upward in the slit, the dry disc becomes tightly clamped to it. When the insect flies away it carries with it the disc and the two masses of pollen strapped to it. Exposed to the air, the strap-like stalks dry and draw the pollinia close together. As the bee alights on another flower, they are easily thrust between two other wings, where they come in contact with the stigma; but, once inserted and pulled upward, they can not again be withdrawn. The insect can obtain its liberty only by breaking the connecting bands. If it can not do this, it perishes slowly of starvation. Disc after disc may thus become attached to an insect, until it is crippled or helpless.

A diagram of the mechanism is included in the above description.

Sensitive Brier - (Leptoglottis nuttallii DC) Family Mimosaceae

This low semicreeping plant is found throughout this region, growing chiefly on the dry banks along roadsides.

Blooming period extends from the first to the third week in June. No bees have been observed visiting them. Neither Pellett (11) nor Lovell (9) have mentioned this plant in their books on nectar and pollen plants.

Wild Four-o'clock - (Mirabilis nyctaginea (Michx) Mac M.) Family Nyctaginaceae

This rather common plant is found growing along the roadsides of this region, though generally in localized areas.

These flowers bloom from the third week in May to the first week in June. Bees have not been observed visiting the flowers. Neither Pellett (11) nor Lovell (9) have mentioned this plant in their books on nectar and pollen plants.

Tree-of-Heaven - (Ailanthus altissima Swingle) Family Simarubaceae

This medium to large tree is found chiefly under cultivation, but in some areas it has escaped.

The flowers bloom from the first to the third week in June and bees gather pollen and nectar in varying amounts. The honey is claimed by some beekeepers to have a faint green color and a bitter taste. Bees utilize the amount gathered for broodrearing.

Basswood - (Tilia americana L.) Family Tiliaceae

This large tree is found growing along stream banks in local areas within this region.

Bees work the blossoms which bloom from first to the last week in June. During 1948 they bloomed for a week, from the first to seventh of July. Climatic conditions may cause a variation in the blooming period.

Blackberry - (Rubus ostryifolius Rydb.) Family Rosaceae

This thorny shrub, along with the Black Raspberry (Rubus occidentalis L.), is to be found growing in open or wooded places requiring some sunshine but ample soil moisture.

They bloom from the last week in May to the second week in June, depending upon the climatic conditions of the spring. Bees work them readily, gathering nectar and pollen. In some regions of the United States the blackberries only furnish pollen while in others they are an important source of nectar as well as pollen.

Germander or Wood Sage - (Teucrium canadense) Family Lamiaceae

This member of the mints, along with catnip (Nepita cataria), is found growing in waste places, hillsides covered with shrubs, fields, along roadsides, and along streams. Catnip is to be found also growing around old buildings but both seem to prefer ground that has ample moisture and that is covered with humus.

They bloom almost simultaneously, the wood sage starting about the third week in June and continuing to the third week in July while the catnip blooms from the fourth week in June to the second in July. Bees visit both gathering nectar and pollen. However, in localities where both are blooming together, a preference is shown for the catnip. They are important sources of nectar following the white sweetclover flow.

Corn - (Zea mays) Family Poaceae

This cultivated grass plant forms the major summer source of pollen after the spring sources such as plums, fruitbloom, cottonwoods, and others.

Blooming begins generally around the first to the middle of July and continues in varying amounts until the middle of August. Bees work the corn plants from early morning until about nine to eleven o'clock depending upon the temperature and humidity during the days. The lower the temperature and the higher the humidity, the longer they work the blooms. Corn is the major competitive source of pollen to alfalfa pollination.

Hoary Vervain - (Verbenus stricta) Family Verbenaceae

This small plant is found growing in pastures, waste places, along roadsides, hillsides, and valleys; generally, in dry soils.

The flowers bloom from the first to the last week in July. Bees have only been observed working it in areas where the moisture content of the soil is ample. The sugar concentration based on one occasion was 25 percent. Bees have not been observed gathering pollen. The solitary bees of the genus Melissodes belonging to the Family Andrenidae, as arranged by Comstock (1), are the chief visitors of the flowers of this plant. Lovell (9, p. 229) and Pellett (11, p. 420) state that surpluses are obtained occasionally in Iowa. In this region, hoary vervain plays a very minor role of supplying nectar or pollen.

Buckbrush - (Symphoricarpos orbiculatus Moench) Family Caprifoliaceae

This small bush is found growing along streambanks, hillsides, and areas bordering pastures or prairies.

The flowers bloom from the second week in July until the second week of August and bees obtain large amounts of nectar and some pollen. The sugar concentration of the nectar averages 52.5 percent which is one of the highest of this region. Along with the mints and ironweed mentioned previously, buckbrush forms the major source of nectar during July and August. Surpluses of 50 pounds per colony from buckbrush are not uncommon if colonies are kept strong.

Cucumber - Family Cucurbitaceae

Cultivated varieties are minor sources of nectar and pollen in areas in which they are grown.

Bees visit the flowers which bloom from the second week in June to the third week in July. A word could be added that various members of the melons also offer the same amounts of bee stores, blooming at the same time.

Climing Milkweed or Blue Vine - (Gonolobus laevis) Family Asclepiaceae

This vine is found growing throughout this region in cultivated fields, in timbers having damp soils, and small thickets.

The flowers bloom from the first week in July to the last week in August. Bees work it readily, obtaining nectar and pollen. The amount of surplus obtained cannot be determined because of the overlapping nectar flows from other plants. Pellett (11, p. 67) cites reports of surpluses of 60 pounds and more.

Ironweed - (Vernonia interior Small) and (Vernonia fasiculata Michx) Family Vernoniaceae

These two species are found throughout this region of Kansas. The first is found growing in the pastures, valleys near streams, and in timbered areas where the soil has ample sub-moisture and fairly rich. The latter is better adjusted to dry areas in pastures, along roadsides, fence rows, and waste areas.

The flowers bloom from the second week in July to the third week in August with the supply dwindling after the end of July. Bees visit them readily, obtaining surplus nectar having a sugar

concentration of 36 percent and ample pollen stores of a blackish-gray color. The color of the pollen may be mistaken for that of smartweed and mustard. Neither Pellett (11) nor Lovell (9) have mentioned Vernonia interior Small in their books on nectar and pollen plants.

Red Clover - (Trifolium pratense L.) Family Fabaceae

This small plant is found in this region in relatively small amounts, growing in fields, hay fields, along roadsides, and in small creek bottoms.

The flowers bloom from the third week in June to the middle of July and bees have not to-date been observed gathering any nectar or pollen from it. Bumble bees visit it freely along with various beeflies. Pellett (11, p. 341-346) cites several reports of honey surpluses being obtained from it.

Snow-on-the-Mountain -(Euphorbia marginata) Family Euphorbiaceae

This plant of about four feet is found growing along hillsides, pastures, and stream bottoms.

The flowers bloom from the end of July to the middle of August. Bees have not been observed working it at anytime but various small sweat bees and mining bees were observed visiting Snow-on-the-Mountain obtaining nectar and pollen.

Swamp Milkweed - (Asclepias syncarnata) Family Asclepiaceae

This plant has perhaps the most fragrant blossoms of all the milkweeds. It is found growing along streams and in swampy areas.

Bees of every description, beside flies and wasps, visited the flower clusters which bloomed from the first to second week in August. Bees obtained pollen and nectar from the flowers. Neither Pellett (11) nor Lovell (9) have mentioned this plant in their books on nectar and pollen plants.

Cockleburr - (Xanthium pennsylvanicum) Family Ambrosiaceae

The medium to large plant is found growing, throughout this region of Kansas, in waste places, cultivated fields, along roadsides, and on stream banks.

Flowers bloom from the middle of August until the end of the month and bees gather large amounts of pollen from them.

Goldenrod - (Solidago glaberrima) Family Astraceae

This plant of medium heighth is found growing over the entire region in pastures, along roadsides, and waste places.

The flowers bloom from the first of August to the middle of September and bees visit them for pollen. Some local beekeepers claim that nectar is secreted during certain years but this claim must be verified. Bees have not been observed obtaining any nectar from them in this region.

Smartweed or Heartsease - (Polygonum longistyla Small and (Polygonum pennsylvanicum L) Family Polygonaceae

Both species are found throughout this region along wet roadside ditches, low poorly drained fields, along stream banks, and in moist waste areas.

The flowers of both begin blooming at about the same date. However, bees do not gather any pollen or nectar from (P. pennsylvanicum)

Bees were observed furiously working large acerages of smartweed of the species P. longistyla to the almost total exclusion of alfalfa fields blooming alongside the smartweed. Large quantities of nectar and pollen were obtained.

Giant Ragweed - (Ambrosia trifida L.) Family Ambrosiaceae

This tall weed, which almost reaches the proportion of small trees, grows all over this region of Kansas encumbering any waste unused area along streams, road ditches, field margins, and fence rows.

The flowers bloom from the middle of August to the middle of September supplying bees with large quantities of pollen. They form the last major source of pollen prior to winter weather.

Sunflowers - (Helianthus annuus L.) Family Helianthaceae

This tall weed, nearing small tree proportions, grows all over this region, in waste place, roadsides, along streams, along fence rows, and in cultivated fields.

The flowers bloom from the middle of August to the middle of September supplying the bees with pollen and probably some nectar. Attempts at taking sugar concentration readings during 1948 proved futile because of a lack of bees on the flowers carrying nectar. Various wild solitary bees were constantly gathering pollen and nectar.

Swamp Verbena - (Phyla lanceolata) Family Verbenaceae

This small aequatic plant grows along stream beds throughout this region. Its value to bees was established after careful field observations.

The flowers bloom from the first of August to the sixth of October. During the early part of August 1948, bees gathered surpluses amounting to about 10 pounds which aided in preparing the colonies for winter. The sugar concentration of the nectar was 36.5 percent. This is one of the most insignificant of nectar sources and yet if beekeepers knew of its value their colonies would be better supplied for winter. Neither Pellett (11) nor Lovell (9) have mentioned this plant in their book on nectar and pollen plants.

Broomweed - (Amphiachyris dracunculoides) Family Asteraceae

This low prairie shrub grows on the upland prairies, pastures, and hills.

The flowers bloom from the first week in September to the middle of October. Bees obtain some nectar as well as pollen from it on certain days. The plant is an irregular source of nectar.

CONCLUSION

The following conclusions have been drawn from these studies.

1. This region of Kansas, consisting of Riley County, Pottawatomie County, and Wabaunsee County, has an abundance of nectar and pollen producing plants. About 90 species have been observed to furnish bee stores and a description of each has been chronologically arranged.

2. The majority of nectar and pollen producing plants of this region are found growing along the banks of streams, edges of ponds and lakes, along hillside draws, or on hillsides where the moisture content of the subsoil is high.

3. The temperature and relative humidity have an effect on the sugar concentration of the nectar of various nectar producing plants. Readings were taken of the temperature, relative humidity, and sugar concentration of nectar carried within the honey stomach of honeybees in the field. The readings from 10 o'clock to 11 o'clock on July 26, 1948, showed that the temperature was 83° F., the relative humidity was 52 per cent, and the sugar concentration of the nectar of buckbrush was 42.2 per cent, ironweed was 26.5 per cent, and horehound was 21.5 per cent. Readings taken from 2 o'clock on the same day, showed the temperature to be 92° F., the relative humidity was 32 per cent, and the sugar concentration of the nectar of buckbrush was 44.0 per cent, ironweed 31.2 per cent, and horehound 25.0 per cent. All three plants were growing in

the same location.

4. There are approximately eleven major nectar sources and eight major pollen sources in this region during the spring months of March to June. The nectar sources are soft maple, dandelion, wild plum, fruit bloom, aromatic sumac, redbud, yellow mustard, black locust, honey locust, yellow sweet clover, and catalpa. The pollen sources are soft maple, elm, wild plum, fruit bloom, cottonwood, willow, oak, and black walnut.

5. There are approximately eight major sources of nectar and five major sources of pollen for this region during the summer months of June to September. The nectar sources are white sweetclover, alfalfa, catnip, buckbrush, ironweed, horehound, smartweed, and swamp verbena. The pollen sources are corn, ironweed, cocklebur, smartweed, and giant ragweed.

6. There are only three major pollen sources and two major nectar sources during the fall months of September, October and November. The nectar sources are smartweed and swamp verbena, and the pollen sources are smartweed, giant ragweed, and goldenrod.

7. Most flowers not visited by honey bees have various visitors such as sweat bees, mining bees, wasps, hornets, bumblebees, numerous flies, and butterflies.

8. Approximately 17 species of plants have been listed in this chart which neither Pellett nor Lovell have mentioned in their books on nectar and pollen plants. They are crocus, shepherd's purse, golden bell, Nanking cherry, aromatic sumac,

Japanese barberry, paw paw, Kentucky coffeetree, evening primrose, white evening primrose, mock orange, sage, sensitive brier, wild four o'clock, ironweed, swamp milkweed, and swamp verbena.

SUMMARY

This problem was studied over a period of two years and was concerned with all the nectar and pollen producing plants of interest to beekeepers in three counties of northeastern Kansas, namely Riley, Pottawatomie, and Wabaunsee counties.

A study of the literature showed that only two authors, Merrill (10) and Small (18) listed some of the major nectar and pollen plants of Kansas. Three types of beekeeping are being practiced in these counties, namely, the let-alone-system, semi-scientific, and the scientific system.

This problem was carried on in three parts namely, the field observation of bee activity on the flowers, the collection of the specimens visited by bees, and the identification of each plant collected.

The field observations consisted in remaining in the field for hours, walking around and observing the different types of flowers in bloom. They were observed for various lengths of time in order to determine whether bees were visiting them. If bee activity was observed on a specific flower, the type of bee supply obtained by the honeybee was noted and a specimen of the plant was collected. Later field trips established the type of environment in which it grew and the amount of bee activity found on it in comparison to other flowers in bloom. The date of blooming was determined after rechecking the following year with the help of a chart drawn up for the previous year's observations. This phenological chart was used to re-

cord the exact date of blooming. It also aided in adding flowers that had not been recorded for the previous year. Sugar concentrations of the nectar of some of the flowers visited most by honeybees were obtained by means of a refractometer.

The second phase of this study merely consisted in the collection of specimens of flowers visited by bees and preserving them in presses for identification at a later date.

The last phase was perhaps the most difficult since there are several species of plants belonging to the same genus and family. For the actual identification the common names were first checked with various books on honey plants of the United States by Lovell, Pellett, and Phillips, in order to determine whether they were listed as nectar or pollen plants. The plants were then keyed down by means of taxonomic keys (for trees, shrubs, flowering plants, herbs, and weeds) by Gates, Robinson, and Rydeberg. Some were checked by authorities on horticultural varieties as they were not listed in the above mentioned keys.

The final step in this study has been to draw up a phenological chart giving the common name, scientific nomenclature, dates of blooming for 1948 and 1949, and the bee stores each supplied to honeybees. A short description was written for each plant stating its distribution, the ecological environment in which it had been observed, the blooming period, and bee activity observed on it.

In order to present a complete picture of the ecology of

Riley, Pottawatomie, and Wabaunsee counties, various authorities on the meteriological factors of this region were consulted. The report of the Kansas State Board of Agriculture, dealing with the climate of Kansas by S. D. Flora, was used for this purpose. The different short analysis of climatic factors such as windage, precipitation, relative humidity, sunshine, growing season, and temperature were elaborated upon from observations carried on for each during the past two years.

Soils and drainage data for this region were obtained from an article written on this subject by E. Fly in the Report of the Kansas State Board of Agriculture for 1946. In this report is included a map showing the soil and vegetative regions and the drainage system for the State of Kansas.

The following facts have been obtained from this study. During the spring months of March to June there are eleven major nectar plants, which are soft maple, dandelion, wild plum, fruit bloom, aromatic sumac, redbud, yellow mustard, black locust, honey locust, yellow sweetclover, and catalpa. There are eight major pollen sources for the same period of time, namely, soft maple, elm, wild plum, fruit bloom, cottonwood, willow, oak, and black walnut.

During the summer months of June to September there are the following major nectar plants, namely, white sweetclover, alfalfa, catnip, buckbrush, ironwood, horehound, smartweed, and swamp verbena. The major pollen plants during the summer are corn, ironweed, cockleburr, smartweed, and giant ragweed.

During the fall months of September to November there are two major sources of nectar, namely, smartweed and swamp verbena. The major pollen sources are smartweed, giant ragweed, and goldenrod.

Approximately eighteen plant species which have been listed in this study as being nectar and pollen plants, have not been mentioned by Pellett or Lovell in their books on nectar and pollen plants. The plants are crocus, shepherd's purse, golden bell, Nanking cherry, aromatic sumac, Japanese barberry, paw paw, Kentucky coffeetree, evening primrose, white evening primrose, mock orange, sage, sensitive brier, wild four-o'clock, ironweed, swamp milkweed, and swamp verbena.

Because of the great number of pollen and nectar plants within these counties, this should be an ideal region for beekeeping.

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