field and the information obtained from the samples of galls show that the parasites were more abundant during the fall than in the spring. This seasonal fluctuation was also true of each of the 3 major parasites. Therefore, even though the parasites were dependent upon their host for food, the parasite population was affected more by the other ecological factors than by the population density of their host. The abundance of the different species of parasites in respect to each other also varied with the locality. However, even though the parasitization by *E. cushmani* and *E. tephritidis* at Waihou was low, their actual populations may have been higher than in other localities where the percentages parasitized by them were higher. This is because, as pointed out earlier, in localities like Waihou and Kanaio there are more pamakani plants in the general area, more galls produced per stem and more *P. utilis* produced per gall, than in localities like Keanae. The total parasitization averaged more than 35% in each locality and would be much higher if only the fall collections were considered. From the standpoint of efficiency, the parasites were more or less equally successful, irrespective of the population densities of the fly, in all of these Maui localities studied intensively. Despite the high parasitization, this fly has been able to eliminate pamakani over large acreages above Ulupalakua and Kipahulu, and it appears that the lack of its success in the other localities cannot be attributed to parasitization.

Summary

1. The abundance of a tephritid gall fly, *Procecidochares utilis*, and its role in the biological control of the weed pest pamakani, *Eupatorium adenophorum*, under a wide range of ecological conditions were studied on Maui from 1949 to 1957. In some localities the fly was abundant throughout this period and caused considerable reduction of its host, while in others it was never conspicuously abundant, and had little detrimental effect on the weed.

2. Five species of parasites were reared from the fly. Parasitization was appreciable, often exceeding 50%. A brief resume of the biologies of the parasites and the parasitization caused by each of the 3 major species is presented.

3. The abundance of the fly, of its host, pamakani, and of the 3 major parasites of the fly, are discussed. These are presented graphically and discussed from the standpoint of season and locality.

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SMALL MAMMALS AND OLD FIELD SUCCESSION ON THE PIEDMONT OF NEW JERSEY[1]

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This study of the small mammal fauna in relation to secondary succession on the Piedmont of New Jersey was stimulated by several factors. The first and most important was the careful description of plant succession in this area by Bard (1952) that serves as a basis for the present study. Secondly, many of the fields where Bard

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studied were still available but the need for prompt study was illustrated when one of the fields succumbed to a housing development. Lastly, since these areas are used for field study by ecology classes at Rutgers, it was apparent that precise information was needed on the (1) species of small mammals represented in the seral stages, (2) patterns of mammal distribution relative to vegetational cover in these fields, and (3) the relative mammal population levels in the successional stages.

The seral stages studied were fields whose "age," or elapsed time since last cultivated, was 7, 11, 16, 46 and 66 years. Also, an oak forest formerly known as Mettler's Woods and now referred to as the Hutcheson Memorial Forest served as the climax forest reference stage. The old fields were 1, 5, 10, 40 and 60 years of age at the time that Bard studied them. All of these fields are in Somerset County and are less than 5 miles from Hutcheson Forest near East Millstone, N. J. They have the same general climate, are all located on the Brunswick Shale Formation of the Piedmont physiographic province, and all have soils of the Penn series. Bard made every effort to reduce as far as possible the number of variables affecting community development, but it should be noted that the 66-year field (Bard's 60-year field) apparently was an orchard rather than a cultivated field and should therefore have a somewhat different successional pattern.

Field work was continued from July 8 through August 24, 1956; November 6-7, 1956; February 6-April 10, 1957, and June 13-16, 1957. The field work was done by the author except for the trapping from February through April, 1957 which was done by Mr. Steven V. Kaye. The general procedure was to use 25 Sherman live traps per census period for each plot representing a seral stage. The number of plots trapped per census period varied from 2 to 6. The census period usually lasted 3 days and the traps were checked during the early morning of each day. The traps were spaced at 50 feet intervals in lines 50 feet apart. In the 11, 46, and 66-year fields and in Hutcheson Forest one line of 12 and one of 13 traps were used, while the 7 and 16-year fields were shaped such that two lines of 8 and one line of 9 traps were set. The traps were baited with oatmeal and on several occasions peanut butter was added. Animals were marked by a toe clipping method similar to that used for spadefoot toads by Pearson (1955). The animals were released at the point of their capture after size, pelage, and other characteristics had been recorded. The behavior of the mammals when released and the location of the trap-site was noted in relation to the vegeation cover.

Results

Seral Stages

1. *Seven Year Stage.* This stage was represented by a 4-acre field located on Cedar Grove Lane, 1.6 miles west of Canal Road in Somerset County. It was surrounded by a paved road, by an old orchard, a fence row and a field of approximately the same age, and by a field of about 25-35 years development.

Herbaceous vegetation formed the dominant aspect of the 7-year field and the vegetation could be divided into 2 cover types that served as habitats for small mammals. One cover type that blanketed about half of the area, centrally located in the field, was dominated by goldenrods (*Solidago nemoralis, S. graminifolia*), aster (*Aster ericoides*) and other forbs. The open growth form of this vegetation was such that much light reached the surface of the soil and the layer occupied by small mammals. The second cover type, dominated by broom-sedge (*Andropogon scoparius*), covered about half of the 4 acres and formed the cover on the perimeter of the field. Broom-sedge provided a dense layer of vegetation just above the surface of the soil and light penetration and evaporation through this cover was low. There were many seedlings of woody plants present at this stage and among them were red cedar (*Juniperus virginiana*), bayberry (*Myrica pennsylvanica*), dogwoods (*Cornus florida* and *C. amomum*), smooth sumac (*Rhus glabra*) and others.

This plot was trapped 7 census periods for a total of 622 trap-nights; of these, about half (290) were in goldenrod-aster cover, 307 in broom-sedge cover and 25 trap-nights were in a mixture of these 2 cover types.

The animal most frequently caught in the forb cover was the white-footed mouse (*Peromyscus leucopus*) which was captured 16 times. The short-tailed shrew (*Blarina brevicauda*) was captured twice and the pine mouse (*Pitymys pinetorum*) was taken 4 times. The trapping data in broom-sedge cover were quite different in that there were only 4 *Peromyscus* captured while there were 22 captures of the meadow mouse (*Microtus pennsylvanicus*), 2 captures of *Blarina* and 4 of the masked shrew (*Sorex cinereus*). Three *Peromyscus* and one *Microtus* captures were made in traps of unassigned cover type.

The indication that the 2 cover types in this field supported different faunas was strengthened by the observations of the behavior of mice when

released. The response of released *Peromyscus* could be subdivided as follows: (1) those released in the cover of goldenrod-astors remained in this cover and were usually traced to the openings of an underground burrow system and (2) those released at the boundary of goldenrod-aster and broom-sedge cover reacted positively to the goldenrod-aster cover. All of the *Microtus* were caught in broom-sedge cover and they were never observed to leave this cover when released at the capture point. Rather they would quickly disappear into runways under the mat of broom-sedge cover.

2. *Eleven Year Stage.* This was represented by a field of about 6 acres across the highway from the 7-year field described above. In addition to the highway this field was bordered on the other 3 sides by a field of similar age, and a hedgerow on 2 sides, one of which separated the field from a farm dwelling and out-buildings. At the most, only about one acre, or one-sixth of this plot, was dominated by the goldenrod-aster cover type and, as in the 7-year field, these perennial forbs were in an area of relatively poor drainage. The broom-sedge was denser than in the 7-year stage and there were large areas of essentially unbroken mats of cover. Shrubs and trees such as red cedar, bayberry, 2 species of dogwood, smooth sumac, and others were higher and denser than in the 7-year field.

Of a total of 625 trap-nights recorded in this field, 68 were in goldenrod-aster, 491 were in broom-sedge, 2 were in shrub and 64 were in a mixture of these. From the goldenrod-aster cover only 3 meadow mice were taken while in the broom-sedge cover 33 captures of meadow mice, 10 captures of house mice (*Mus musculus*), 8 captures of short-tailed shrews and 7 of masked shrews were recorded. The only white-footed mouse observed in this field was taken in a large cluster of bayberry shrubs, while 2 captures of house mice were made in mixed cover.

Thus, in this stage there was a great reduction in the white-footed mouse population and an absence of pine mice. The meadow mice, house mice, and short-tailed and masked shrews were the most abundant small mammals and all of these were characteristically taken under the dense ground cover of broom-sedge leaves and stems. In this mat of vegetation runways currently being used were conspicuous and scats, cut grass stems and other signs of activity were obvious.

3. *Sixteen Year Stage.* This stage was represented by a 4-acre plot located on Elizabeth Avenue, 0.3 mile from Amwell Road. This field was bordered by a road, a residence, and, on 2 sides, a hedgerow that marked the boundary between this and other fields. About three-fourths of this field was dominated by broom-sedge cover. There were extensive areas covered by a thick mat of this vegetation, but at the same time in several parts of the field there appeared to be considerable broom-sedge mortality with consequent removal of small mammal cover. The goldenrod-aster cover was less than in previous stages and, together with the shrubs and trees, covered about one-fourth of the field. The woody plants of this stage had considerable areal coverage and provided shelter for small mammals. In addition to the trees mentioned in the previous stages red maple (*Acer rubrum*) was common and a few pin oaks (*Quercus palustris*) were present.

Of the recorded trap-nights for the various types 98 were in goldenrod-asters, 432 were in broom-sedge, 21 in shrub and 46 were in various combinations of these. Twelve white-footed mice were taken in the perennial forbs, 5 were trapped in shrub-tree cover, while 5 *Peromyscus* and 2 meadow mice were taken in mixed cover. Five species were caught in broom-sedge cover; there were 3 captures of *Peromyscus,* 42 captures of *Microtus,* one capture of *Mus,* 5 of *Blarina* and 3 of *Sorex*. It should be noted that in proportion to the amount of trapping effort there was a higher frequency of *Microtus* captures in the broom-sedge of this field than in the 2 earlier stages.

4. *Forty-six Year Stage.* This and the next stage were located on property owned by Mr. Bolmer on Cedar Grove Lane northwest of Middlebush, N. J. The plot of approximately 10 acres was bounded by roads on 2 sides, by the 66-year stage on another, and by the Bolmer residence and gardens on the fourth side. The road borders were excluded from trapping since in these there was more shrub and tree vegetation than normally occurred in the remainder of the field. The cover at this stage was formed by broom-sedge and aggregations of trees and shrubs. While the relative importance of the cover types was not measured, it was obvious that the woody plant cover was greater both in areal extent and in height. However, even with this increase, broom-sedge still occupied extensive areas. This broom-sedge, unlike the same species in the earlier stages, offered poor cover for small mammals as a result of the degeneration of the mat and the widely spaced distribution of the individual plants.

Of the trap-nights recorded for this field 190 were in broom-sedge cover, 139 were in shrub and tree cover, 52 were in mixtures of these, and cover type was not recorded for 111 trap-nights. Since the traps were systematically and uniformly

spaced in the field the number of trap-nights recorded gives a general idea of the extent of coverage by the 2 cover types. The catch in broom-sedge included 8 captures of white-footed mice and one of *Microtus* while under the shrubs and trees only 14 white-footed mice were captured. Four captures of white-footed mice and 2 of short-tailed shrews were made from the traps in cover of mixed type.

The most interesting aspects of the results from this field are (1) the sharp decline of meadow mouse captures and (2) the abundance of white-footed mice in shrub and tree cover. Herbaceous vegetation, primarily broom-sedge, covered extensive areas. One might expect then to find meadow mice abundant, except for the fact that at this stage the dense, homogeneous mat of grass had been broken and instead it was usual to find only isolated plants of *Andropogon* surrounded by larger areas covered by lichens. There was no goldenrod-aster cover and the white-footed mice were trapped more often in clusters of trees and shrubs. Also, it was noted that while the *Peromyscus* might move through areas dominated by broom-sedge they nearly always disappeared underground in the woody plant cover. The behavior of several of these mice upon release in broom-sedge was to run across lichen cover and to avoid the individual broom-sedge plants.

5. *Sixty-six Year Stage.* This stage consisted of an 8-10 acre field located on Cedar Grove Lane as noted above. It apparently represented an abandoned orchard as was indicated by even-spaced aggregations of red cedar corresponding to the original sites of orchard trees. The dead stumps of a few of these trees were found in the center of the red cedar clusters. The shrub and tree cover was quite extensive with only small patches of herbaceous vegetation between them. This relation is illustrated, as above, by the number of trap-nights recorded for cover types. Ninety-six trap-nights were in broom-sedge cover, 227 were in shrub-tree cover, 63 were in a mixture of these and for 240 trap-nights the cover-type was not recorded. One white-footed mouse and 3 short-tailed shrews were taken in the broom-sedge, while 24 *Peromyscus* and 2 *Blarina* captures were recorded for the shrub-tree cover. Twenty-one captures of white-footed mice and 2 captures of short-tailed shrews were made in a mixture of grasses and shrubs. It was quite apparent that the dominant small mammal of this stage was the white-footed mouse and that its capture was associated with shrub and tree cover.

6. *Climax Oak Forest.* A 4-acre section of Hutcheson Memorial Forest, that according to Bard (1952) is the nearest approximation to the local climax oak association, was trapped to provide a frame of reference in the successional picture. The forest has been described by Monk (1957) and was characterized by a shrub cover of *Viburnum acerifolium.* The herbaceous cover in this mature forest was sparse except during the spring when May-apple (*Podophyllum peltatum*) and other herbs flourish. From a total of 499 trap-nights 58 captures of white-footed mice, 8 captures of pine mice and one capture of a short-tailed shrew were made.

Analysis of Cover Types

It has been noted above that vegetation cover composed of goldenrods, asters, and other perennial forbs occupied a large part of the 7-year field and a decreasing amount in the 11 and the 16-year stages. The small mammal data for perennial forb cover combined from these 3 fields are in Table I. The white-footed mouse was the most abundant small mammal in this cover. The aggregate trapping data for the broom-sedge cover type in the 5 fields (7 through 66-year) are given in Table I and it is seen that the meadow mouse was the most abundant small mammal in this type of cover. Trap data for the shrub and trees from the 16, 46, and 66-year fields show the white-footed mouse to be the dominant small mammal with only short-tailed shrews, and pine mice as associates. Similar results were noted in the mature forest.

TABLE I. A summary of trap-nights, number of captures of each species, and the number of captures per 100 trap-nights according to cover type. Species are listed in order of abundance for each cover type

Broom-sedge 1516 Trap-nights			Goldenrod-Aster 456 Trap-nights		
	No. of Captures	Captures per 100 Trapnights		No. of Captures	Captures per 100 Trapnights
Microtus	98	6.5	Peromyscus	28	6.1
Peromyscus	16	1.1	Pitymys	4	0.9
Blarina	15	1.0	Microtus	3	0.7
Sorex	13	0.9	Blarina	2	0.4
Mus	12	0.8			
All Species	154	10.2	All Species	37	8.1
Shrub and Tree 366 Trap-nights			**Mature Oak Forest 499 Trap-nights**		
Peromyscus	38	10.4	Peromyscus	58	11.6
Blarina	2	0.6	Pitymys	8	1.6
Pitymys	1	0.3	Blarina	1	0.2
All Species	41	11.2	All Species	67	13.4

Two animals, *Peromyscus* and *Blarina,* were trapped in all cover types with the former being the most abundant small mammal in all but the broom-sedge. Two other genera, *Mus* and *Sorex,* were taken only in broom-sedge cover where *Microtus* was the dominant small mammal. *Pitymys* was taken in all but the broom-sedge cover

and was found in the earliest and in the last 2 seral stages. The greatest number of species was taken in broom-sedge. The greatest population density of small mammals was in the mature forest.

Species Account

The masked shrew was observed only in the 11 and 16-year fields. These shrews were limited also to the trapping periods from February through April, 1957. Whether this reflects a seasonal change in abundance or different trapping techniques by the author during the summer and by Mr. Kaye during the winter period is not known; however, in so far as we could determine the trapping techniques were the same.

The short-tailed shrew was caught throughout the year in all stages of succession and in all cover types. A test of the association between the captures of this form and cover type was made by using a 2 × 2 contingency table similar to those of Table II using data from the 7, 11, and 16-year stages. This test showed that although the shrew was caught more often in broom-sedge than in goldenrod cover there was no statistical significance in this association ($\chi^2 = 1.3$). A similar test was made that compared the capture data of *Blarina* for association with broom-sedge or with shrub and tree cover in the 46 and 66-year stage. It failed to give evidence of significant association ($\chi^2 = 2.0$). This apparent lack of association between *Blarina* captures and cover type might be an indication of its vagility which is reflected in its wide distribution throughout the collecting.

TABLE II. An analysis of association between capture data and vegetation cover for data from the 7, 11 and 16 year-fields

Peromyscus leucopus	Catch	No Catch	Total
Broom-sedge	7	1223	1230
Goldenrod	28	428	456
Total	35	1651	1686

$\chi^2 = 48.0$

Microtus pennsylvanicus	Catch	No Catch	Total
Broom-sedge	97	1133	1230
Goldenrod	3	453	456
Total	100	1586	1686

$\chi^2 = 29.9$

The population of meadow mice increased from the 7 to the 16-year stage as shown in Table III. It has been noted above that this mouse was most abundant in broom-sedge and a test of association between meadow mice and broom-sedge shows a highly significant relationship (Table II). The positive reaction to *Andropogon* or to the runways and nests therein, upon release from traps has been noted previously. It should also be pointed out that it is not the presence of broom-sedge alone but the presence of a heavy mat of broom-sedge cover that seems to be important as shelter for the meadow mice.

TABLE III. Small mammal trapping data for stages in old field succession. The numbers represent the average of the number of different individuals caught per census period per 100 trap-nights

	"AGE" OF PLOT (years)					
	7	11	16	46	66	250+
Total Trap-Nights	622	625	597	492	626	499
Sorex cinereus	0.6	1.3	0.5	...	...	...
Blarina brevicauda	0.6	1.3	1.0	0.4	1.1	0.2
Microtus pennsylvanicus	2.8	3.7	5.5	0.4	...	...
Pitymys pinetorum	0.6	...	...	...	0.3	1.4
Peromyscus leucopus	3.2	0.2	3.3	5.1	5.2	10.0
Mus musculus	0.2	1.6	0.1	...	...	...
Total of All Species	8.2	8.0	10.5	5.8	6.7	11.6

The pine mice were trapped only by Mr. Kaye during the winter season and only in the goldenrod-aster cover of the 7-year stage and in the woody cover of the 66-year field and Hutcheson Forest. Their distribution in relation to cover was very similar to that of white-footed mice in that they apparently showed a negative response to broom-sedge cover and a positive response to the forb and shrub-tree cover.

The captures of the white-footed mouse were strongly associated with perennial forbs in the early fields, and their behavior gave indications of a negative reaction to the broom-sedge (Table II). If data from the 46 and 66-year stages are combined, 9 captures of this species and 277 trap-nights of no capture were recorded in broom-sedge while in the shrub and tree cover there were 38 captures and 328 trap-nights of no capture. Contingency tests of these data show a significant association between captures of *Peromyscus* and shrubs and trees ($\chi^2 = 11.5$). Therefore this species was caught more frequently in perennial forbs in the 7-year stage, in both this and shrub and tree cover in the 16-year stage and then in the latter in subsequent stages.

The house mouse was captured only during the summer seasons and only in a cover of broom-sedge. Of the 12 captures made in this cover, one each was in the 7 and 16-year fields and 10 were in the 11-year field. There is considerable evidence, although not statistically significant, that these mice are associated to a greater degree with *Andropogon* cover ($\chi^2 = 3.6$) than with the goldenrod-aster cover.

DISCUSSION

In some respects the results of this study parallel those of a study in Michigan by Beckwith

(1954). Beckwith found that in the annual-biennial stage the prairie deer mouse (*Peromyscus maniculatus bairdii*) was the most common small mammal although in the perennial grass stage that followed the number of deer mice decreased and the meadow mouse became most common. Data were not obtained on small mammals in the perennial forb stage of goldenrods and asters that followed rather than preceded the grass stage in Michigan. In the shrub and later tree stages the white-footed mouse (*Peromyscus leucopus*) became most common and the meadow mouse population was considerably decreased. Therefore, Beckwith's study revealed that in Michigan, *Peromyscus* is most common in the early and late seral stages while *Microtus* is most abundant in the grass stage. It is especially interesting that in New Jersey *Peromyscus leucopus* fills the *Peromyscus* niche both in the early and late seral stages, while in Michigan *P. maniculatus* fills the niche in the early stages.

The observed relationship between *Microtus* and heavy grass cover has been tested by Eadie (1953) and by Mossman (1955). The former found a significant association between meadow mouse activity and heavy herbaceous cover. Furthermore, Mossman has concluded that there is a significant correlation between the abundance of *Microtus, Sorex, Blarina, Peromyscus* and *Mustela* and light penetration through herbaceous vegetation. Thus, there is good correspondence between these studies and the observations of the present study on the association of *Microtus* captures with a dense homogenous mat of broom-sedge. It would appear from all of these studies that the growth form of vegetation is of first importance in determining small mammal distribution and density.

With regard to interspecies relationships within the seral stages the conclusions of King (1957) from a laboratory study of aggressive behavior in *Mus musculus* and *Peromyscus maniculatus* are interesting. He concluded that the greater aggressiveness displayed by *Mus* would suggest that wherever the 2 met under natural conditions, *Peromyscus* would be driven away by *Mus*. Since *Peromyscus* does not resist the attacks it could easily escape. This type of behavior might explain the near exclusion in the present study of *Peromyscus* from broom-sedge cover where *Mus, Microtus,* and *Sorex* are characteristically found and the fact that the white-footed mouse was most common in all the other cover types where these species were not common. A study of the aggressive relationship between the species represented in this study might well point to causal factors in the observed small mammal-cover associations.

The presence or absence and the relative abundance of small mammals in the various seral stages can be explained on the basis of changes in the types and amount of vegetative cover. For example, the presence of *Sorex, Mus* and *Microtus* in the 7 to 16-year stages is apparently related to the presence of adequate broom-sedge cover. Also, the relative abundance of the mammals is directly proportional to the density and areal extent of this cover type. Likewise the occurrence and density of *Pitymys* and *Peromyscus* are apparently related to the cover of perennial forbs or shrub and tree cover.

The relative abundance of all small mammals may be a reflection of the degree of development of field or grassland aspects from the 7 to the 16-year stages. The grassland aspect degenerated between the 16 and 46-year stages and the small mammal population likewise decreased abruptly in abundance and in species representation. However, the forest aspect began to be prominent with the 16-year stage and continued to increase in extent to the mature oak forest; at the same time the white-footed mouse population apparently also increased as did *Pitymys* in the last two stages. In other words we might think in terms of a grassland and a forest community with a zone of interaction, overlap, or tension occurring temporally somewhere around the 16-year stage. This might even be considered as a temporal ecotone (Pearson 1955) between these two communities. Johnston and Odum (1956) have found essentially similar results in their study of breeding bird populations in relation to plant succession on the Piedmont of Georgia. They conclude from their work and from a review of the literature on bird studies that densities usually increase with increasing ecological age with a leveling off or slight population reduction in the climax stage. However, these authors noted an increase in density of breeding birds through the grassland and grassland-shrubland stages with a decrease in pine forests of 25 and 35 years of age. Then, as an understory of deciduous trees developed, the density of birds increased until there was a slight decrease in the climax oak-hickory forest stage. It is interesting that their results show the same population decrease in the mid-successional period as is shown in this study with small mammals.

Summary

1. A study was made of the relative abundance and species occurrence of small mammals in stages of secondary succession on the Piedmont of New Jersey. The association of trap captures of these

species with dominant vegetation cover types was analyzed.

2. White-footed mice were associated with perennial forbs in the earliest seral stages as well as with shrub-tree cover in the late seral stages. In Michigan, the *Peromyscus* niche of the early seral stages is filled by *P. maniculatus* while *P. leucopus* are found in later stages.

3. As with the white-footed mouse, the pine mouse was associated with perennial forbs in the early stages and with shrub-tree cover in the late seral stages.

4. The captures of meadow mice, masked shrews and house mice were associated with broom-sedge cover of a dense, homogeneous nature that was found in the 7, 11 and 16-year stages, but not in later ones.

5. The relative abundance of the total small mammal fauna increased from the 7 and 11 to the 16-year stage as the field aspect developed, decreased by the 46-year stage and then increased as the forest matured. The species distribution was a reflection of the change from a well developed grassland stage at 16-years to a developing forest aspect afterwards.

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A PHYTOSOCIOLOGICAL ANALYSIS OF THE TALL-GRASS PRAIRIE IN NORTHEASTERN OKLAHOMA[1]

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The tall-grass prairie in northeastern Oklahoma has been described in several reports. Bruner (1931) named this association the Andropogon associes, and described it as a large tongue of prairie extending south from Kansas into northeastern Oklahoma. Blair and Hubbell (1938) designated this same area as the Cherokee Prairie biotic district. The principal plant association was given as the tall-grass sod produced by *Andropogon gerardi*,[2] *Andropogon scoparius, Sorghastrum nutans*, and *Panicum virgatum*. The occurrence of the tall-grass prairie throughout the northeastern part of the state was also shown by Carpenter (1940). A map of the state, showing current vegetative types as related to wild life, has been presented by Duck and Fletcher (1943). The presentation of the tall-grass prairie on this map coincides almost exactly with the northeastern delineations already cited. The only quantitative investigation of the tall-grass prairie in northeastern Oklahoma was conducted by Little (1938), who reported the prairie formation in Muskogee County as the *Andropogon gerardi* association with *Andropogon gerardi* as the dominant but associated with *Andropogon scoparius, Koeleria cristata, Manisuris cylindrica, Panicum virgatum, Paspalum floridanum*, and *Sorghastrum nutans*.

The purpose of this research was to investigate the upland tall-grass prairie in Northeastern Oklahoma and to provide quantitative data relating to the grasses and forbs as they exist in this association.

Location and Description of Study Area

The upland tall-grass prairie was studied as it occurs on three different plots in Rogers County, Oklahoma, approximately 5 miles northeast of Owasso or 15 miles northeast of Tulsa. The area of Plot 1 slopes to the south and east and its cover is continuous, with a minimum of clumping. Plot 2, a gently rolling field of about 60 acres, drains to the northeast. The general cover here is continuous, with some evidence of disturbance

[1] Based on a thesis submitted to the Graduate College of the University of Tulsa, Tulsa, Oklahoma.

[2] Nomenclature of the grasses is according to Hitchcock and Chase (1950); that of the other species follows Fernald (1950).