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The food habits of two congeneric rodent species in Point Pelee National Park, southwestern Ontario.

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THE FOOD HABITS OF TWO CONGENERIC RODENT SPECIES IN POINT PELEE NATIONAL PARK, SOUTHWESTERN ONTARIO

BY

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ABSTRACT

The food habits of two congeneric rodent species, *Peromyscus leucopus noveboracensis* and *Peromyscus maniculatus bairdii*, were studied in Point Pelee National Park, southwestern Ontario from June to August, 1972. Three habitats studied were an old field, an abandoned orchard and a deciduous forest.

Fecal analysis indicates that *P. leucopus* prefers *Vitis riparia* (river-bank grape), *Rhus typhina* (staghorn sumac), *Campanula americana* (tall bellflower), and *Eupatorium perfoliatum* (thoroughwort). Invertebrate composition of *P. leucopus* diets ranged from 25.4% to 48.9% whereas, *P. maniculatus* had a diet of invertebrates (77.1%).

Measures of plant species-diet overlap in all plots ranged from 0.49 to 0.83 with the greatest temporal difference noted in the forest. Plant-diet overlap was approximately the same for *P. leucopus* and *P. maniculatus* in the old field (0.76 and 0.71).

P. leucopus capture frequency was correlated with the presence of *Vitis riparia* and *Rhus typhina* in the orchard plot. Food items which are widely distributed (frequency of quadrats) appear most frequently in the diet regardless if they are rare or common as determined by biomass measurement.

Mean food niche breadths were estimated from a diversity formula ($\frac{1}{\sum p_i^2}$). *P. leucopus* means ranged from 1.39 items to 1.96 items over all plots and those of *P. maniculatus* averaged 1.22 items. Mean food breadths were significantly different for *P. leucopus* and *P. maniculatus*.

Food niche overlap was estimated from the formula

$$\frac{\sum (x_i + y_i) \log(x_i - y_i) - \sum x_i \log x_i - \sum y_i \log y_i}{(X + Y) \log (X + Y) - X \log X - Y \log Y}$$

Food niche overlap between the two congeners revealed an intermediate value of 0.54.

ACKNOWLEDGEMENTS

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INTRODUCTION

A consideration of niche breadth and niche overlap gives valuable insight into the ways in which resources are subdivided. Niche breadth represents the number of resource categories utilized. Niche overlap represents the number of resource categories shared. The relationship between the level of competition and maximum tolerable niche overlap has been considered by several authors (Klopfer and MacArthur, 1961; MacArthur and Levins, 1967). Unfortunately, the general relationship of niche overlap to competition is not very clear. Arguments have been presented suggesting, paradoxically, that niche overlap can be evidence for or against the existence of competition (Colwell and Futuyma, 1971).

Peromyscus leucopus and Peromyscus maniculatus are studied with a view to quantifying food niche breadth and niche overlap between the two congeneric rodents. The food habits of these two cricetid rodents have been studied extensively by gut and fecal analysis (Williams, 1962; Whitaker, 1963). In most studies, the frequency method is compared with the abundance of plants available. In this study, an attempt is made to avoid highly subjective plant measurements by listing the plants found on study plots on the basis of their biomass. Zimmerman (1965) and Meserve (1971) ranked the plant species according to their visually observed abundance and distribution. This quantifies the availability of plant species, and is readily applied to a weighting of food niche breadth and overlap between species.

P. leucopus and *P. maniculatus* are studied, with a view to establishing plausible explanations for their co-occurrence. Food is assumed to be an important resource that is subdivided. The degree of overlap and its affect on food niche breadth for both species should give some clues to resource utilization.

STUDY AREA AND RODENT SPECIES

Point Pelee National Park, Ontario (82.5° longitude and 42° latitude) is the most southern portion of Canada's mainland. The park extends six miles into the western basin of Lake Erie and formed as the result of the interaction between geological and limnological factors (Terasmae, 1969). Formation of the Point Pelee-Lorain moraine, in combination with rising water levels, caused sand to erode east and west of the point. The moraine, which influenced the regime of water currents in the western basin was responsible for the alongshore transport of sand which eventually built up the point. The general shape has remained the same over the last 4,000 years, although there has been considerable change in detail with the point gradually extending southward as the sand accumulated (Chapman and Putnam, 1966; Terasmae, 1969).

P. leucopus and P. maniculatus have wide geographical distributions in North America extending from Canada's northern boreal forest to the Yucatan peninsula in Mexico (King, 1968). These ubiquitous species exhibit varying patterns of distribution in localized habitats with either P. leucopus or maniculatus being severely limited in distribution. This was particularly evident at Pelee where P. leucopus oriented toward a shrub-forest physiognomy and P. maniculatus was confined primarily to early succession (M'Closkey, 1971).

Three study plots were selected which represented different seral stages of forest succession. The orchard plot is a mid-successional stage consisting of red cedar (Juniperus virginiana), riverbank grape, (Vitis riparia), staghorn sumac (Rhus typhina), and grasses such as Poa glauca. This area was utilized for approximately 30-40 years as an apple orchard. The second plot is a broadleaf deciduous forest dominated by hackberry (Celtis occidentalis), black walnut (Juglans nigra), and red oak (Quercus rubra). This forest will eventually converge to a true climax of black walnut, basswood (Tilia americana), and red oak. The old field is an early succession of cottonwood, (Populus deltoides), horseweed (Conyza canadensis), and staghorn sumac (*Rhus typhina*). Half of this plot is an asparagus field which was abandoned two years previous to this study.

A list of plants found in each plot is given in Appendix A.

MATERIALS AND METHODS

Field Methods

Based on a general inventory of small mammal distributions at Point Pelée National Park in July-August of 1971 (M'Closkey, 1971), three study areas were selected and live-trapped in the summer, 1972. These plots encompassed different successional stages and included an orchard (300 m. S. of Nature Centre), a deciduous forest (50 m. S. of Nature Centre), and an old field (50 m. E. of Service Compound). Grids of 15 m intervals were established, and traps were set at the intersections of the grid lines. There were a total of 110 stations in the orchard, 64 stations in the forest, and 66 stations in the old field. Live-trapping was conducted in June and August in the orchard and forest, and in August in the old field. The traps used were single-catch Sherman traps, baited with a mixture of peanut butter and Quaker Oats. However, only peanut butter was used when fecal samples were collected. All traps were set at dusk and checked at dawn. Fecal pellets were removed from the traps, placed in plastic vials, and stored in a freezer. All animals were marked either with ear tags or by toe-clipping as described by Blair (1941). During a check of the trap grid, species identification number and trap station were recorded as well as pelage colouration and sexual condition.

Vegetation samples were collected in all plots during the middle of the summer. Sample quadrats were placed randomly (with a random numbers table) in each habitat using the trap stations as sample areas. Quadrats measuring 1 x 1 m were chosen as a convenient sampling unit (Greig-Smith, 1964). Twelve quadrats were sampled in the orchard, 14 were sampled in the deciduous forest, and 10 quadrats were sampled in the old field. For each quadrat, all plant material was collected (including root systems), separated into individual species, bundled in the field, and quickly frozen in plastic bags to avoid desiccation. In the laboratory, each set of quadrat samples were analyzed separately. Wet weights of individual plant species were measured to 0.1g. Weights of each species over all quadrats in the same plot were combined. The plants were then ranked in decreasing order of abundance according to biomass.

Food Analysis

Techniques of food analysis were patterned after those of Dusi (1949), Williams (1962), and Meserve (1971). Permanent slide mounts were made from plant material which had been collected from the field. Strips of epidermis were removed from roots, stems, petioles, seed coats, and abaxial and adaxial portions of leaves. This was done either with forceps or by scraping epidermal cell layers with a scapel (Baumgartner and Martin, 1939; Dusi, 1949, 1952). These strips were fixed in formalin-aceto-alcohol (FAA), dehydrated in ethanol (EtOH), stained with Toluidine Blue, and cleared in xylene. Prepared material was mounted in permount. Examination of these plant slides at 100x revealed recognizable features. A key was developed for dicots based on general cell shapes, size and shape of guard cells, and the presence or absence of hairs, spines and crystalline inclusions. Stomate structure proved to be a confusing feature. For monocots, appearance of walls of the long cells, and the shapes, sizes and spatial relationships of siliceous and suberified cells, were used as important diagnostic features.

Temporary slide mounts were made of fecal pellets after treatment with a clearing and staining solution composed of 100 ml each of glycerol, lactic acid and phenol (100 g in 100 ml of distilled water) and 3 ml of 1% toluidine blue (Meserve, 1971). Williams (1962) found permanent unstained mounts to be both unsatisfactory and indistinguishable. Pellets collected from each rodent per trap were counted and placed in separate glass vials. Three drops of staining and clearing solution were added per fecal pellet, and the samples in each vial were macerated to the same consistency with a fine glass stirring rod. Ten drops of macerated fecal pellet material were added to each slide, and all fragments of food items were counted at 100 x over a field of 20 mm. A grid slide was used when counting the epidermal fragments.

Data Analysis

A comparison of the plant frequency measurements with those plant items available, based on biomass, is determined utilizing an index of similarity. A number of indices are presently available for use as empirical measurements of overlap. All are sensitive to measuring the proportional compositions of the samples compared (Morisita, 1956; MacArthur, 1965; Horn, 1966). Overlap can be represented by the following computational formula where Ro is calculated directly from the diet counts and sample biomass counts of each plant species.

$$\text{Overlap} = \frac{\sum (x_i + y_i) \log (x_i + y_i) - \sum x_i \log x_i - \sum y_i \log y_i}{(X + Y) \log (X + Y) - X \log X - Y \log Y}$$

where x_i represents the plant frequency, y_i represents the measured biomass of each plant species, and

$$X = \sum_i^n x_i, \text{ and } Y = \sum_i^n y_i .$$

The index of overlap is also used to compare the similarity of diets of two species of rodent. A comparison of the diets of two congeneric species of rodent, Peromyscus maniculatus and P. leucopus is made where both occur together.

In addition to the measure of overlap, a measurement of niche breadth has been proposed,

$$B = \frac{1}{\sum p_i^2}$$

where p_i is the proportion of the total in the i^{th} category

(Levins, 1968). In this study p_i represents the proportion of the i^{th} plant species. This measurement is suitable since it gives the niche breadth equal to N for N equally used resources.

For comparing niche breadths by Levins' formula, it is usually necessary to divide the measurement B by the number of food categories available, since the number of categories is arbitrary. In the old field this is not necessary since the number of food categories available are the same for P. leucopus and P. maniculatus. However, the categories are not equally available, thus the ratio of the frequency of different items in the diet (y_i) to the biomass (x_i) was computed. These ratios y_i/x_i are summed over all categories and each ratio is calculated as a proportion of the total. These weighted proportions are used in the computation of niche breadth.

RESULTS

Food Habits

The percent of unidentifiable fragments ranged from 14.6% to 26.2%. Invertebrates comprise a large portion of the identified items. For P. leucopus the values ranged from 25.4% in the orchard (Table 1) to 48.9% in the deciduous forest (Table 2). The deer mouse diet in the old field was almost exclusively invertebrates (77.1%)(Table 3).

Table 1. Plant availability, and per cent relative volumes of food items in the diet of *P. leucopus* (orchard), 1972

Food items	Availability (g.)	Relative volumes (%) June	August
Poa glauca	4272.6	8.8	7.3
Solidago canadensis	522.1	---	0.5
Glycine max	365.1	---	2.4
Rhus typhina	349.2	9.9	39.0
Cornus stolonifera	337.6	0.6	---
Melilotus alba	205.2	---	1.0
Rhus aromatica	170.6	6.4	0.5
Vitis riparia	162.2	11.7	14.6
Celastrus scandens	154.3	---	1.5
Rhus radicans	147.1	11.7	0.5
Asclepias syriaca	97.2	---	4.9
Lithospermum canescens	64.5	10.5	---
Verbascum thapsus	27.2	2.9	---
Polgonatum pubescens	8.7	---	---
Cercis canadensis	---	7.0	1.5
Endogone	---	4.7	1.0
Invertebrates	---	25.7	25.4

Table 2. Plant availability, and per cent relative volumes of food items in the diet of P. leucopus (forest), 1972

Food items	Availability (g.)	Relative volumes (%) June	Relative volumes (%) August
Parthenocissus quinquefolia	1332.5	3.3	---
Campanula americana	1174.2	22.5	19.8
Osmorhiza longistylis	1137.8	6.6	2.8
Geum canadense	876.6	2.7	1.9
Geranium robertianum	560.7	6.0	5.6
Phryma leptostachya	340.9	---	0.5
Vitis riparia	252.3	---	---
Smilax ecirrhata	157.9	---	1.2
Urtica urens	152.6	0.5	4.7
Ribes grossularia	120.0	---	0.5
Stipa avenacea	86.3	4.9	3.8
Rhus radicans	73.7	---	---
Rubus occidentalis	65.0	---	---
Podophyllum peltatum	43.2	1.6	0.7
Polygonatum pubescens	40.6	3.8	2.6
Smilax hispida	27.5	0.5	0.2
Viola pallens	26.8	1.6	0.5
Celtis occidentalis	23.5	1.1	0.5
Quercus rubra	6.5	0.5	---
Carya ovata	5.0	0.5	0.7
Endogone	----	---	5.2
Invertebrates	----	43.4	48.9

Table 3. Plant availability, and per cent relative volumes of food items in the diets of *P. maniculatus* and *P. leucopus* (old field), 1972

Food items	Availability (g.)	Relative Volumes (%) (August) *P. maniculatus*	*P. leucopus*
Asparagus officinalis	1994.7	7.0	3.8
Eupatorium perfoliatum	1696.2	0.4	21.6
Senecio vulgaris	1060.0	---	---
Lactuca scariola	885.9	0.9	---
Melilotus alba	123.7	---	---
Carex cristatella	116.8	1.3	6.5
Rhus typhina	110.0	---	10.8
Vicia cracca	98.3	0.4	---
Trifolium repens	91.1	---	---
Populus deltoides	87.0	---	2.2
Scirpus paladosus	76.5	3.5	6.5
Salix interior	60.8	---	2.2
Verbena hastata	27.9	2.6	5.9
Conyza canadensis	15.7	0.9	---
Carex --------	13.7	2.2	---
Solunum nigrum	10.8	---	---
Endogone	------	3.5	---
Invertebrates	------	77.1	40.5

A list of the food items eaten by *P. leucopus* is given in Table 1 (orchard). The seven major plants eaten in June were *Poa glauca*, *Rhus typhina*, *Rhus aromatica*, *Vitis riparia*, *Rhus radicans*, *Lithospermum canescens*, and *Cercis canadensis*. These totaled 66% of the diet with the relative contribution of each item approximately the same, ranging from 6.4% to 11.7%. In contrast, the three major plants, *P. glauca*, *R. typhina* and *V. riparia* comprised 61% of the diet during the month of August. This indicates a reduction in the number of major foods eaten, as well as an increase in the relative volumes of *R. typhina*.

Endogone, a fungus belonging to the family Endogonaceae, was consumed during both time periods with observed values of 4.7% and 1.0%. While *Endogone* may comprise as much as 20% of the diet in many small mammals (Diehl, 1939; Calhoun, 1941; Jameson, 1952; Dowding, 1955; Bakerspigal, 1956; Williams and Finney, 1964), Whitaker (1962) reported values of 1.1% in the diet of *P. leucopus*. Availability of alternative food sources and the season were important in determining the volume observed.

Invertebrates made up 25.7% and 25.4% of the diet for *P. leucopus* in June and August, respectively, and values as high as 83% have been reported (Hamilton, 1941). For the deciduous forest plot (Table 2), the relative contributions of invertebrates was approximately double that found for *P. leucopus* in the orchard (Table 1).

The most important items in the diet of forest P. leucopus include Campanula americana, Osmorhiza longistylis, Geranium robertianum, Urtica urens, Stipa avenacea, and Polygonatum pubescens (Table 2). The above plants comprise approximately 44% and 39% of the foods eaten in June and August respectively. Endogone appeared only in the late summer diet.

P. maniculatus and P. leucopus diets are listed in Table 3 for the old field. Only an August breakdown of food items is given as samples were not collected during the month of June. The following herbs are important foods for both species: Asparagus officinalis, Eupatorium perfoliatum, Carex cristatella, Scirpus paladosus, and Verbena hastata. These formed 14.8% of the deer mouse and 44.3% of the white-footed mouse diets. The results of a test of diet overlap between species will be referred to later.

Dietary Overlap Between Species

To measure the amount of dietary overlap between P. leucopus and P. maniculatus in the old field, the food items are expressed as the proportions of the total diet taken from various taxonomic categories. Only plant items are considered when computing an overlap value since availability measures of invertebrates were not taken. Horne's

(1966) information theory measure of overlap was applied. The index of overlap (Ro) varies from zero, when the dieatary items are completely distinct (containing no plant items in common), to one (1.0), when the items are identical with respect to proportional contribution. Computation of diet overlap in the old field yields intermediate values (Ro = 0.54). Other reported values for Peromyscus ranged from 0.89 to 0.96 (P. maniculatus and P. eremicus), and those for P. maniculatus and P. californicus varied from 0.35 to 0.80 (Meserve, 1972).

Observed and Available Diet

The degree of overlap between the biomass of plants and the occurrence of these items in the diet was tested. A summary of biomass-diet overlap is given in Table 4. Correlation analysis was performed to determine if foods were consumed in proportion to their biomass. No correlations were found between raw diet counts and biomass for forest P. leucopus either in June ($r = 0.467$, $.05 < p < .10$) or, in August ($r = 0.461$, $.05 < p < .10$). Similarly, no significant correlations were found between diet counts and biomass for orchard P. leucopus in June ($r = 0.201$, not significant), or in August ($r = 0.068$, not significant). Non-significant correlations were observed for the deer mouse ($r = 0.378$, not significant) and the white-footed mouse ($r = 0.233$, not significant) in the old field.

Table 4. Biomass-Food Overlap (Ro) in plots 1, 2 and 3 (1972).

Plot	June	August	
Orchard (1)	0.66	0.60	
Forest (2)	0.49	0.83	
Old Field (3)	----	0.76	*0.71

* Value for P. maniculatus

Quadrat Measurements

The frequency of contact of a rodent with any one plant species increases with a greater distribution of that plant species. The quadrat data were analyzed, and the degree of distribution of a plant species was determined by considering the number of sample quadrats in which it was found. In the orchard, P. leucopus diet and plant distributions (quadrats) were correlated during the months of June and August ($r = 0.65$, $p < .05$, Fig. 1a; $r = 0.68$, $p < .05$, Fig. 1b respectively). For the deciduous forest, similar relationships between diet frequency and plant species frequency (quadrats) were observed ($r = 0.76$, $p < .01$, Fig. 2a; $r = 0.64$, $p < .01$, Fig. 2b). In the old field, significant correlations were found between diet and plant frequency (quadrats) for P. maniculatus ($r = 0.64$, $p < 0.05$, Fig. 3a) but, not for P. leucopus ($r = 0.06$, not significant, Fig. 3b).

Distributions of plant species in the plots were also analyzed for correlations between rodent activity (number of captures) and specific plant types at the trap stations. Previously, the distribution and abundance of small rodents have been explained on the basis of plant composition and structural habitat. For the white-footed mouse, patterns of local distribution and abundance were correlated with habitat structure (M'Closkey and Lajoie, 1975). Cover,

Figure 1a. Relationship between the frequency of plants in the diet of *P. leucopus* and the quadrat frequency in the orchard during June. The correlation coefficient ($r=0.65$) is significant at $p<0.05$.

Figure 1b. Relationship between the frequency of plants in the diet of *P. leucopus* and the quadrat frequency in the orchard during August. The correlation coefficient ($r=0.68$) is significant at $p<0.05$.

FIGURE 1a

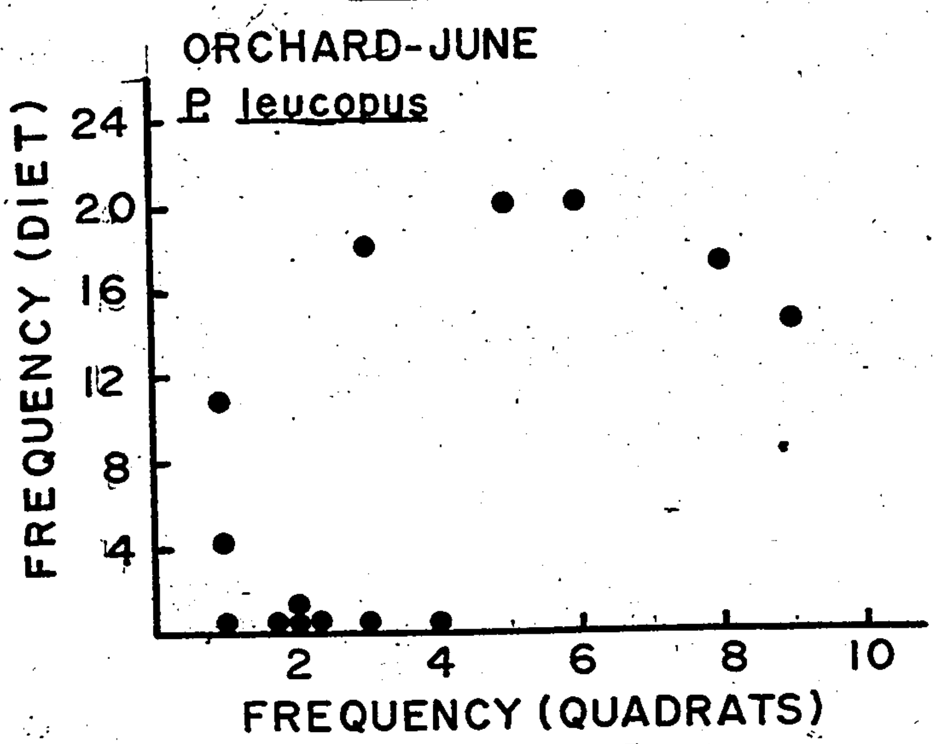


FIGURE 1b

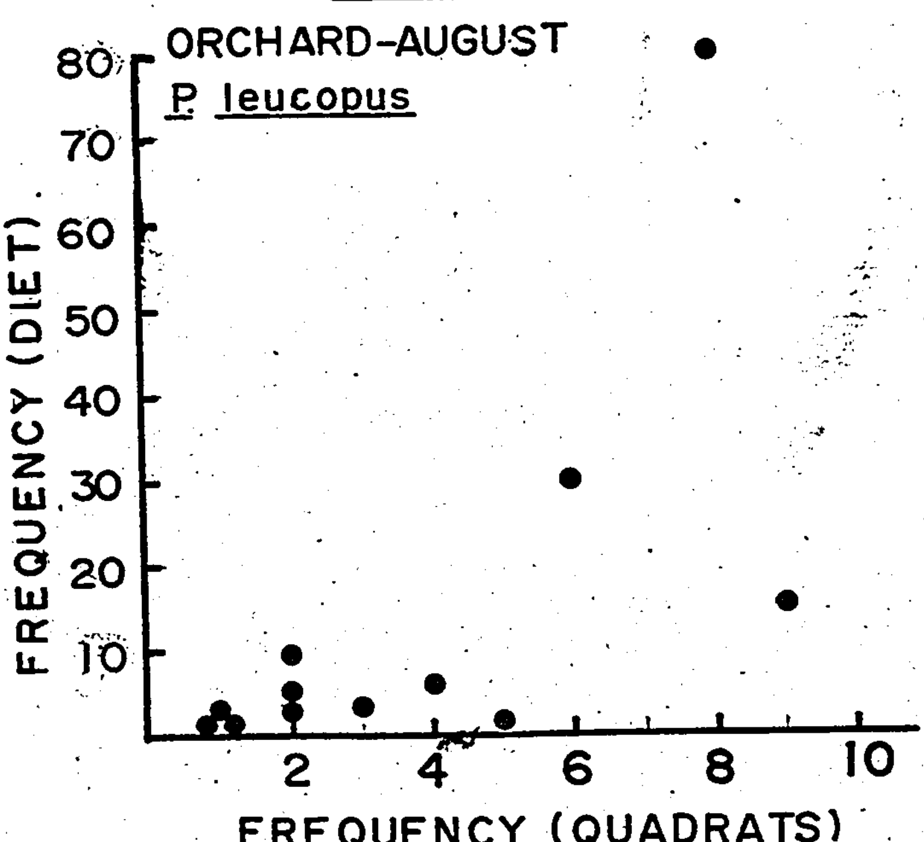


Figure 2a. Relationship between the frequency of plants in the diet of P. leucopus and the quadrat frequency in the forest during June. The correlation coefficient ($r=0.76$) is significant at $p<0.01$.

Figure 2b. Relationship between the frequency of plants in the diet of P. leucopus and the quadrat frequency in the forest during August. The correlation coefficient ($r=0.64$) is significant at $p<0.01$.

FIGURE 2a

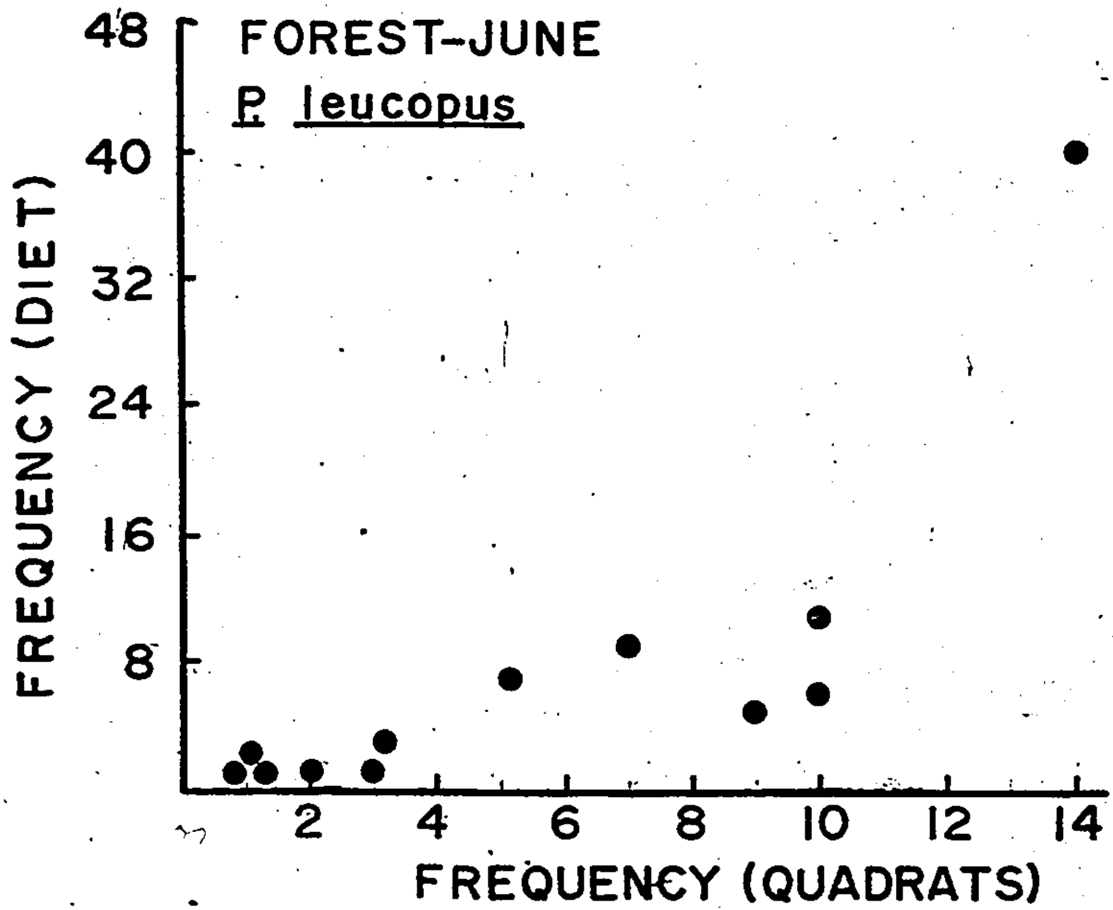


FIGURE 2b

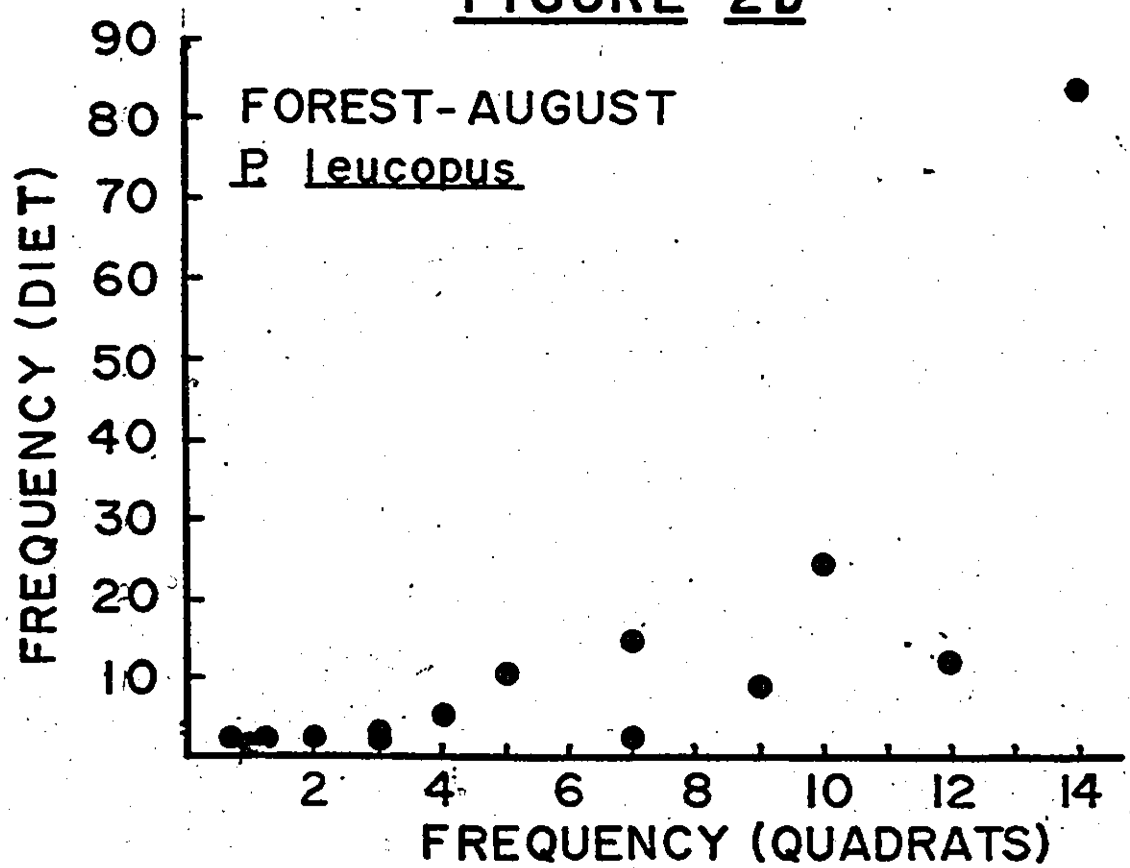


Figure 3a. Relationship between the frequency of plants in the diet of *P. maniculatus* and the quadrat frequency in the old field during August. The correlation coefficient (r=0.64) is significant at $p<0.05$.

Figure 3b. Relationship between the frequency of plants in the diet of *P. leucopus* and the quadrat frequency in the old field during August. The correlation coefficient (r=0.06) is not significant.

FIGURE 3a

OLD FIELD - AUGUST

P. maniculatus

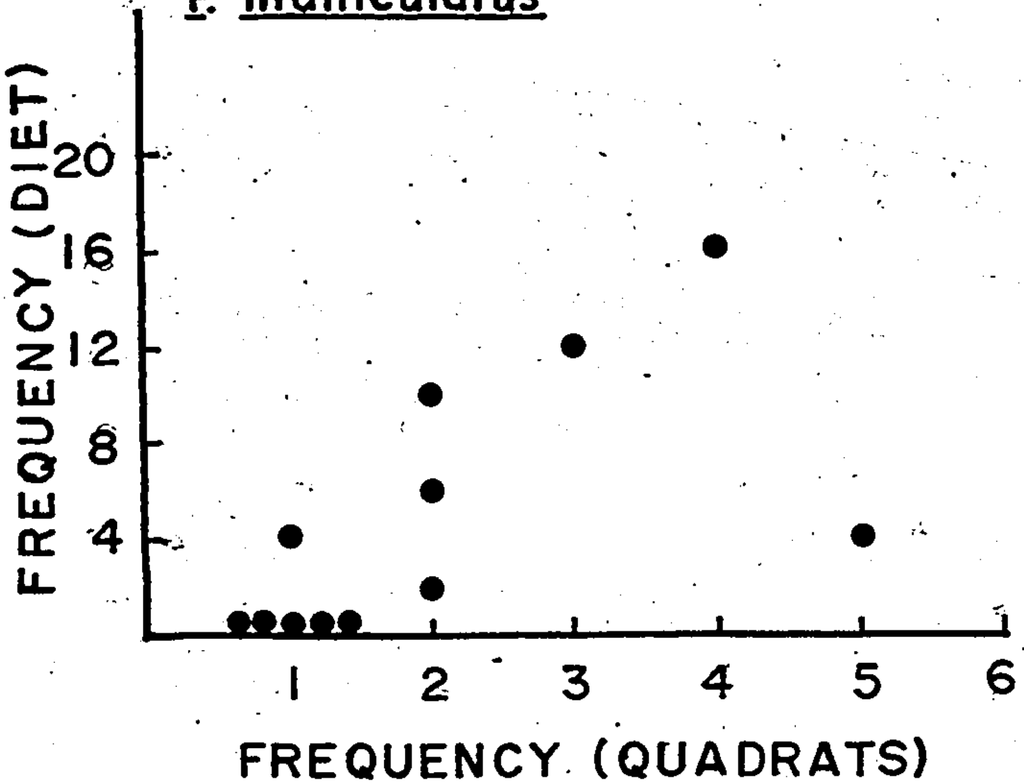
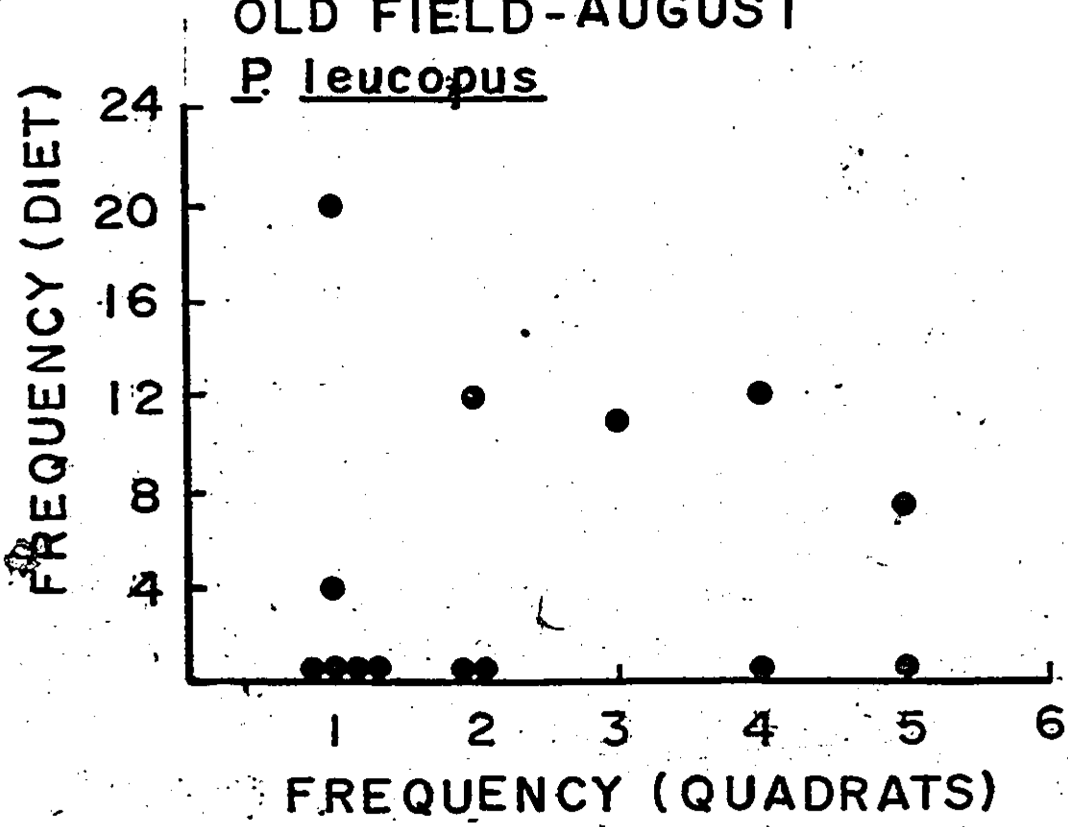


FIGURE 3b

OLD FIELD - AUGUST

P. leucopus



which is a subjective measure of the proportion of ground shadowed by plants, was an important variable for the grassland vole, Microtus ochrogaster (Batzli, 1968). Getz (1961) suggested a definite correlation between M. pennsylvanicus and amount of cover, but no correlation was found between M. ochrogaster and cover type.

The importance of various plant species to P. leucopus and P. maniculatus activity was considered. For example, Rhus typhina and Vitis riparia comprise 9.9% and 11.7% by volume of the total diet in June (Table 1), yet these plants are relatively low in biomass (rare). Greater rodent activity would be expected at those trapping stations where these plants occurred since they must contribute significantly to the diet. A significant difference in means of rodent captures ($p<0.05$) was noted between trap stations containing Rhus typhina and Vitis riparia and trapping stations in which these two species were absent (Table 5).

Niche Breadth

Food niche breadth is a measure of the number of food categories and the proportional contribution of each to the diet. Standardized niche breadths are computed for individual rodents, and are averaged for the total number of mice sampled in each plot (Table 6). P. maniculatus had the lowest breadth and there was a significant difference

Table 5. Rodent activity vs. the presence or absence of *Vitis riparia* and *Rhus typhina* (1972).

Vitis riparia and *Rhus typhina*	mean* captures/station	mean* individuals/station
Present	1.4	1.2
Absent	0.25	0.25

* means ($\bar{X}$) for presence and absence are significantly different ($t=2.14$, $p<0.05$).

Table 6. Mean food niche breadth (standardized), 1972.

Plot	June	August	
	P. leucopus	*P. leucopus*	*P. maniculatus*
	$\bar{X}$ ± S.E. of the mean	$\bar{X}$ ± S.E. of the mean	$\bar{X}$ ± S.E. of the mean
Orchard	1.70 ± .13	1.44 ± .11	----------
Forest	1.39 ± .08	1.62 ± .09	----------
Old Field*	----------	1.67 ± .16	1.22 ± .08

* significant difference, $p<0.05$
(*P. leucopus* and *maniculatus*).

($p<0.05$) between mean individual breadths for *P. leucopus* and *P. maniculatus* in the old field.

DISCUSSION

Technique

A number of different techniques have been used to gather information on the food habits of small mammals. In fecal analysis, the most common evaluation procedure is the "frequency" method which gives a reliable estimate of diet composition (Hansson, 1970).

Measured deviations of the plant items in the diet may arise due to the different rates of passage of various foods along the digestive tract. Generally, the larger and harder food items are passed through slowly. Biochemically, carbohydrates ~~pass~~ most rapidly and fat slowest through the intestines. Therefore, inaccuracies in estimating certain items may be present.

Seasonal changes in recognizability of food items may result as the plants undergo an increase in size and lignifica~~tion and,~~ a concomitant change in their digestibility. In addition, differences in recognizability of the same plant species fed to various herbivores has been demonstrated (Stewart, 1967). Therefore, food items in the diet may be mis-represented in some cases depending on their digestibility, recognizability, varying retention rates, and seasonal attributes.

Familiarity with diet micro-analysis technique results in the gradual improvement of the capacity to recognize diet itmes. This personal bias can be alleviated somewhat by taking a number of trial counts prior to actual data collection. Identification of the number of items varies with different ocular magnifications and with increased field area. This necessitates that a standard magnification and field area be used and reported (Hansson, 1970). Inconsistent technique may lead to differential mechanical fragmentation of food items and, a biased estimate of fragmented material. A check for inconsistency of fragmentation was carried out by comparing the raw diet counts (frequency) to the area measurement of individual diet items. In all cases, the measurements were highly correlated suggesting homogeneity of fragmentation.

The quadrat technique for sampling plants is not without error. It is possible for a plant species to have the same frequency in different communities, but, concurrently, to exhibit either different spatial distribution of different density. In addition, visual estimates of the plant species assume constant growth forms and distributions. An attempt to circumvent subjective visual measurements was made by scaling each plant species on the basis of biomass measurements. This method may be analagous to the visual estimate method if there is a positive correlation between density and biomass. Some obvious exceptions would occur with woody plants having large biomass per shoot but not necessarily high population density.

Niche Breadth and Overlap

Measures of plant species-diet overlap in all plots ranged from 0.49 to 0.83 (Table 4). The greatest temporal difference was noted in the forest. Plant-diet overlap was approximately the same for *P. leucopus* and *P. maniculatus* in the old field. The overlap values are indicative of the way in which the food resource is utilized. A high value means the food items are searched and eaten in the proportion in which they occur. The lower value indicates a preference, with some plants not eaten at all or at least not in the proportion found.

In the orchard, there is a predilection for *Rhus typhina*, *Vitis riparia*, *Rhus radicans* and *Lithospermum canescens* during summer. The highest plant frequencies are not matched by the largest relative volumes in the diet. In the forest, the largest biomass represented by plants such as *Campanula americana*, *Osmorhiza longistylis* and *Geranium robertianum* make up a large proportion of the diet (35.1% and 28.2%). In the old field, the largest frequency of plant material in the diet corresponds with the highest availability. However, there is some preference for Scirpus paladosus and Verbena hastata by P. maniculatus and P. leucopus. Rhus typhina was preferred by P. leucopus.

Plants with high preference, but low biomass revealed greater P. leucopus activity. Correlations of activity with floristic composition were not found in either the forest or the old field. With the exception of Rhus typhina, plants with low availability were not highly preferred in the old field.

A plot of diet frequency against plant frequency avoids considering whether the rodents are food specialists or generalists. Those food items which are widely distributed appear most frequently in the diet regardless if they are rare or common as determined by biomass measurement (Fig. 1a, 1b; 2a, 2b; 3a). The only exception arises with P. leucopus in the old field (Fig. 3b). This could be due to small sample size.

Measurements of mean food niche breadth for P. leucopus and P. maniculatus was determined by combining individuals of the respective local populations. In this manner, the food niche is treated like a gene pool since it is a property of a set of individuals. P. maniculatus has a smaller food niche breadth than P. leucopus in all plots during all time periods. The most important observation is that the breadths are significantly different while the two species were co-occurring in the old field (Table 6). Food niche overlap between the two congeners revealed an intermediate value of 0.54. Assuming that local competition for food exists between the putative competitors P. maniculatus and P. leucopus, a reduction in food niche breadth and overlap might be expected. Unfortunately, the general relationship of overlap to competition is not very clear. Arguments have been presented implying niche overlap as evidence for or against the existence of competition (Colwell, 1971). An examination of invertebrate diets may help explain the co-occurrence of these two species. P. maniculatus ate a larger proportion (77.1%) of invertebrates than P. leucopus (40.5%).

Evidence for P. leucopus influencing the niche breadth of P. maniculatus is debatable. P. leucopus exhibits a flexibility of niche breadths between seasons and habitats in the forest and orchard (Table 6). The value for the old field P. leucopus is within that range. The possible influence of one species on another should be examined more closely by removing the suspected competitor (either P. leucopus or P. maniculatus) and observing changes in niche breadth and overlap.

SUMMARY

1) To study the food habits of two congeneric rodent species, Peromyscus leucopus and Peromyscus maniculatus, 3 study plots were established in Point Pelee National Park, southwestern Ontario during June and August, 1972.

2) Invertebrate composition of P. leucopus diets ranged from 25.4% to 48.9%. P. maniculatus had an invertebrate diet of 77.1%.

3) P. leucopus prefer Vitis riparia (rever-bank grape), Rhus typhina (staghorn sumac), Campanula americana (tall bellflower), and Eupatorium perfoliatum (thoroughwort).

4) Observed and available diet overlap ranged from 0.49 to 0.83 with the greatest temporal difference noted in the forest. P. leucopus and P. maniculatus had a plant-diet overlap of 0.76 and 0.71 in the old field.

5) Correlations were found between distributions of plant species and frequency of occurrence in the diet.

6) Greatest P. leucopus activity (captures) was correlated with the presence of Vitis riparia and Rhus typhina in the orchard plot.

7) Levins' diversity formula $\frac{1}{\sum P_i^2}$ was used to quantify mean food niche breadths for the species. P. leucopus

means ranged from 1.39 items to 1.96 items and those of *P. maniculatus* averaged 1.22 items. Mean food breadths were significantly different for *P. leucopus* and *P. maniculatus*.

8) An intermediate food niche overlap value of 0.54 was recorded between *P. leucopus* and *P. maniculatus* in the old field.

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APPENDIX A

TABLE 1

PLANT SPECIES LIST FOR THE STUDY PLOTS

PLOT NUMBER	PLANT SPECIES
1 (ORCHARD)	Poa glauca, speargrass Solidago canadensis, goldenrod Glycine max, soy-bean Rhus typhina, staghorn sumac Cornus stolonifera, red-ozier dogwood Melilotus alba, white sweet clover Rhus aromatica, fragrant sumac Vitis riparia, river-bank grape Celastrus scandens, bettersweet Rhus radicans, poison ivy Asclepias syriaca, milkweed Lithospermum canescens, hoary puccoon Verbascum thapsus, mullein Polygonatum pubescens, Solomon's seal Smilacina racemosa, false spikenard Cercis canadensis, red-bud Gymnocladus dioica, kentucky coffee-tree Galactia volubilis, downy milk-pea Pyrus malus, apple Juniperus virginiana, red cedar
2 (FOREST)	Parthenocissus quinquefolia, virginia-creeper Campanula americana, tall bellflower Osmorhiza longistylis, anise-root Geum canadense, white avens Geum virginianum, rough avens Geranium robertianum, Herb-Robert Phryma leptostachya, lopseed Vitis riparia, river-bank grape Smilax ecirrhata, greenbrier Urtica urens, burning nettle Bochmeria cylindrica, false nettle Ribes grossularia, European gooseberry

TABLE 1 (continued)

PLOT NUMBER	PLANT SPECIES
	Stipa avenacea, needle grass Rhus radicans, poison ivy Podophyllum peltatum, may apple Polygonatum pubescens, Solomon's seal Smilax hispida, true Smilax Viola pallens, northern white violet Celtis occidentalis, hackberry Quercus rubra, red oak Carya ovata, shagbark hickory Tulipa sylvestris, tulip tree Tilia americana, basswood Juglans nigra, black walnut
3 (OLD FIELD)	Asparagus officinalis, asparagus Eupatorium perfoliatum, thoroughwort Senecio vulgaris, ragwort Lactaca scariola, prickly lettuce Melilotus alba, white sweet clover Carex cristatella, crested sedge Rhus typhina, staghorn sumac Vicia cracca, cow vetch Trifolium repens, bea clover Populus deltoides, cotton-wood Scirpus paladosus, bayonet grass Salix interior, sandbar willow Verbena hastata, blue vervain Conyza canadensis, horseweed Carex -----------, Carex (sp. unknown) Solunum nigrum, night shade Trifolium pratense, red clover Solidago canadensis, goldenrod Rumex crispus, curled dock

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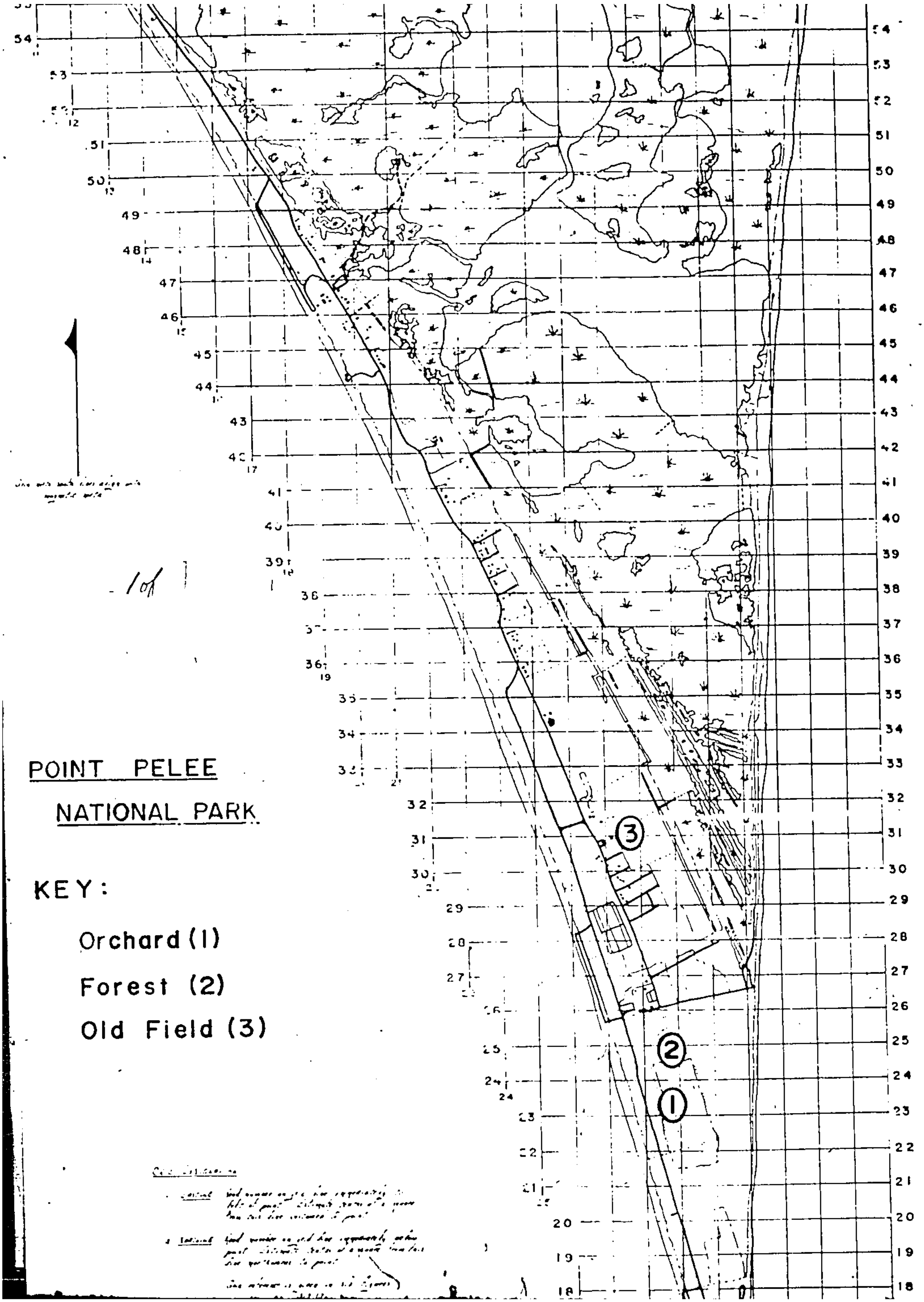
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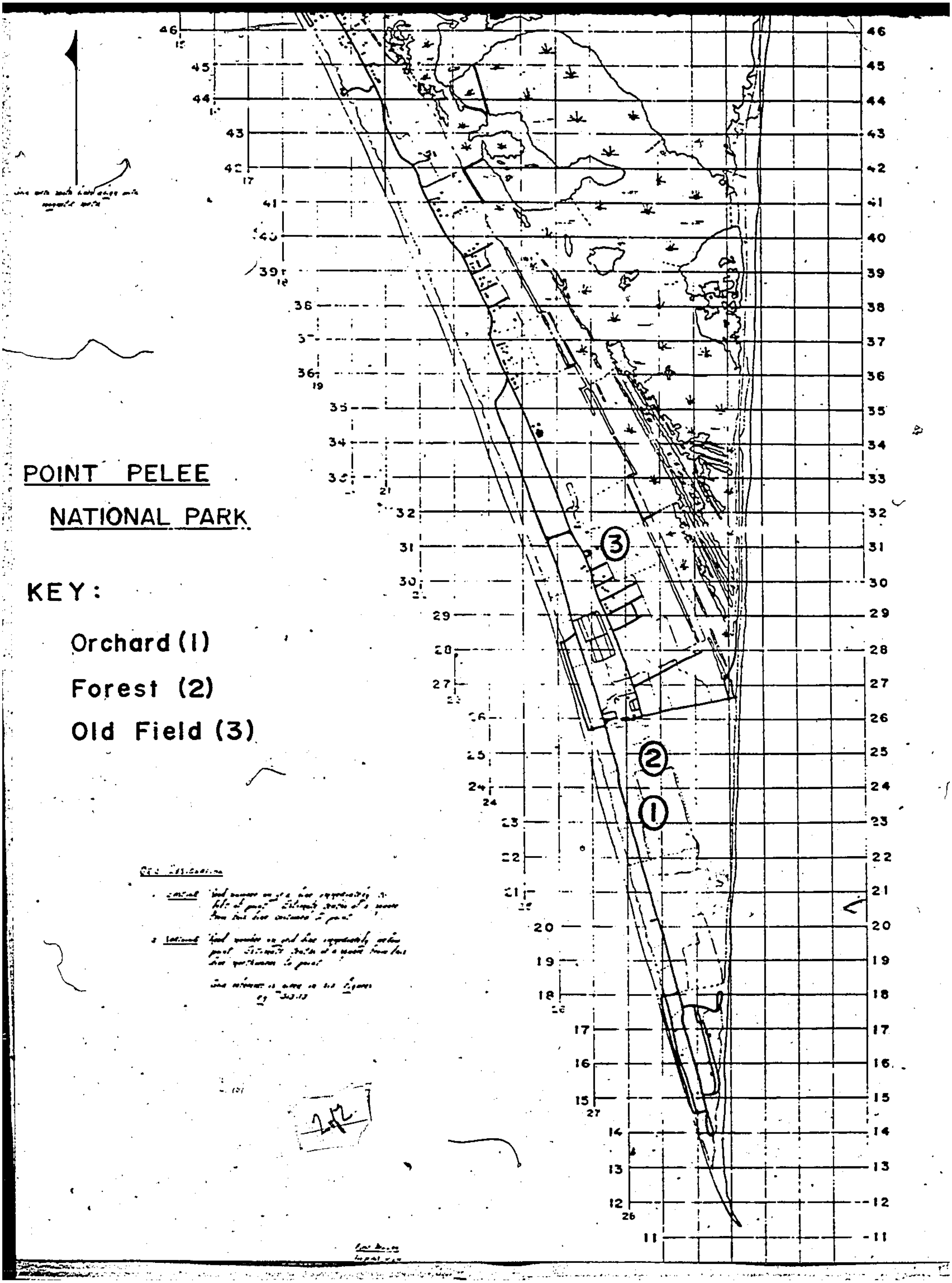
KEY:
Orchard (1)
Forest (2)
Old Field (3)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NATIONAL PARK
KEY:
Orchard (1)
Forest (2)
Old Field (3)
3
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