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MAN AS A MAKER OF NEW PLANT COMMUNITIES

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SUMMARY

(1) Fourty-four sites, dispersed throughout an urban area in Ohio were sampled for their arboreal vegetation.

(2) Ordination of the sites yielded five major community types: an inner city complex, a maple complex, a conifer complex, a mixed suburban complex and an old oak complex.

(3) Correlation analysis and an overlay of various socio-economic variables on the basic site ordination revealed some of the major cultural factors structuring the urban landscape.

(4) In the city, changing patterns of landscape taste and fashion, correlated with various socio-economic variables, appear to have been the primary factors responsible for the ordering of plants into specific associations.

INTRODUCTION

Edgar Anderson (1956) once commented that whole landscapes are now occupied by man-dominated (and in part by man-created) floras. Man has been the primary agent in the creation of new plants and new plant communities. While research on the domestication of many crop species would easily fill several volumes, little attention has been given to the creation of new plant communities. This is particularly surprising given man's intimate association with the artificial plant communities of urban areas. Although the urban forest is limited to approximately 28×10^6 ha, roughly 3% of the land area of the United States of America (Grey & Deneke 1978), it is the habitat of 73·5% of the total population of the United States (U.S. Bureau of the Census 1973).

Despite a growing interest in man-induced modifications of natural ecosystems, little is known of the actual structure of urban ecosystems, or the processes responsible for their development. The urban forest represents a relatively inhospitable environment. Toxic substances, compaction, paving, and modification of urban soils, the disruption of normal nutrient cycles and radiant energy transfer mechanisms, all constitute important limiting factors. Environmental constraints, however, represent only one of a constellation of factors influencing the design and composition of the urban plant community. An understanding of the structure and dynamics of urban plant communities must ultimately be based on an understanding of the socio-cultural processes governing the selection and disposition of the flora. Unfortunately, the available American literature in this field is rather limited. Some of the recent analyses of residential neighbourhoods in Chicago, Illinois (Schmid 1975) and Berkeley, California (Derrenbacher 1969) have at least

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focused attention on the more important socio-economic determinants of urban plant communities. In the selection of street and shade trees, changing patterns of fashion and taste have added a temporal dimension to the problem. 'Within the city as elsewhere, sight and history result in an ordering of plants into associations and successional patterns' (Stearns 1972).

The following study represents an attempt to delineate the arboreal plant communities of a representative midwestern urban area and to outline the factors which have been instrumental in the design of urban plant communities.

MATERIALS AND METHODS

The study area

Situated on the glaciated Appalachian plateau area of northeastern Ohio, Akron is part of the larger Cleveland-Akron-Canton-Youngstown urban industrial complex (Pyle 1975). The pre-settlement vegetation of the Akron area reflected the underlying topographic and substrate diversity characteristic of the southern extremity of the glaciated plateau. Dry mixed oak forests, composed of *Quercus rubra*, *Q. alba*, and *Q. velutina*, dominated most of the area (Gordon 1966). They were inevitably associated with coarse sandy morainal, outwash or kame deposits (Forsyth 1970, White 1953). More mesic conditions favoured the development of mixed mesophytic forests (Gordon 1966). The steep slopes and medium textured alluvial soils of the Little Cuyahoga and Cuyahoga River Valleys supported a diverse community composed of *Fagus grandifolia*, *Acer saccharum*, *A. rubrum*, *Liriodendron tulipifera*, *Magnolia acuminata*, *Quercus alba*, *Q. rubra*, and *Fraxinus americana* (Sampson 1930). Little of the original forest vegetation remains. Due to its highly productive nature (Noble 1975a) much of the land was converted to crop production in the nineteenth century. Second and third growth forests today represent less than 25% of the total land area of the standard metropolitan statistical area (Kingsley & Mayer 1970) and even these remnants are rapidly being converted to urban uses (Hanten 1977).

Sampling design

A wide range of sites was sampled to cover both age of residential area and socio-economic background. The study was limited to Akron, Ohio and the surrounding closely settled territory. Most of the relevant socio-economic information was extracted from the 1970 U.S.D.C. census tract and block data for the Akron urban area (U.S. Bureau of the Census 1971, 1972). Census tracts are defined as small relatively homogeneous socio-economic areas into which large cities and adjacent areas are divided for the purpose of providing comparable small area statistics (U.S. Bureau of the Census 1972). Each of the census tracts was assigned to one of the categories listed in Table 1 with respect to each of three major variables: yearly income, education, and age of development. As the 1970 census did not differentiate between the pre- and post-World War I periods, the age of the pre-1939 developments was based on the architectural styles of the period (Whiffen 1969). Four census tracts were randomly selected as representative of each of the more prevalent combinations of the three major variables, while two census tracts were randomly selected as representative of the rarer combinations, i.e., the specific income, education, and age category was represented by five or fewer census tracts. One block composed largely of single or two-family residential dwellings was randomly selected from each of the previously designated census tracts. In the case of

TABLE 1. Character states of three major socio-economic variables selected for analysis

Income— < \$5000	A
5000– < 10 000	B
10 000– < 15 000	C
10 000– < 20 000	D
> \$20 000	E
Education (years completed)	
8–9	A
10–11	B
12	C
13+	D
Age of development (period during which majority of housing was completed)	
1965–present	A
1940–1964	B
Post World War I–1939	C
Pre World War I	D

variable combinations represented by only one census tract, two blocks were selected from the designated tract. In order to conform to the overall characteristics of the census tract, the study was mainly limited to blocks whose average house value approached the mean value (± \$1000) given for the census tract as a whole. The range was extended to ± \$2000 in the case of several census tracts, where few of the blocks fell within the ± \$1000 range.

Five additional sample blocks were also included in the survey. Two sample sites represented areas of unique historic interest—the Perkins Estate associated with Colonel Simon Perkins, a member of Akron's founding family, and the Fir Hill Area, a mid-town site formerly considered the reserve of many of Akron's leading citizens during the latter part of the 19th century. Three sites were added due to the unique nature of their vegetation. All were representative of the closed landscape tradition (Schmid 1975), i.e., the attempt to build around or preserve the native forest vegetation. Figure 1 shows the resulting geographic distribution of the forty-four blocks or sites which were analysed during the summer of 1978.

Only one side of each block was actually sampled, the selection generally being limited to the longest side of the block. Preliminary data, utilizing a species/area curve, suggested that the longest side of the block provided a relatively reliable subsample of the block's vegetation. Blocks with less than five residential units per side were automatically excluded from consideration. Each of the sample blocks or sites was analysed with respect to its arboreal vegetation. Individual trees were recorded according to species, size (sapling, 2·5–12·5 cm dbh; pole 12·5–28 cm dbh; and mature, > 28 cm dbh). Sampling was limited to the ornamental and shade trees occuring on the front lawn. Trees with a diameter of less than 2·5 cm were excluded from the present study. Botanical nomenclature follows Fernald (1950). In several cases where the species' identity proved difficult, i.e. *Crataegus*, non-native *Juniperus* and non-native flowering *Prunus*, the generic name was used.

Ordination technique

Ordination of the various sites by means of reciprocal averaging provided a convenient means of identifying groups of related sites and species. Reciprocal averaging was used

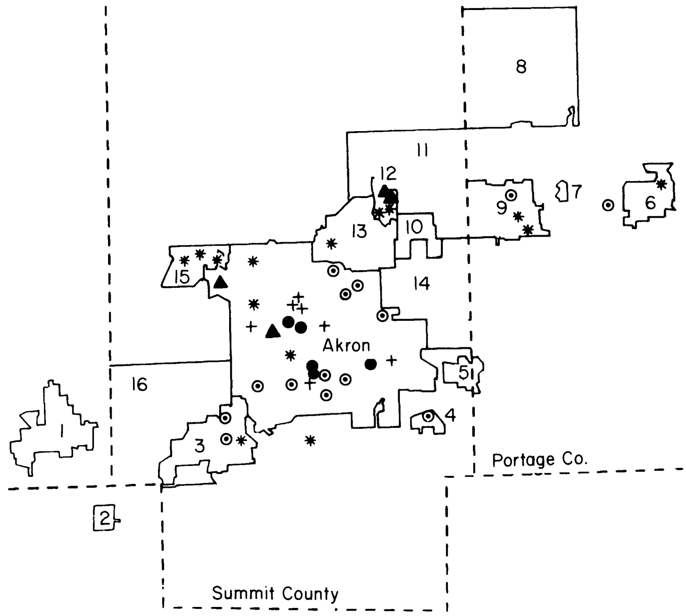

FIG. 1. Location of sample sites: (1) Wadsworth, (2) Doylestown, (3) Barberton, (4) Lakemore, (5) Mogadore, (6) Ravenna, (7) Brady Lake, (8) Streetsboro, (9) Kent, (10) Munroe Falls, (11) Stow, (12) Silver Lake, (13) Cuyahoga Falls, (14) Tallmadge, (15) Fairlawn, (16) Norton. The various complexes are roughly distributed in a concentric manner with the inner city complex (●) giving way to the maple (+), conifer (⊙), mixed suburban (*) and old oak (▲) complexes as the outer limits of the urbanized area are approached.

in the present study because (1) it produces a good species ordination and a site ordination and (2) it is an objective technique of ordination relatively free of distortion characteristic of other commonly employed techniques (Hill 1973; Gauch, Whittaker & Wentworth 1977). The original data matrix consisted of density class values scored as follows: number of trees of a given species noted per block and the associated class score, i.e. 1 tree = 1; 2 trees = 2, 3–4 trees = 3, 5–8 trees = 4; 9–16 trees = 5; and >16 trees = 6. The matrix was limited to those species which were represented by four or more individuals and were noted in at least two sites. All analyses were run on a CDC computer using the reciprocal averaging program (Cornell Ecology Program 20), developed by Hugh Gauch Jr, Section of Ecology and Systematics, Cornell University.

RESULTS AND DISCUSSION

The location of the various species along the two major ordination axes is shown in Fig. 2. Species occurring in roughly the same portion of the two-dimensional coordinate system are also frequently associated in the block samples. Five major community complexes were recognized on the basis of their more representative or characteristic species (Table 2). Character species were defined on the basis of their coordinate positions in the species ordination (Fig. 2). The position of a species in the coordinate system was not always representative of its actual status. This was particularly true of species which occurred in a variety of communities or complexes. *Cornus florida*, for instance, was a

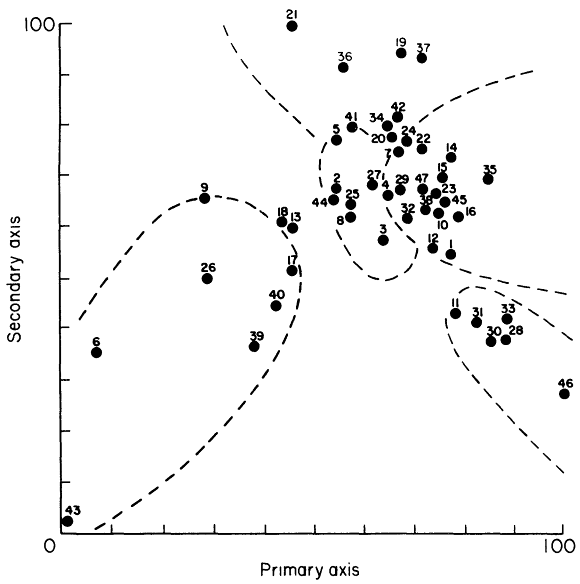

FIG. 2. Species ordination based on residential vegetation occurring in front lawns: (1) *Acer palmatum*, (2) *A. platanoides*, (3) *A. rubrum*, (4) *A. saccharum*, (5) *A. saccharinum*, (6) *Ailanthus altissima*, (7) *Betula pendula*, (8) *Chamaecyparis* sp., (9) *Catalpa speciosa*, (10) *Cornus florida*, (11) *Fraxinus americana*, (12) *Ilex opaca*, (13) *Juniperus* sp. (exotic), (14) *Liquidambar styraciflua*, (15) *Liriodendron tulipifera*, (16) *Magnolia soulangeana*, (17) *Morus alba*, (18) *Picea abies*, (19) *Picea glauca*, (20) *Picea pungens*, (21) *Pinus strobus*, (22) *Pinus sylvestris*, (23) *Prunus* sp. (exotic species, flowering), (24) *Prunus serotina*, (25) *Pyrus malus*, (26) *Prunus persica*, (27) *Pyrus* sp. (crab), (28) *Quercus alba*, (29) *Q. palustris*, (30) *Q. rubra*, (31) *Q. velutina*, (32) *Robinia pseudacacia*, (33) *Sassafras albidum*, (34) *Sorbus aucuparia*, (35) *Taxus* sp., (36) *Thuja occidentalis*, (37) *T. orientalis*, (38) *Tsuga canadensis*, (39) *Ulmus rubra*, (40) *Juniperus virginiana*, (41) *Aesculus hippocastanum*, (42) *Gleditsia tricanthos*, (43) *Prunus domestica*, (44) *Salix fragilis*, (45) *Ulmus pumila*, (46) *Carya ovata*, (47) *Pinus nigra*. Species occurring within an area bounded by dotted lines, are generally indicative or characteristic of a specific complex.

prominent species in both the mixed suburban complex and the old oak complex. As a result it was recognized as a species characteristic of both community types, although its centre of distribution was the mixed suburban complex.

Sites were typed as to their representative complex on the basis of the relative density of the various characteristic species. Each site was classified according to its dominant characteristic species group with a requirement that at least 30% of the total number of individuals recorded belonged to that group. Figure 3 shows the resulting site ordination.

Sample positions on the primary axes were subjected to correlation analysis with known socio-economic variables. Median family income, for instance, was positively correlated ($P < 0{\cdot}001$) with the primary axis position of the various sites. The relationship is $Y = 2540 + 136{\cdot}6x$ ($r = 0{\cdot}662$) where Y = median family income in dollars for calendar year 1969 and x = primary axis position. Average owner house and lot value as defined in the 1970 block statistics was also positively associated ($P < 0{\cdot}001$) with the primary axis position. In this case, however, a linear transform of the exponential function $Y = 5639e^{0{\cdot}018x}$ where Y = dollar value of house and lot and x = primary axis position, provided the best fit ($r = 0{\cdot}71$). As has been the case in many studies employing reciprocal averaging as an ordination technique (Noy-Meir & Whittaker 1977), the

TABLE 2. Species characteristic of the five major complexes. Number in parentheses indicates location on species ordination given in Fig. 2

Inner city	Maple	Conifer	Mixed suburban	Old oak
Ailanthus altissima (6)	*Acer platanoides* (2)	*Juniperus* sp. (exotic) (13)	*Acer palmatum* (1)	*Carya* sp. (46)
Catalpa speciosa (9)	*A. pseudoplatanus*	*Juniperus virginiana* (40)	*A. saccharum* (4)	*Cornus florida* (10)
Juniperus sp. (13, 40)	*A. saccharinum* (5)	*Picea abies* (18)	*Betula pendula* (7)	*Fraxinus americana* (11)
Morus alba (17)	*A. saccharum* (4)	*P. glauca* (19)	*Cornus florida* (10)	*Quercus alba* (28)
Prunus domestica (43)		*P. pungens* (20)	*Gleditsia tricanthos* (42)	*Q. rubra* (30)
P. persica (26)		*Pinus strobus* (21)	*Ilex opaca* (12)	*Q. velutina* (31)
Ulmus rubra (39)		*Taxus* sp. (35)	*Liquidambar styraciflua* (14)	*Sassafras albidum* (33)
		Thuja occidentalis (36)	*Liriodendron tulipifera* (15)	
		T. orientalis (37)	*Magnolia soulangeana* (16)	
		Tsuga canadensis (38)	*Picea pungens* (20)	
			Pinus sylvestris (22)	
			Prunus sp. (flowering) (23)	
			Quercus palustris (29)	
			Robinia pseudacacia (32)	
			Sorbus aucuparia (34)	
			Tsuga canadensis (38)	
			Ulmus pumila (45)	

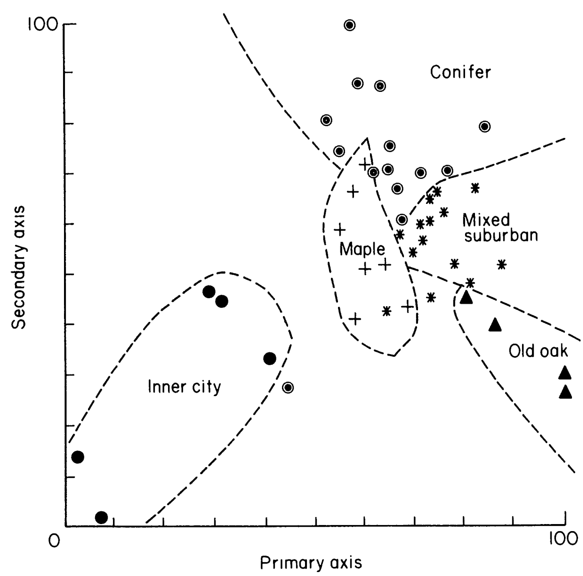

FIG. 3. Site ordination. Sites were classified as to complex type as follows: Inner city (●), Maple (+), Conifer (⊙), Mixed suburban (*), and Old oak (▲).

secondary axis was not directly interpretable, at least in terms of the known social and economic variables. It was, however, roughly correlated with a structural change in the composition of the vegetation. In both the species and the site ordinations, deciduous species were largely relegated to the lower end of the secondary axis while most of the coniferous species and coniferous complexes were clustered at the opposite end of the gradient (Fig. 2).

Composition and characteristics of the five major complexes

The composition of each of the major complexes is summarized in Table 3. Density values were determined by summing the total number of individuals recorded at all of the sites in a specific complex. Frequency values were likewise representative of the percentage occurrence of the species in the designated sample sites, i.e. block samples. The relative density (species density expressed as a percentage of density values for all species) and the relative frequency (species frequency as a percentage of frequency values for all species) values were summed to yield the relative importance value.

Old oak complex

Large extensively wooded lots (Fig. 4) dominated by an overstorey canopy of *Quercus velutina*, *Q. rubra*, and *Q. alba* with an admixture of *Fraxinus americana* and *Acer rubrum*, are representative of the old oak complex. The understorey is largely composed of *Cornus florida* and *Sassafras albidum*. The old oak complex is a direct descendant of the mixed oak forest and to a lesser extent the mixed mesophytic forest. Both the relative size of the trees and the presence of certain indicator species, notably *Fagus grandifolia* and *Carya ovata* are indicative of the natural or residual nature of the vegetation. *Fagus grandifolia* is extremely susceptible to soil compaction and soil disturbances while the strong development of a taproot system makes transplanting difficult in the case of many

TABLE 3. Species composition of five major complexes. Numerical values given only for those species with a relative density value >1%. *Indicates presence of species

	Old oak			Mixed suburban			Conifer			Maple			Inner city		
	Density	Frequency	Importance value	Density	Frequency	Importance value	Density	Frequency	Importance value	Density	Frequency	Importance value	Density	Frequency	Importance value
Abies nordmanniana										2	14	3·2			
Acer palmatum	5	75	4·3			*						*			
Acer platanoides	5	75	4·3	17	57·1	7·7	17	42·8	13·7	41	86	40·8	7	40	11·3
Acer pseudoplatanus										2	14	3·2			
Acer rubrum	39	75	11·0	18	71·4	8·9	9	28·6	8·1				7	40	11·3
Acer saccharum	7	75	4·6	16	50·0	7·5				7	57	12·2			
Acer saccharinum	5	50	3·2	30	71·4	11·6	16	500	14·3	13	86	20·3	7	60	13·7
Aesculus hippocastanum			*							2	14	3·2			
Ailanthus altissima										4	14	4·6	24	100	34·4
Betula pendula				9	35·7	4·5			*						
Chamaecyparis sp.				7	21·4	3·0				2	14	3·2	2	20	4·2
Carya ovata	5	50	3·2												
Catalpa speciosa									*			*	2	20	4·2
Cornus florida	104	100	25·0	50	92·8	20·5	3	14·3	3·4			*			
Fagus grandifolia	7	25	2·4												
Fraxinus americana	42	75	11·6	7	28·6	3·5			*			*			*
Ilex opaca			*	12	21·4	4·1						*			
Juniperus sp. (exotic)			*	13	35·7	5·3	5	21·4	5·3				3	20	5·1
Juniperus virginiana				7	21·4	3·0	3	7·1	2·3						*
Liquidambar styraciflua				6	28·6	3·3									

Liriodendron tulipifera			*	7	35·7	4·0			*						
Magnolia soulangeana	5	50	3·2	9	50·0	6·0			*						
Morus alba										9	43	11·9	3	20	5·1
Picea abies			*			*	18	28·6	12·0	5	71	12·5	7	60	13·7
Picea glauca			*			*	6	21·4	5·8						
Picea pungens	7	100	5·6	40	92·8	15·3	28	50·0	19·5	5	43	9·0			*
Pinus strobus							4	21·4	4·9						*
Pinus sylvestris			*	7	14·3	2·5									
Prunus domestica									*				3	20	5·1
Prunus persica						*							2	40	6·5
Prunus sp. (flowering)	11	50	4·4	9	21·4	3·5	3	21·4	4·5						*
Prunus serotina	12	50	4·6	19	35·7	6·7	7	28·6	7·3	4	14	4·6			
Pyrus malus			*			*			*			*	2	40	6·5
Pyrus sp. (crab)			*	15	50·0	7·3	5	21·4	5·3	3	28	5·7			
Quercus alba	27	75	8·6			*			*						
Quercus palustris	29	75	9·1	17	78·6	9·2	4	21·4	4·9	6	14	6·2			*
Quercus rubra	23	100	8·9			*									
Quercus velutina	41	100	12·5							9	28	10·1			
Robinia pseudacacia			*			*				2	14	32			
Sassafras albidum	54	100	15·0												
Sorbus aucuparia			*			*	3	14·3	3·4			*			
Taxus sp.	6	50	3·4			*	9	14·3	5·9						
Thuja occidentalis				32	78·6	12·5	65	85·7	40·6	8	71	14·7	5	20	7·1
Thuja orientalis				11	21·4	3·9			*						
Tilia americana													3	20	5·1
Tsuga canadensis	14	50	5·0	35	50·0	11·7	5	21·4	5·3	2	28	5·0			
Ulmus rubra						*			*				13	40	17·0

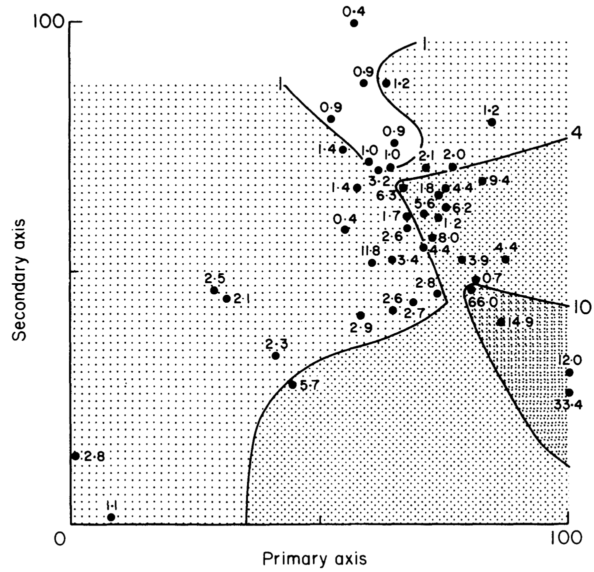

FIG. 4. Overlay of tree density on basic site ordination. Values indicate number of trees per yard.

of the native oaks and hickories (Elias & Irwin 1976, Zion 1968, Wyman 1951). Although native species dominate the residential landscape (Fig. 5), understorey plantings of introduced species, i.e. *Tsuga canadensis*, *Acer palmatum*, and *Taxus* sp. are often common in the immediate vicinity of the house.

Mixed suburban complex

As its name implies, the mixed suburban complex is a characteristic feature of the post World War II landscape. Both with respect to floristic composition and tree form or size, it is an extremely diverse community. Figure 6 is an overlay of the Shannon-Wiener diversity index on the basic site ordination. Given the relatively diverse nature of the suburban complex, it is not surprising that the Shannon-Wiener index reaches its highest value in the suburban complex. Cultivars of *Acer saccharinum*, *A. rubrum*, *A. saccharum*, *A. platanoides* and *Quercus palustris* dominate the larger shade tree category, while *Picea pungens*, *Thuja occidentalis* and *Tsuga canadensis*, are well represented among the conifers. A number of smaller-tree species, notably *Cornus florida* and several small flowering species of *Pyrus* are commonly planted as ornamentals. Several species, *Betula pendula*, *Ilex opaca*, *Liriodendron tulipifera* and *Liquidambar styraciflua*, are largely confined to this complex, lending further credence to their value as representative species.

Conifer complex

The conifer complex is largely associated with modest single family suburban residences constructed during the period between the two World Wars. *Thuja occidentalis* and *Picea pungens* are among the more ubiquitous indicators of this complex, although several other species, *Picea abies*, *P. glauca*, and *Taxus sp.* are also well represented. The conifer complex is notable in several respects. Large portions of the conifer complex are almost treeless. Much of the planting is limited to a few evergreen trees and shrubs placed along the houses' foundations. The low density of tree species (Fig. 4) undoubtedly contributed to the relatively low diversity values characteristic of much of this complex (Fig. 6).

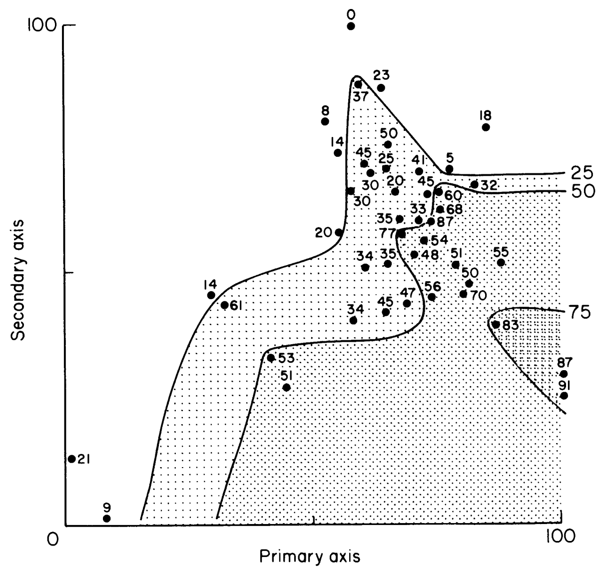

FIG. 5. Overlay of percentage of native species on basic site ordination. Figures are indicative of the site's percentage representation of tree species listed by Braun (1961) as occurring in Summit and Portage Counties. □ >0–25%; □ >25–50%; □ >50–75%; □ >75%.

Maple complex

The maple complex is a relatively difficult community to categorize. It occupies a pivotal position in the site ordination (Fig. 3). Many of its characteristic species, *Acer platanoides*, *A. saccharinum*, and *A. saccharum*, occur in a number of related complexes (note Table 3). *Acer platanoides* and *A. saccharinum* are the two dominant species. Both

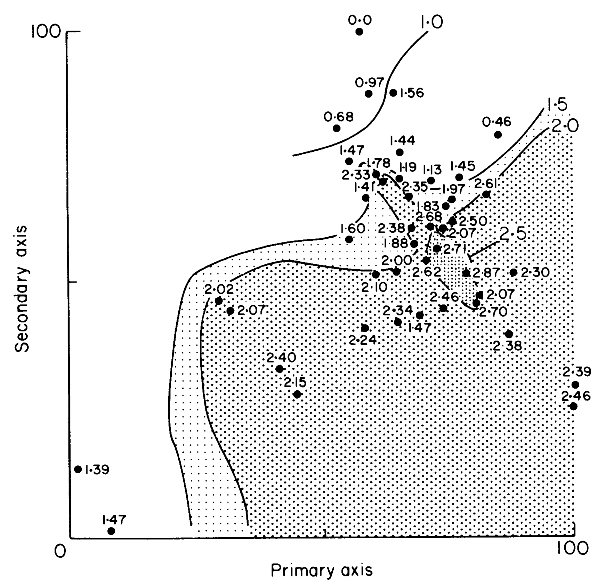

FIG. 6. Overlay of Shannon-Wiener diversity index ($H = -\sum Pi \ln Pi$) on basic site ordination. Pi = the proportion of total sample belonging to the ith tree species.

were largely associated with some of the suburban tract developments constructed immediately after World War II and with prosperous middle class housing in Akron during the turn of the century and shortly thereafter. Several species representative of the maple complex, *Morus alba*, *Acer pseudoplatanus*, *Aesculus hippocastanum*, and *Abies nordmanniana*, are of historic interest and will be discussed later.

Inner city complex

The inner city environment is unique in several respects. First, it is dominated by retail and service business outlets, and manufacturing and wholesale outlets. Single family dwelling units comprise only a small portion of the total area and are largely limited to the periphery of the central city area. Relatively high ambient concentrations of particulate materials and gaseous pollutants are generally associated with the intense industrial and commercial activity of the central city area (Noble 1975b). As a result, it is probably not surprising that several of the more representative species of the urban complex, *Ailanthus altissima*, *Acer platanoides* and *Morus alba*, are noted for their ability to withstand or at least tolerate stress conditions associated with the urban environment (Daniels 1975, Zion 1968).

Ailanthus altissima is a prime example of an urban specialist. Along with *Morus alba* and *Acer saccharinum* it represents one of a limited number of fast growing 'weed' trees. Lund (1974) has suggested that a general pre-adaptation to disturbed habitats may favour certain weedy species in the urban environment. *Acer saccharinum*, for instance, is a common inhabitant of flood plains in the mid-west. The association of weedy old world species and open, man-made habitats has also been well documented in the literature (Sargent 1889, Lund 1974). *Ailanthus altissima*, *Morus alba*, and *Koelreuteria paniculata*, have a long history of co-existence with man. *Morus alba* was cultured by the silkworm industry in China for centuries (Wyman 1951). *Ailanthus altissima* and *K. paniculata* have long been associated with the highly disturbed, open field conditions of northern China's great plain region (Wang 1961).

Vegetative reproduction is another factor favouring the persistence of weedy perennials and the colonization of vacant lots or disturbed sites. Both *Ulmus rubra* and *Ailanthus altissima*, two dominant species of the inner city complex, are capable of vegetative reproduction either by means of rhizomes or the production of root suckers (Curtis 1959, Downing 1869). Fruit trees were also well distributed throughout the inner city area, although they never reached the frequency or density characteristic of some of the more common 'weed' species.

Socio-economic determinants

Taste, fashion, and the relative availability of various species or cultivars are the major factors influencing the composition of the urban forest. Warner (1959) was one of the earliest investigators to comment upon the symbolic significance of the front lawn particularly as it reflected upon the taste and the status of the inhabitants. The close association of taste and status was later amplified by Derrenbacher's (1969) study of residential vegetation in the San Francisco Bay region and Schmid's (1975) study of urban vegetation in the Chicago area.

The rank sum multiple group comparison test of Dunn (1964) was used to test for differences in the cultural variables associated with each of the complexes. Means of four of the relevant variables, income, house value, education, and age of housing, are given in Table 4. The distinction between the more affluent old oak and mixed suburban

TABLE 4. Multiple group comparison of various socio-economic variables associated with each of the five major complexes. Connecting lines indicate that there is no significant difference beween the complexes at the 0·20 significance level. The 0·20 significance level was recommended by Dunn (1964) as an appropriate overall significance level

	Inner city	Maple	Conifer	Mixed suburban	Old oak
Income $\bar{x}$ (dollars)	6214	8889	9914	13 924	19 153
S.E. $\bar{x}$	137	509	218	1085	1071
House value $\bar{x}$ (dollars)	9280	13 416	15 750	28 364	45 733
S. E. $\bar{x}$	1008	1018	789	2616	6421
Education $\bar{x}$ (yrs completed)	9·20	11·13	11·59	13·05	14·00
S.E. $\bar{x}$	0·27	0·47	0·22	0·39	0·20
	Inner city	Maple	Conifer	Old oak	Mixed suburban
Age of house $\bar{x}$	3·40	3·28	2·71	2·50	2·07
S.E. $\bar{x}$	0·24	0·36	0·12	0·20	0·50

complexes and the middle to low income conifer, maple, and inner city complexes is readily apparent.

The quantity, the species composition and the arrangement of urban plants are contingent upon a number of factors. The underlying cultural and social milieu is one of the more important.

Old oak complex

Low density, wooded tracts have often been associated with the more prestigious residential areas of many American cities (Zube 1971). Schmid (1975) for instance, noted the development of the wooded landscape in the wealthier suburban sectors of Chicago's north shore region. Due to the relatively open nature of the highly agriculturally oriented landscape, wooded tracts are relatively rare in the Akron area. Few can afford either the initial purchase price or the additional cost of constructing a home around existing vegetation (Schmid 1975).

Mixed suburban

The mixed suburban complex is indicative of the classical association of trees and upper middle class residential values. To a certain extent the middle class flight to the suburbs at the turn of the century (Glaab & Brown 1976) can be viewed as an attempt to recreate the rural pastoral ideal, the so-called Arcadian myth (Schmitt 1969; Zube 1973; Tobey 1973). The highly manicured, landscaped appearance of the mixed suburban complex is also indicative of the relatively high importance accorded to amenity and prestige values in many middle class communities (Zube 1973, Goodchild 1974). The obvious emphasis on amenity values and the development and marketing of a wider variety of shade and ornamental trees and cultivars in the past 30 yr are probably the major factors responsible for the floristic diversity of the mixed suburban complex.

Conifer complex

The development of the conifer complex represents one of the more interesting chapters in the evolution of the urban landscape. Conifers, due to their evergreen nature, are unsurpassed in their ability to tie the house to the grounds and screen out the more objectionable features of the house, notably the exposed masonry. Foundation plantings, complete with conifers, came into vogue in the latter part of the 19th century, when houses with relatively high foundations were popular. Although the installation of the new gravity warm air furnace required a relatively deep basement, few could justify the excavation costs. Foundation planting represented one of the more viable alternatives (Buscher & Carpenter 1976).

While its utilitarian function has been somewhat outmoded with time, foundation plantings are still one of the more ubiquitous features of the contemporary urban landscape. Foundation plantings of *Taxus sp.*, *Juniperus sp.*, and *Thuja sp.*, form the core of the conifer complex and are often well represented in areas completely devoid of any other form of arboreal vegetation. It is interesting to note (U.S. Bureau of the Census and Manpower Administration 1974) that the percentage of the total labour force employed in the blue collar occupations was well above that of the Akron SMSA average in all but four of the fourteen conifer complex sites. Although the incomes of skilled blue collar workers and white collar workers are often similar, the distribution of their incomes may differ profoundly. As Michelson (1976) noted 'skilled blue collar workers . . . spend a greater proportion of their income on automobiles, television sets, and the like.' 'The quality of their housing,' and one might add parenthetically their landscaping, 'is simply less salient to them than it is to the white collar people, for whom housing [and landscaping] may be a greater symbol of respectability' (Michelson 1976). The scaled down landscaping programmes characteristic of the conifer complex as a whole are compatible with these observations.

The maple complex

Due to its enduring nature, the arboreal vegetation of a given area is often indicative of the landscaping styles and fashions of the past. As a result, the floristic composition of the older, more settled urban areas often reflects the tastes of an earlier era (Schmid 1975, Detwyler 1972). This is particularly true of the maple complex, whose plantings and architectural styles largely date back to the latter portion of the 19th century and the early pre-World War I years of the 20th century.

Unfortunately, it is often difficult to obtain detailed information on the historical progression of styles and tastes which have moulded the development of the urban forest. Landscaping and gardening guides represent one of the more readily available sources of information and were employed in the construction of Fig. 7. It is interesting to note that many of the earliest trees planted were exotics, generally of European origin. Several large specimen trees of *Fagus sylvatica*, planted in the 1830s dominate the Perkins Estate today while *Acer pseudoplatanus*, *Aesculus hippocastanum*, and *Tilia platyphyllos* frame many of the older Victorian mansions of the Fir Hill area. *Acer platanoides*, as the name of the maple complex implies, was one of the more popular introductions and is still heavily employed as a street tree today (Elias & Irwin 1976). The fact that many horticulturists were trained in Europe, the fact that most of the ornamentals stocked by the earliest nurseries were imported from Europe (Sundberg 1972, Grey & Deneke 1978), and the fact that European styles and tastes often dominated the field of fashion (Tobey 1973) accounted for the emphasis on introduced species. It was not until the latter part of the

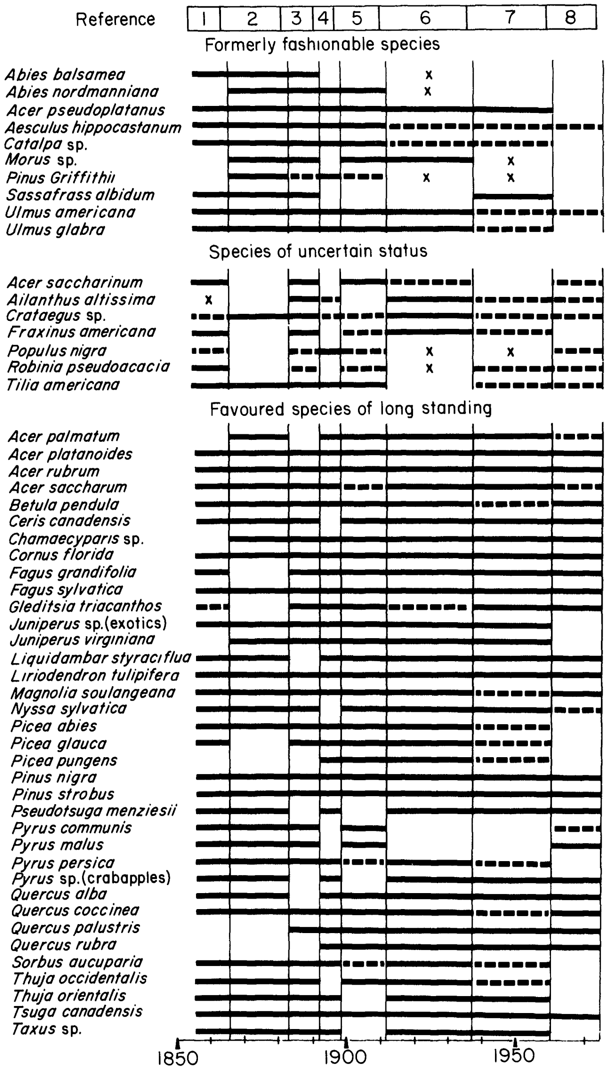

FIG. 7. Historical sequence of fashionable shade and ornamental tree species. Symbols are as follows: solid line, species highly recommended; dashed line, recommended with reservation, other species were preferable; blank space, not mentioned; and ×, use discouraged. References are arranged chronologically as follows: (1) Downing (1844, 1869); (2) Scott (1870); (3) Elliott (1885); (4) Parsons (1891); (5) Maynard (1899); (6) Taylor (1921); (7) Wyman (1951); (8) Zion (1968).

19th century that native species gained widespread popularity. Apparently neither the physical nor the intellectual climate favoured the perpetuation of many of the more exotic species. While a number of introduced species have managed to maintain their popularity over the years, others like *Acer pseudoplatanus*, *Aesculus hippocastanum* and *Abies nordmanniana* are remnants of an earlier era of taste and fashion.

Inner city complex

To a certain extent the inner city complex is the endpoint of an obvious filtering process. Both the landscape tastes and the housing styles of the middle to upper middle income classes eventually filter down to the lower end of the socio-economic spectrum as the real value of the house and its landscaped grounds decline and the house changes hands. The occurrence of *Catalpa speciosa* and *Acer platanoides* in the inner city complex is again indicative of middle class values and tastes at the turn of the century.

Either directly or indirectly the personal preferences and value systems of the current owners and renters also come into play. Volunteer or naturally seeded trees like many of the *Ailanthus altissima* and *Ulmus rubra* encountered in the inner city, probably reflect a more casual attitude with respect to the introduction of 'weedy' species (Schmid 1975) When new trees are intentionally introduced, there is probably a tendency to select the more readily available species, the relatively inexpensive, high volume species emphasized by the garden mart or the local discount store.

Fruit trees are one of the more interesting features of the inner city complex. Their occurrence may be related to the World War II and more recent influx of black migrants from the rural south (U.S. Bureau of the Census 1971). The more pragmatic utilitarian emphasis is reminiscent of the results of Thomas (1970) who studied vegetable gardening in the Baton Rouge, Louisiana, area. Thomas (1970) found that vegetable gardening was largely confined to neighbourhoods dominated by lower income urban and suburban residents who had grown up in rural surroundings.

Distributional patterns of major complexes

The various complexes shown in Fig. 1, are arranged in an irregular concentric pattern of zonation with the inner city complexes of the central city area grading into the maple complex, the conifer complex, and eventually the mixed suburban and old oak complexes on the urban fringe. The pattern complements the concentric zone theory of urban expansion developed by Burgess (1925) to depict the physical growth of the city. According to Burgess (1925), the city is composed of five concentric zones: the central business district, the zone in transition which is an area of deterioration which at one time contained the residences of the more prosperous members of the community but is now being invaded by business and light manufacture, the zone of workingmen's homes, the residential zone composed of prosperous residents living in single family dwellings, and finally, the commuter zone which encompasses satellite cities and suburban areas. Both Burgess' theory and the spatial arrangement of the various complexes in the present study are in one sense complimentary models of the processes of urban expansion, succession, and change. The inner city complex and the maple complex are the dominant vegetation types of the zone in transition. The conifer complex, with its blue collar orientation, is the equivalent of the zone of workingmen's homes, while the old oak complexes and the mixed suburban complexes are scattered throughout the residential and commuter zones. Although the overall fit to the above mentioned scheme is imperfect, the generalization is still robust enough to serve as a crude model of the spatial arrangement of urban plant communities. It is interesting to note that Detwyler (1972) reported a similar distributional pattern in the Ann Arbor, Michigan area. *Morus alba* and *Ailanthus altissima* dominated the central city area and gave way respectively to conifers and oaks in the outer, more recently annexed portions of the city.

The urban environment is largely a creation of man—a series of structures and spaces which personify man's goals and value systems. The degree to which the vegetation articulates these felt goals, life styles, and value systems, is often remarkable. Urban plant communities are as much a product of the cultural environment as they are a part of the physical landscape.

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