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A STUDY OF VIABLE SEEDS IN A SELECTION OF BIRDS' NESTS

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A STUDY OF VIABLE SEEDS IN A SELECTION OF BIRDS' NESTS

CHAPTER I

INTRODUCTION

The dissemination of plant seeds by birds was reported as early as 1749, when Peter Kalm noted that birds played an important part in the distribution of red cedar in eastern North America (Benson, 1937; vol I, p 303). McAtee (1947) listed and annotated 94 papers in this field. These writings cover transport of seeds by three general methods: (1) external adhesion to feathers, or in mud on feet, (2) seeds and fruits, especially nuts and other large fruits, transported for storage, and (3) seeds eaten directly as food, or taken with fruit. No paper in McAtee's list suggested that the nest-building process could account for some seed distribution.

In his comprehensive work on dispersal of plants, Ridley (1930) devoted more than 130 pages to dissemination by birds. A little more than two of these pages was devoted to birds' nests. Apparently this is the only published report on work concerning seeds in birds' nests.

The purpose of this study was to determine the presence and variety of viable seeds in some nests of selected species of birds in Cleveland County, central Oklahoma.

CHAPTER II

METHODS AND PROCEDURES

Eighty nests of 24 species, all from Cleveland County, Oklahoma, were utilized in this study (Table 2). Nests that had not been subjected to cold weather before collecting were stored in a cold room at 3° C or colder for at least three days in an attempt to break dormancy of any seeds present and to induce flowering in emergent plants. All parts of each nest, with the exception of heavier sterile material, were planted in pots in a greenhouse. Large seeds and fruits were removed and treated separately. Before planting, the remaining nest material was crumbled to small pieces in a hand operated coffee-grinder with grinding surfaces separated enough to avoid damaging seeds. The crushed material was then sieved through grid openings of 4000 microns and 500 microns. The sieving produced three grades of material: coarse, medium, and fine, which were planted separately. This grading of material facilitated the planting of very small seeds at a depth shallow enough to permit emergence of the seedlings.

The potting soil used was a sandy loam taken from a Norman garden plot. The soil was autoclaved at 250° F overnight to destroy any seeds that might be present, and was kept covered until used.

Planted pots were subirrigated in metal trays for several weeks in the potting-house. As plants emerged and needed more light, the pots

were moved individually to the greenhouse. Pots of nest material that produced no plants were kept at least 30 days before being discarded. Some "damping off" (a fungal infection of the emerging seedlings) was encountered. In attempting to correct this problem the surface of the soil in the pots was kept drier, and in some pots a fungicide, Captan, was applied to the surface. Attention was given to prevention of contamination of potting soil, nest material, and planted pots by seeds from sources other than the nests. Nests were kept in paper bags before processing, and were then stored in screw-top jars until planted. Newly planted pots were kept away from avenues of activity.

Because of the lack of complete keys to plants in the vegetative state, individual plants of many species were grown to the flowering or fruiting stage for identification. One or two individual plants of an unknown species were usually transplanted to separate pots until identification could be made. The following publications were useful aids in solving problems of identification, especially in the absence of flowers: Buchholz (1954), Copple and Aldous (1932), Gates (1941), Harrington and Durrell (1944), A. S. Hitchcock (1950), C. L. Hitchcock (1937), Launchbaugh (ca. 1966), and Phillips Petroleum Company (1956). One specimen of each species was deposited in the Bebb Herbarium at the University of Oklahoma. Special labels and numbers distinguish these specimens from others collected by me.

CHAPTER III

PROBLEMS OF CONTAMINATION AND IDENTIFICATION

Steps taken to prevent contamination of potting soil, nest material, and planted pots by stray seeds have been discussed above. The greatest risk of contamination existed after the pots with growing plants were removed from the potting-house to the greenhouse proper. Contamination was possible from two sources: seeds from plants that were maturing in the greenhouse, and airborne seeds blown into the greenhouse through the ventilators. At one time several pots were adjacent to a row of potted Euphorbia supina[1] that was being grown for seed. The fruit of this Euphorbia possesses a mechanism by which the seeds are forcibly ejected. Most of the pots in the row nearest the Euphorbia, and some in the next row, repeatedly contained young plants of Euphorbia. All of these were removed and not included in the totals. The Euphorbia that is listed in the appendix grew from a small piece of inflorescence that was taken from a nest and planted separately.

Another source of contamination was Oxalis sp. that grew as a weed in some parts of the greenhouse. This plant occurred repeatedly in pots containing only transplants, and therefore presumably did not come

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[1] Scientific nomenclature of plants follows Waterfall (1966), unless authority is given in the text.

from nest material. For this reason all of the Oxalis was discarded and not included in the totals, except for one plant that germinated from a piece of inflorescence that was taken from a nest and planted separately.

The possibility of contamination by airborne seeds coming through the ventilators caused the most concern. One dandelion seed found on the surface of a pot of soil led me to question whether any dandelion seed was from a nest. However, careful examination of the data for the two species of dandelion indicated that few if any dandelions were from stray seeds. The pattern of occurrence in pots was not random, rather the plants tended to group in pots containing material from certain nests. This was also true for horseweed (Conyza canadensis), another plant that is disseminated by the wind. With this consideration in mind, all of the dandelion and horseweed plants were included in the totals.

Three woody plants, two cottonwoods and a willow, developed from three different nests during the second summer of the study. Ware and Penfound (1949) previously pointed out that cottonwood seeds in central Oklahoma do not remain viable more than four weeks after dispersal, and Moss (1938) reached similar conclusions on Canadian poplars. The cottonwoods grew in pots containing material from a red-winged blackbird nest and a house sparrow nest, both of which were collected about four months before they were prepared for planting. The species of willow was not determined, but Cleveland County has two wild species, Salix nigra and S. interior, and one or more cultivated ones. Ware and Penfound (1949) found the longevity of Salix interior seed to be not more than a week. Mayer and Poljakoff-Mayber (1963) stated that willow seeds are ". . . characterized by a very rapid loss of viability." The plant

in question grew from a pot containing a planted red-winged blackbird nest that had been collected on 12 August, and had been in storage more than seven weeks before planting. Since willow seed had dispersed some six weeks before I collected the nest, it seems highly unlikely that willow seed from the nest could still have been viable. For these reasons, the poplar and willow records were discounted.

Because some plants do not flower readily under glass, and others require an extended period of vegetative growth, identification of certain plants required several months time. Many of the perennial and biennial forbs remained in the winter-rosette stage in the greenhouse for months. A few of the grasses grew luxuriantly but did not flower in the greenhouse. A limited amount of experimenting in a growth chamber and a cold room was not wholly successful. Twelve broadleafed plants and four grasses which grew in the greenhouse for many months were transplanted outside for full exposure to climatic factors. All but two of these, curled dock(Rumex crispus) and poison hemlock (Conium maculatum), eventually flowered. Identity of these two was decided on the basis of vegetative characteristics. One of the grasses that flowered after growing in the open for several months was meadow fescue (Festuca elatior). The blue grosbeak nest from which it grew was planted in March, 1966, and the plant was harvested in February, 1968. One of the perennial forbs of the group, white evening-primrose (Oenothera speciosa), was harvested with flowers 17 months after planting. Kentucky bluegrass (Poa pratensis), planted in February, 1967, was finally harvested in flower May 12, 1969. A plant of Erigeron strigosus from a robin nest planted April 22, 1967, was transplanted in the rosette stage to a garden plot August 26, 1968, and was harvested in flower May 31, 1969.

CHAPTER IV

RESULTS AND DISCUSSION

Nine of the 80 nests used produced no plants (numbers in parentheses, Table 2). The total number of plants produced from a single nest varied from one to 864 (Table 9). A total of 276 nine-inch clay pots was used in planting the nest material (Table 1). Some of the

Table 1. List of numbers of pots according to grade of material planted and presence or absence of germinating seeds. All pots were nine-inch clay pots.

Grade of Nest Material	Total Pots	Pots Producing Plants	Per-cent	Sterile Pots	Per-cent
Fine	77	45	58.4	32	41.6
Medium	106	95	89.6	11	10.4
Coarse	85	49	57.6	36	42.4
Fine and Medium Combined	5	1	20.0	4	80.0
All Grades in One Pot	3	1	33.3	2	66.7
Totals	276	191	69.2	85	30.8

smallest nests, e.g., Bell's vireo, were planted each in one pot, while some of the largest, e.g., robin and blue jay, each required from five to eight pots. Regardless of nest-source, it was often the fine or coarse

Table 2. List of bird species and numbers of nests used. Numbers in parentheses indicate nests that produced no plants. Nomenclature follows Sutton, 1967.

American Goldfinch	*Spinus tristis*	1
Barn Swallow	*Hirundo rustica*	4 (1)
Bells' Vireo	*Vireo bellii*	5 (2)
Bewick's Wren	*Thryomanes bewickii*	1
Blue Grosbeak	*Guiraca caerulea*	5
Blue Jay	*Cyanocitta cristata*	1
Brown Thrasher	*Toxostoma rufum*	1
Cardinal	*Pyrrhuloxia cardinalis*	8 (5)
Carolina Wren	*Thryothorus ludovicianus*	1
Dickcissel	*Spiza americana*	3
Eastern Bluebird	*Sialia sialis*	10
Eastern Phoebe	*Sayornis phoebe*	3
Field Sparrow	*Spizella pusilla*	1
House Sparrow	*Passer domesticus*	3
Indigo Bunting	*Passerina cyanea*	1 (1)
Lark Sparrow	*Chondestes grammacus*	4
Mockingbird	*Mimus polyglottos*	1
Orchard Oriole	*Icterus spurius*	1
Red-winged Blackbird	*Agelaius phoeniceus*	8
Roadrunner	*Geococcyx californianus*	1
Robin	*Turdus migratorius*	10
Scissor-tailed Flycatcher	*Muscivora forficata*	4
Tufted Titmouse	*Parus bicolor*	1
Yellow-billed Cuckoo	*Coccyzus americanus*	2

material that was sterile (Table 1), thus indicating that most of the seeds were of a size that would pass through the large screen and not through the small one. No quantitative analysis was attempted because of the possibility of some seeds being retained in parts of inflorescences larger than sieve screen openings through which the seed alone would pass. In accounting for some of the sterile nests, it is possible that some of those first processed were of sufficient age that seeds they contained were no longer viable. This pertains especially to a barn swallow nest of unknown age from which no plants developed (Table 2). Barn swallow and eastern phoebe nests may remain in place for years, because of their location in buildings, beneath bridges, and in other protected places. In 22 nests, plants emerged and died before identification could be made. These were counted simply as live plants, and were not included in the appendix.

The plants produced and identified represented 28 families and 93 genera (Appendix I). One-hundred thirty species were identified, and two more plants were identified to genera. Fifty-one, or 38.7% of the 132 plants were in the family Gramineae (grasses), 20 were in the Compositae (composites), six in the Cruciferae (mustards), and six in the Umbelliferae (parsley family). Lesser numbers were in the other 24 families.

The large number of species of the grass family used by birds as nest material probably indicates a preference for this type of material. Preliminary examination of the nests revealed that parts of grass plants, even inflorescences, were prominent in the nest structure. Bent (1942, 1949, 1950, 1958, 1968) indicated that grasses are almost always used,

and often in large amounts, by most of the bird species concerned in this study. A comparison of total grass plants with total non-grass plants is presented in Table 3. The high percentages of grass plants from the eastern bluebird and house sparrow nests, 95.6% and 98.4% respectively, reflect the almost exclusive use of grasses by these two species as cited by Bent (1949 and 1958).

The considerable number of non-grass plants from the robin nests is probably due to the relatively large amounts of mud and the source of the mud used as building material. The mud of these nests was of a dark loamy appearance, as though it had come from a fertile soil. Bent (1949) cited examples of robins waiting for rain to complete nest building. This is in contrast to the barn swallow that takes mud from more permanent bodies of water. The mud of the barn swallow nests examined in this study was a heavy red clay, much like the exposed subsoil in excavated stock ponds and erosion gullies in this area. Chickweed (Stellaria media) and henbit (Lamium amplexicaule) are usually found in gardens and lawns (Gates, 1941), therefore mud gathered at rain pools on fertile soil would be much more likely to contain the small seeds of these plants than would mud gathered at the margins of stock ponds. These two species of forbs constituted a considerable number of the non-grass plants from the robin nests. In contrast, the barn swallow nests contained neither of them (Appendix I). The presence of the seeds of such other forbs as purslane speedwell (Veronica peregrina), buffalobur (Solanum rostratum), plains coreopsis (Coreopsis tinctoria), and curltop smartweed (Polygonum lapathifolium) in robin nests indicate that the mud came from places where water collects on fertile soil.

Table 3. A comparison of total grass plants with total non-grass plants.

Bird Species	Productive Nests	Total Grass Plants		Total Forb Plants	
		No.	Percent	No.	Percent
Barn Swallow	3	118	97.5%	3	2.5%
Blue Grosbeak	5	133	79.2	35	20.8
Dickcissel	3	118	78.7	32	21.3
Eastern Bluebird	10	1274	95.6	59	4.4
Eastern Phoebe	3	116	95.1	6	4.9
House Sparrow	3	1952	98.4	31	1.6
Lark Sparrow	4	60	63.2	35	36.8
Red-winged Blackbird	8	853	96.4	32	3.6
Robin	10	683	63.8	387	36.2
Scissor-tailed Flycatcher	4	80	66.7	40	33.3
Others	18	303	45.2	368	54.8
Totals	71	5689	84.7	1028	15.3

If a study of this type were to be extended, it appears that the variety of plant seeds to be found in birds' nests could be almost as great as that of the local flora. Plants new for the list were still being found at the end of this study, as shown by the 78th nest which contained three new species. Nickell (1958), writing of nesting materials, considered the variety as a whole for all species nesting in a region to be almost as great as that of the plant species. Nikitina and Shklyarov (1962), after studying nest construction by passerine birds in White Russia, commented that the structural material of nests corresponded with the floristic composition of the nesting biotope.

Plants Most Often Growing from Nests

The most common genus germinating from planted nests was Bromus (Appendix I and Table 4). Rescue brome (B. catharticus) flowered readily in the greenhouse, and was thus easily identified. Japanese brome (B. japonicus) rarely flowered in the greenhouse, with only a few plants producing a scraggly inflorescence or two. Other plants of Japanese brome were identified from seed before planting, using the keys and illustrations in a book by Musil (1963). Downy brome (B. tectorum) growing wild in central Oklahoma is almost as prevalent as Japanese brome, yet no seeds were found in the nests and no plants flowered. The writers of keys to grasses in the vegetative condition usually state that B. tectorum and B. japonicus are very difficult to differentiate without flowers or fruits (Harrington and Durrell, 1944; Nowosad, Swales, and Dore, 1938; Hitchcock, 1937). Because of the difficulty in identification, and because both of these grasses are common, all of this Bromus group that did not flower are listed as Bromus sp. However, when

Table 4. List of plants growing from at least seven birds' nests. Percentage is computed from a total of 71 productive nests.

Plant Species	Number of Nests	Percent of Total Nests
Bromus sp.	29	40.8%
Chloris verticillata	25	35.2
Digitaria sanguinalis	22	31.0
Conyza canadensis	18	25.4
Paspalum setaceum	14	19.7
Stellaria media	13	18.3
Sporobolus cryptandrus	12	16.9
Cynodon dactylon	12	16.9
Bromus catharticus	10	14.1
Eleusine indica	9	12.7
Festuca octoflora	9	12.7
Leptoloma cognatum	9	12.7
Bromus japonicus	8	11.3
Aristida oligantha	8	11.3
Poa annua	8	11.3
Sporobolus vaginiflorus	8	11.3
Lamium amplexicaule	8	11.3
Lepidium densiflorum	8	11.3
Agrostis hyemalis	7	9.9
Capsella bursa-pastoris	7	9.9
Plantago purshii	7	9.9

comparing these unknown plants with B. tectorum and B. japonicus grown from known local seed, it appeared that most of the unknown plants were B. japonicus.

Almost as numerous as the undetermined Bromus was windmill grass (Chloris verticillata). This low-growing grass begins fruiting in May and continues all summer (Hitchcock, 1950). When mature, the inflorescences break away and are blown about by the wind. The fruits are persistent on the inflorescences, which, in part, accounts for the large number of plants growing from such nests as eastern bluebird and house sparrow (Appendix I). This is in contrast to the seeds of crabgrass (Digitaria sanguinalis), which are not as persistent on the inflorescence and will not be picked up by birds using only plant parts in the nests. On the other hand, crabgrass could be in the mud used by birds such as the robin. It is postulated that the bluebirds and house sparrows, in gathering inflorescences, pick up many Chloris seeds and somewhat fewer Digitaria seeds, and the mud gathered by robins contains much Digitaria and very little Chloris.

Horseweed (Conyza canadensis) was found in 18, or 25.4% of the nests from which plants grew. This is a very common weedy species that begins flowering in late June and matures seed soon thereafter. Considering that most birds build in April or May, the seeds of horseweed are dispersed too late in the season to be incorporated into the structure of current nests. The alternatives are that the birds in gathering nest material in spring picked up seeds that matured in the previous summer, or seeds were blown into the nests by the wind as they were dispersed from the plants. Considering the ubiquitousness of horseweed in this

region, the latter possibility does not seem beyond reason. Also, as stated in Chapter III, some of the seeds that germinated in pots in the greenhouse may have been stray seeds blown in through the ventilators.

Comparison of Grasses and Forbs from All Nests

Tables 5, 6, and 7 give the average number of species and total plants per nest for each species of bird. Percentages of grasses and forbs from the nests of each species are also given. All nests, including those from which no plants emerged, are included in the totals of nests used in calculating the averages.

All nests producing five or more species of plants usually had more grasses than forbs. There were three exceptions: the dickcissel nests (average of three, Table 5), the brown thrasher nest (Table 5), and the tufted titmouse nest (Table 7). There is no obvious explanation as to why the dickcissel nests produced a limited number of grass species. Bent (1968) stated that some nests may be made almost entirely of one type of grass. One of these three nests produced 102 brome grass plants of a total of 104. This certainly supports Bent's observation.

The three house sparrow nests were large and bulky, and were composed almost exclusively of grasses. This is in agreement with Bent (1958) concerning a nest in Baltimore that was ". . . made chiefly of very long, coarse grass stems with the heads still on. . ." One of the nests of this study produced mostly Bromus and some Chloris for a total of 332 grass plants, and only 7 non-grass plants. The other two house sparrow nests, taken from a barn in April and August, produced a great number of Chloris plants (Appendix I). The divergently branched inflorescences of Chloris apparently provided bulk for the large nests.

Table 5. Plants produced from exposed nests of leaves, stems, and other plant material. Species averages were derived by adding number of species from each nest and dividing by number of nests. The species percentages for grasses and forbs were computed from the species list for all nests of any species of bird.

Bird Species	Nests Used	Averages Per Nest					
		Species			Plants		
		Total	Grasses	Forbs	Total	Grasses	Forbs
American Goldfinch	1	3.0	33.3%	66.7%	4.0	25.0%	75.0%
Bell's Vireo	5	1.4	71.4	28.6	20.2	96.0	4.0
Blue Grosbeak	5	3.8	63.2	36.8	33.6	79.2	20.8
Blue Jay	1	15.0	66.7	33.3	120.0	71.6	28.3
Brown Thrasher	1	16.0	43.8	56.2	49.0	34.7	65.3
Cardinal	8	0.4	50.0	50.0	0.6	33.3	66.7
Dickcissel	3	5.0	40.0	60.0	50.0	79.6	21.4
Field Sparrow	1	2.0	100.0	0.0	16.0	100.0	0.0
Indigo Bunting	1	0.0	0.0	0.0	0.0	0.0	0.0
Lark Sparrow	4	4.3	58.1	41.9	23.8	63.0	37.0
Mockingbird	1	6.0	66.7	33.3	14.0	64.3	35.7
Orchard Oriole	1	1.0	100.0	0.0	20.0	100.0	0.0
Red-winged Blackbird	8	5.0	62.0	38.0	110.6	96.4	3.6
Roadrunner	1	11.0	63.6	36.4	44.0	75.0	25.0
Scissor-tailed Flycatcher	4	5.8	55.2	44.8	30.0	60.0	40.0
Yellow-billed Cuckoo	2	2.0	75.0	25.0	6.5	46.2	53.8

Table 6. Plants from nests of mud and some plant material. Species averages were derived by adding number of species from each nest and dividing by number of nests. The species percentages for grasses and forbs were computed from the species list for all nests of any particular species of bird.

Bird Species	Nests Used	Averages per Nest					
		Species			Plants		
		Total	Grasses	Forbs	Total	Grasses	Forbs
Barn Swallow	4	3.3	75.8%	24.2%	30.2	97.4%	2.6%
Eastern Phoebe	3	8.4	79.8	20.2	40.7	95.1	4.9
Robin	10	13.2	53.0	47.0	107.0	63.8	36.2

Table 7. Plants produced from nests built in cavities and made of leaves, stems, and other plant material. Species averages were derived by adding numbers of species from each nest and dividing by number of nests. The species percentages for grasses and forbs were computed from the species list for all nests of any particular species of bird.

Bird Species	Nests Used	Averages per Nest					
		Species			Plants		
		Total	Grasses	Forbs	Total	Grasses	Forbs
Bewick's Wren	1	3.0	33.3%	66.7%	3.0	33.3%	66.7%
Carolina Wren	1	6.0	83.3	16.7	193.0	3.1	96.9
Eastern Bluebird	10	7.2	72.2	27.8	133.3	95.6	4.4
House Sparrow	3	7.0	71.4	28.6	661.0	98.4	1.6
Tufted Titmouse	1	9.0	33.3	66.7	88.0	10.2	89.8

The brown threasher and tufted titmouse nests, both low in numbers of grass species, were very different in construction. The thrasher built on a tree branch, and the titmouse used a cavity. Headstrom (1949) described the brown thrasher nest as being built ". . . of sticks, twigs, leaves, bark strips, and weed stalks: lined with rootlets. . ." Initial examination of this nest indicated that it contained sticks, weed stems, and some grass material. The titmouse nest was composed largely of duff that had apparently been picked up beneath trees near the nest site. Headstrom (1949) stated that the tufted titmouse nest usually contains ". . . moss, leaves, grass, bark, hair, feathers. . ." the plants germinating from the thrasher and the titmouse nests reflect the findings of the initial examinations, and confirm the statements of Headstrom concerning nest materials.

Most nests that were high in grass species were also high in total numbers of grass plants. An outstanding exception was a Carolina wren nest in which the grasses comprised 80% of the species, and only 3.1% of the total plants. This nest had been built in a can attached to the side of a building and was near a lawn in which much chickweed (Stellaria media) was growing. The plants growing from this nest were almost all of this species.

Among nests producing five or more species of plants, the ratio of species of grass to total grass plants was fairly constant. Nests in this category were those of red-winged blackbird, eastern phoebe, eastern bluebird, and house sparrow (Tables 5, 6, and 7). In this group of 24 nests, grasses constituted more than 95% of all plants harvested, and between 60% and 80% of the species. Forbs were produced in variety (20% to 40% of all species), but were very low in quantity.

Grasses and Forbs from Three Classes of Nests

All of the nests used were grouped into three classes: nests containing largely mud, but with some plant material; nests placed in cavities and made largely of plants; and exposed nests of leaves, stems, and other plant parts (Table 8).

Table 8. Plants produced from three classes of nests. Averages were computed from the individual nest data, and not from the averages shown in Tables 5, 6, and 7.

Classes of Nests	Nests Used	Averages per Nest					
		Species			Plants		
		Total	Grasses	Forbs	Total	Grasses	Forbs
Nests of Mud	17	10.0	58.8%	41.2%	77.2	70.0%	30.0%
Nests in Cavities	16	6.9	68.5	31.5	225.0	90.1	9.9
Exposed Nests	47	3.9	58.8	41.2	38.4	84.4	15.6

The nests build of considerable amounts of mud produced the greatest number of species, and the cavity nests produced the largest number of plants (Table 8). The robin nests averaged highest in number of species among the mud users (13.2 species, Table 6), although in this study this number is exceeded by two other nests (brown thrasher with 16 species and blue jay with 15). The cavity nesters exceeded by nearly three fold either of the other two classes on the basis of total numbers of plants per nest (Table 8). The house sparrow, one of the cavity nesters, had the highest total plant average of all birds (661 plants per nest, Table 7). Other individual nests regardless of class, exceeding the average number of plants for the cavity nesters were: robin 289,

eastern bluebird 550, 288 and 354, and red-winged blackbird 433. The cavity nests had the highest percentages of both grass species and grass plant numbers (Table 8). Over 90% of all plants produced from the 16 cavity nests were grasses. The parts of the grass plants, being more flexible than the stems and other parts of many forbs, are probably more easily managed by the birds in entering the cavity and in forming the nest inside. Also since the walls of the cavity form the supporting structure, there is less need for the more substantial forb parts in this type of nest. Ten of the cavity nests were eastern bluebird. Most of these bluebird nests examined had considerable amounts of material in the nest-box below the nest. Apparently this "filler" served to raise the level of the nest in relation to the next-box opening. This material was almost all grass plant parts.

The mud users had the highest percentage of forb species and forb plants of any of the three classes. This reinforces the statement made above concerning the robin nests (see elsewhere in Chapter IV), that some of the small forb seeds are picked up with the mud and not with plant parts.

Comparative Production from Nests

Table 9 deals with the total plants produced from all nests used. In many cases the great variation in numbers cannot be accounted for, but in other cases certain conclusions can be reached. For example, the yellow-billed cuckoo nests consisted of a few loosely arranged twigs and a scrap of lining. However, when they were processed and planted they produced an average of more than six plants each. On the other hand, the

Table 9. Total number of plants produced from each of 80 nests.

Species of Bird	Number of Plants per Nest									
	Nest No.									
	1	2	3	4	5	6	7	8	9	10
American Goldfinch	4									
Barn Swallow	14	0	12	95						
Bell's Vireo	6	2	93	0	0					
Bewick's Wren	3									
Blue Grosbeak	2	3	30	114	19					
Blue Jay	120									
Brown Thrasher	49									
Cardinal	2	0	0	1	0	0	0	2		
Carolina Wren	193									
Dickcissel	104	38	8							
Eastern Bluebird	32	32	12	42	6	1	354	15	288	550
Eastern Phoebe	55	29	38							
Field Sparrow	16									
House Sparrow	339	864	780							
Indigo Bunting	0									
Lark Sparrow	5	85	2	3						
Mockingbird	14									
Orchard Oriole	20									
Red-winged Blackbird	3	22	8	203	7	72	137	433		
Roadrunner	44									
Robin	58	195	48	210	20	104	49	75	289	23
Scissor-tailed Flycatcher	8	61	34	17						
Tufted Titmouse	88									
Yellow-billed Cuckoo	11	2								

much larger and more substantial cardinal nests produced five plants from all eight nests. The very small Bell's vireo nests, constructed of various small plant parts woven and fastened together with spider webs, would appear to be relatively sterile of seeds. This was true, generally, but one of the five nests produced 93 plants. Of this total, 89 were the grass Agrostis hyemalis. The builder of this nest may have used an inflorescence, or several inflorescences, of this grass in construction of the nest.

The robin nests were the most consistently productive of those species of which more than three nests were used (Table 9). The average of the ten eastern bluebird nests exceeded that of the ten robin nests (Tables 6 and 7), but the variation in numbers of plants was extreme (from 1 to 550). This extreme in numbers from the bluebird nests can be explained in part. The nest that produced one plant only came from the edge of a stand of oaks, and much of the material within the nest-box was oak catkins which should be devoid of seeds. The nest producing the highest number of plants, 550, was from a nest-box on a roadside with ungrazed pasture, abandoned field, and unmowed roadside nearby. Many grass inflorescences were evident upon initial examination, and Chloris verticillata comprised 479 and Bromus japonicus 53 of the plants produced from this nest. These are species of disturbed areas, and their presence reflects the habitat from which the nest was collected. Bent (1949) stated that the nest of the eastern bluebird is "often entirely of dried grass and weed stems" -- material readily available in disturbed areas.

The three bulky house sparrow nests were the greatest producers of plants, both as a species and as individual nests (Table 9). The size

of the nests accounts for most of this production. As the birds build their nests on ledges or in clefts in buildings, they seem to try to fill the space with gathered plant material. The result being a great pile of trash stuffed into an opening in such a way that most of it does not fall to the ground. This mass of coarse material is likely to contain many plant inflorescences.

Plants of Unusual Interest

The specimen of Anthriscus scandicina placed in the Bebb Herbarium was the second collection of this species in the state. The first was made by Dr. George Goodman in the Caddo Canyons area, Canadian County, in 1964. Fernald (1950) described the species as being adventive from Europe, and "as yet local, se. Va." Steyermark (1963) reported the species from St. Louis County, Missouri, and further indicated it to be introduced and naturalized in Nova Scotia, Virginia, and the Pacific States. The robin nest from which these plants grew was collected near the Animal Behavior Laboratories on the North Campus of the University of Oklahoma. For the past two springs this species has been observed growing in the same locality. It is possible that zoologists bringing specimens collected in the Caddo Canyons to the Behavior Laboratory brought the first Anthriscus seed to this area.

The Trisetum interruptum of this study came from a lark sparrow nest collected about six miles southeast of Norman, and was the first collection from this county in the Bebb Herbarium. This species is a small annual grass of the southwest, rarely found as far northeast as Oklahoma.

The hackberry (Celtis occidentalis) was in the nest of a tufted titmouse. The nest-box contained considerable amounts of duff and other heavy material that formed a compacted layer one or two inches deep in the bottom of the box.

The plants of the American elm (Ulmus americana) grew from three robin nests and one eastern bluebird nest. The robin nests were taken, respectively, from a lower limb of a large sycamore tree in Norman, a pine tree on the campus of the University, and a small American elm in an ungrazed vacant area on the east side of Norman. The nest from the elm was collected in January before the time of elm fruiting, but it may have been begun early enough in the preceding spring to have trapped some of the elm fruits maturing and falling that season. No fruits were found on examination of the nest, but two plants grew from the planted material. The bluebird nest came from a nest-box on a roadside near a tree-lined creek. The outermost branches of an elm were within 60 feet of the nest. A few elm fruits could have blown into the nest-box through the $1\frac{1}{4}$ inch hole, but it is doubtful that the twenty that were found would all have entered that way. Two of these seeds germinated (Appendix I). The petunia came from the robin nest from the sycamore referred to above. The part of Norman where the tree stands is thickly settled with a house on every lot. The petunia seed was probably picked up with mud from a flower garden. The above nest also produced one plant of Sorghum vulgare of the milo variety. The seed was not embedded in the dried mud of the nest, but was found with other loose material when the nest was examined. Since the nest was collected in January, it is possible that this field-crop grain was carried from a bird feeder to the nest by some wintering bird.

The nest of the American goldfinch produced three plants; one of these was the wavyleafed thistle (Cirsium undulatum), a common weed of local upland pastures. Headstrom (1949) described the nest of the goldfinch as being ". . . lined characteristically with thistledown." Bent (1968) cited at least three observers who listed thistledown or thistle seeds as being found in goldfinch nests.

The common pokeberry (Phytolacca americana) from an eastern bluebird nest, and the mulberry (Morus) from a bluebird, a tufted titmouse, and two robin nests may have been carried to the nests with fruit being fed to the young (McAtee, 1940). All three species are known to eat fruit as adults (Bent, 1949; Hamilton, 1940; Martin, Zim, and Nelson, 1951). Ridley (1930) pointed out that large seeds of fruit are often regurgitated after the pulp or aril is detached in the crop. In some cases the young may be fed the pulp only, and the seeds dropped in the nest or below the nest.

The rayless gaillardia (Gaillardia suavis) was found in the nests of a lark sparrow and an eastern bluebird. The two nests, collected about 4½ miles southeast of Norman, were separated by about 3/4 of a mile. Both were near dry shaley hillside habitats where this plant is often found. This type of habitat, and consequently the distribution of the plant, is relatively limited in Cleveland County.

Two varieties of Sporobolus vaginiflorus, the type variety and neglectus, were identified, but are not presented separately in the tables or the appendix. Two nests, a robin and a lark sparrow, produced five and two plants, respectively, of Sporobolus vaginiflorus var. vaginiflorus. S. vaginiflorus var. neglectus was found in three nests: robin, brown

thrasher, and scissor-tailed flycatcher, with 7, 2, and 1 plants, respectively.

There were also two varieties of tall dropseed (Sporobolus asper). One plant of the type variety came from a dickcissel nest. One plant of S. asper var. hookeri grew from an eastern phoebe nest, and another from an eastern bluebird nest.

Bent (1942) cited the writings of two long-time observers of the scissor-tailed flycatcher who referred to Evax (Indian tobacco) as being an almost inevitable part of the nests of this species. One of the scissortail nests of this study contained several seeds of Evax prolifera. This floccose, woolly plant is a common weed in heavily grazed upland pastures, where isolated trees often provide nesting sites for the scissortail.

It is of interest to note that about 26% of the species are not native to this area, and in a large part are introduced weeds (cf. Fernald, 1950). Most of the species that were recorded in large numbers and from many nests are weedy species, both introduced and native. In contrast, many of the native non-weedy species occurred as single plants from one or two nests (Appendix I).

Plants Most Frequently Growing from Robin and Bluebird Nests

A list of plant species most often encountered in robin and eastern bluebird nests is presented in Tables 10 and 11. Although these two species are placed in the same family, Turdidae, the relationship is not evident throughout the life cycles. The morphology and food habits have many points of similarity, but the placing of the nest and the nest

Table 10. List of plant species growing from three or more robin nests. Total of plant species from all ten robin nests taken collectively was 66.

Plant Species	Individual Nests									
	1	2	3	4	5	6	7	8	9	10
Digitaria sanguinalis		X	X	X	X	X	X	X	X	
Cynodon dactylon			X		X	X	X	X	X	X
Eleusine indica			X	X	X	X	X		X	
Bromus catharticus			X	X		X			X	
Chloris verticillata		X	X						X	
Conyza canadensis	X	X	X							X
Digitaria ischaemum		X	X						X	
Lamium amplexicaule	X					X	X		X	
Paspalum setaceum	X	X	X							X
Poa annua	X		X			X				
Poa pratensis						X		X		X
Sorghum halepense	X				X					X
Sporobolus cryptandrus		X				X			X	
Stellaria media			X	X		X	X			
Taraxacum officinale	X		X			X				
Ulmus americana						X	X	X		

Table 11. List of plant species growing from two or more nests of eastern bluebird. Total of plant species from all ten bluebird nests taken collectively was 40.

Plant Species	Individual Nests									
	1	2	3	4	5	6	7	8	9	10
Chloris verticillata	X	X			X		X	X	X	X
Digitaria sanguinalis					X			X	X	X
Andropogon saccharoides			X		X					
Aristida oligantha	X					X			X	
Bromus catharticus					X			X		
Capsella bursa-pastoris		X			X					
Conyza canadensis		X	X				X			
Digitaria ischaemum				X	X					
Eleusine indica	X							X		
Eriochloa contracta	X									X
Lepidium densiflorum			X		X					
Leptoloma cognatum			X			X			X	
Plantago purshii		X	X							
Poa annua		X						X		
Sorghum vulgare									X	X
Sporobolus cryptandrus	X						X			X

structure are very different. The bluebird nests in cavities which may have but one opening and that as small as 1¼ inches in diameter. The robin places its nest in the open--usually in trees, but also on shelves and ledges on the sides of buildings (Headstrom, 1949). The robin uses a substructure of coarse grasses, twigs, and rootlets, with an inner wall of mud. The nest is lined usually with small grasses. The bluebird uses fine grasses almost exclusively to fill the hollow limb or nest-box to proper depth, and for forming the nest cup.

Crabgrass (Digitaria sanguinalis) was the only plant found in abundance in both groups of nests. This grass was described by Pohl (1966), Buchholtz (1954), and Gates (1941) as being an ubiquitous weed with the ability to survive almost anywhere in this climate in open sunlight. The great variety of habitats in which this grass occurs is probably the reason it was picked up by so many robins and bluebirds. Chloris verticillata is also a common grass of weedy places. This plant was the most common one to grow from bluebird nests, but it was much less important in robin nests. Many inflorescences of Chloris verticillata were seen in the nests of bluebirds, but the plant was rarely found during the initial examination of the robin nests.

The second most frequently found plant in robin nests, bermudagrass (Cynodon dactylon), was not found at all in the bluebird nests. Bluebirds prefer open fields and roadsides where bermudagrass is less common. Robins, on the other hand, seem to require mowed lawns in the nesting habitat. The two robin nests that were collected in rural areas were in trees over or near bermudagrass lawns.

Large Seeds and Fruits

The nests were always given an initial inspection for rocks, large sticks, and other objects that might damage the grinder. When large seeds or fruits were encountered they were separated from the remainder of the nest and given individual treatment. A scissor-tailed flycatcher nest, collected in an isolated hackberry tree, contained an acorn of post oak (Quercus stellata). The acorn did not germinate, so could not be included with the list of plants.

A watermelon (Citrullus vulgaris Schrad.) seed was found in a nest of the Carolina wren. The seed was inadvertently run through the coffee grinder and destroyed.

One fruit of the pecan (Carya illinoensis) was found embedded in the mud of a robin nest that was not used in this study. This nest is being preserved with a collection of nests, and no attempt was made to germinate the seed.

A Look at Ridley's Book

In the section on birds' nests, Ridley pointed out the possibility of parts of plants with attached seed being carried to the nest. He also noted that plumed seed may be used to line the nest, and that parts of living plants have been carried to nests and continued to grow there. Ridley suggested that some seeds or fruits that readily become attached to animals or birds may be brought to the nest, and later adhere to the bird in more distant flights. He gave bedstraw (Galium aparine) as an example of this type of plant, and as one that is often found in nests of the Old World garden warbler (Sylvia borin). This species of plant was found in a dickcissel nest (Appendix I).

Ridley (1930, p 512) wrote of the house sparrow (Passer domesticus): they ". . . carry grasses and other scraps of vegetation, often bearing seeds, to their nests from some distance, and in doing so frequently let them fall in the neighborhood of the nest, or on the way to it, so that the seeds may be dispersed in that manner." Ridley continued: "I find them in June collecting pieces of new-mown hay to repair the nest, below which I found panicles of Poa pratensis, Trisetum flavescens, and Luzula campestris, all containing ripe seeds."

In a paper by Willis and Burkill cited by Ridley, the authors listed six genera of plants of which parts of the plants, seeds or fruits, had been found in "thrush" nests. Five of these six genera were found in various nests of this study. Three of the species reported by Willis and Burkill were found in Cleveland County nests. These were bedstraw (Galium aparine), annual bluegrass (Poa annua), and Kentucky bluegrass (Poa pratensis). In "sparrow" and "wren" nests, Willis and Burkill reported finding 13 genera of plants. Four of these genera were found in nests of this study. Binger (Ridley, 1930, p 513) reported finding five genera of plants in nests of four water birds of the Swedish islands. I found two of these, Agrostis and Solanum, in very different kinds of nests. The grass genus Agrostis occurred in scissor-tailed flycatcher, red-winged blackbird, eastern bluebird, Bell's vireo, and blue grosbeak nests; and Solanum occurred in two robin nests (Appendix I).

The Significance of Seed Dissemination by Nest-building Birds

Most of the seeds which germinated from the nests were carried to the nests with building materials. Seeds of a few species (e.g.,

mulberry and pokeberry) may have been carried in with fruit as food for the young. Some airborne seeds may have blown into the nests before the nests were collected for study. The probability of food seeds being in the nests is small, largely because seeds eaten by seed-eating birds are usually destroyed by the digestive process (McAtee, 1947). McAtee (1908) found many mulberry seeds in the feces of nestling cardinals, although the cardinal is a seed-eating bird. The mulberry fruit was probably fed to the nestlings, and the nestlings may not have the ability to digest seeds. Furthermore, most birds remove the feces from the brood nest, thus preventing an accumulation of any seeds that might survive the digestive process.

The loss of seeds from plant material on the way to the nest may be more significant in dispersal than the seeds actually found in the nest. The entire inflorescence may be dropped, as noted by Ridley (1930), or seeds may fall to the ground as the bird carries the plant parts. In such plants as peppergrass (Lepidium) and shepherd's purse (Capsella bursa-pastoris) the two parts of the fruit fall away readily at maturity, and could easily be lost in transport to the nest. Seeds of some of the grasses, e.g., the dropseeds (Sporobolus), also shatter easily at maturity.

Seeds, once lodged in cavity nests, have little chance of germinating in a situation where the plants can become established. However, destruction of the cavity, or removal of the nest material by mammals or other birds is possible. Seeds of some species could lie dormant in a cavity nest for many years and still germinate under proper conditions. Various experiments of testing the longevity of seeds of weedy species have been made. Seeds of Lepidium virginicum and Rumex

crispus have been known to remain alive in the soil for 40 and 70 years, respectively. Both of these species were found in nests of this study. A similar situation exists for seeds in barn swallow and eastern phoebe nests. These nests are built in protected places, but eventually disintegrate and return to moist soil.

Most tree nests are destroyed and the contents fall to the ground within a year's time. However, many of the plants grown from the nests of this study probably are not shade tolerant, and certainly would not be in the most favorable habitat beneath a tree. Considering the possibility of wind drift as the nest breaks apart, and water movement on the ground, it is not beyond reason to assume that some seeds would germinate in favorable places.

At best any dispersal of seeds by nest-building birds takes place within small areas. Nickell (1958) stated that most small birds gather nest material in the immediate vicinity of the nest-site. Bent (1949) cited observations making clear that at one eastern bluebird nest the birds secured material within a radius of 75 feet (much of it within half that distance), and that at another most of the 289 observed trips for material took the birds less than 50 yards from the nest.

Dispersal through nest building may have its principal significance in transport of seeds up-slope, across barriers, or into areas where populations of plants have been eliminated by drought, fire, flood, or other catastrophe. Seeds of plants can easily be moved downhill by gravity, aided by wind and water. In moving up-slope, the help given by nest-building birds could increase the distance of dissemination and the rate of migration. Movement across barriers such as walls, roads, and small bodies of water could also be accomplished in this manner.

CHAPTER V

SUMMARY

A study of 80 nests of 24 species of birds revealed that more than 88% of them contained viable seeds. The nests were collected from a variety of habitats in Cleveland County, central Oklahoma. A total of 130 species of plants was identified, and two additional genera were listed where the species could not be determined. In all, 93 genera and 28 familes were represented. The greatest variety of plants grew from the planted robin nests: a total of 67 species for all ten nests, and, allowing for duplication among the nests, an average of 13 species per nest. The three house sparrow nests averaged the largest number of plants per nest, 661. The cardinal nests were the poorest producers with only five plants developing from eight nests. The most common plant species identified was windmill grass (Chloris verticillata), found in 35% of the productive nests. Next in abundance was crabgrass (Digitaria sanguinalis), 31%. It is postulated that nest-building birds may disseminate seeds for short distances, and may be of some significance in distributing seeds up-slope or across barriers.

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Appendix I. List of plants by families, and species of nest from which grown. Each number in parentheses represents the number of plants from an individual nest. Common names of plants largely follow Anderson (1961).

Gramineae

Agrostis elliottiana	Scissor-tailed Flycatcher	(4)
Agrostis hyemalis (winter bentgrass)	Scissor-tailed Flycatcher	(4)
	Eastern Bluebird	(1)
	Bell's Vireo	(89)
	Red-winged Blackbird	(4)(1)(1)
	Blue Grosbeak	(5)
Alopecurus carolinianus (Carolina foxtail)	Robin	(1)
Andropogon saccharoides (silver bluestem)	Eastern Bluebird	(1)(1)
	House Sparrow	(1)
Andropogon virginicus (broomsedge)	Roadrunner	(1)
Aristida dichotoma (churchmouse threeawn)	Eastern Bluebird	(1)
Aristida oligantha (prairie threeawn)	Scissor-tailed Flycatcher	(2)
	Robin	(1)
	Eastern Bluebird	(1)(2)(4)
	House Sparrow	(6)
	Red-winged Blackbird	(1)
	Dickcissel	(1)
Bromus catharticus (rescue brome)	Yellow-billed Cuckoo	(2)
	Carolina Wren	(1)
	Mockingbird	(1)
	Brown Thrasher	(1)
	Robin	(2)(27)(5)(19)
	Eastern Bluebird	(2)(3)
Bromus japonicus (Japanese brome)	Scissor-tailed Flycatcher	(1)
	Eastern Phoebe	(29)
	Tufted Titmouse	(1)
	Robin	(1)
	Eastern Bluebird	(53)
	House Sparrow	(5)
	Blue Grosbeak	(1)
	Dickcissel	(2)

Gramineae (continued)

Bromus sp.	Yellow-billed Cuckoo	(1)
	Scissor-tailed Flycatcher	(33)(2)
	Eastern Phoebe	(1)
	Barn Swallow	(14)(7)(15)
	Bewick's Wren	(1)
	Carolina Wren	(1)
	Brown Thrasher	(5)
	Robin	(2)(13)(3)
	Eastern Bluebird	(11)(1)(7) (116)(9)
	House Sparrow	(309)(111)
	Red-winged Blackbird	(6)
	Orchard Oriole	(20)
	Blue Grosbeak	(16)(3)(1)
	Dickcissel	(98)(13)
	Lark Sparrow	(31)
	Field Sparrow	(13)
Cenchrus pauciflorus (sandbur)	Roadrunner	(21)
	Eastern Phoebe	(2)
	Robin	(1)(1)
	Eastern Bluebird	(1)
	Lark Sparrow	(1)
Chloris verticillata (windmill grass)	Yellow-billed Cuckoo	(3)
	Scissor-tailed Flycatcher	(19)(2)
	Eastern Phoebe	(1)(1)
	Barn Swallow	(71)(3)
	Blue Jay	(25)
	Brown Thrasher	(5)
	Robin	(6)(1)(94)
	Eastern Bluebird	(5)(221)(479) (2)(225)(17)(3)
	House Sparrow	(17)(723)(745)
	Red-winged Blackbird	(1)
	Blue Grosbeak	(1)
	Lark Sparrow	(18)
Cynodon dactylon (bermudagrass)	Tufted Titmouse	(1)
	Robin	(5)(2)(2)(1) (1)(2)(1)
	Eastern Bluebird	(1)
	House Sparrow	(1)
	Red-winged Blackbird	(1)(1)
Digitaria ischaemum (smooth crabgrass)	Roadrunner	(2)
	Robin	(4)(1)(4)
	Eastern Bluebird	(1)(1)

Gramineae (continued)

Digitaria sanguinalis (crabgrass)	Roadrunner	(4)
	Eastern Phoebe	(43)(20)
	Blue Jay	(14)
	Tufted Titmouse	(7)
	Carolina Wren	(2)
	Mockingbird	(1)
	Robin	(4)(3)(33)(147) (1)(3)(10)(9)
	Eastern Bluebird	(1)(9)(3)(1)
	House Sparrow	(13)
	Blue Grosbeak	(1)
	Lark Sparrow	(2)
Eleusine indica (goosegrass)	Blue Jay	(26)
	Robin	(4)(1)(66) (1)(33)(3)
	Eastern Bluebird	(2)(4)
Elymus canadensis (Canada wildrye)	House Sparrow	(1)
Eragrostis barrelieri (Mediterranean lovegrass)	Eastern Phoebe	(1)
Eragrostis capillaris (lacegrass)	Eastern Phoebe	(1)(1)
	House Sparrow	(2)
Eragrostis curtipedicellata (gummy lovegrass)	Barn Swallow	(4)
	Blue Jay	(12)
Eragrostis hirsuta	Scissor-tailed Flycatcher	(1)
	Blue Jay	(1)
Eragrostis intermedia (plains lovegrass)	Scissor-tailed Flycatcher	(1)
Eragrostis megastachya (stinkgrass)	Blue Jay	(1)
	House Sparrow	(1)
Eragrostis pilosa (India lovegrass)	Robin	(8)(1)
Eragrostis spectabilis (purple lovegrass)	Scissor-tailed Flycatcher	(1)
	Eastern Phoebe	(1)
	Robin	(1)
	Bell's Vireo	(1)
Eragrostis sp.	Eastern Phoebe	(1)

Gramineae (continued)

Eriochloa contracta (prairie cupgrass)	Brown Thrasher	(1)
	Robin	(2)
	Eastern Bluebird	(1)(6)
	Red-winged Blackbird	(1)
Festuca elatior (meadow fescue)	Blue Grosbeak	(1)
Festuca obtusa (nodding fescue)	Carolina Wren	(1)
Festuca octoflora (sixweeks fescue)	Roadrunner	(2)
	Eastern Bluebird	(1)
	House Sparrow	(6)
	Red-winged Blackbird	(131)(197) (2)(432)(62)
	Blue Grosbeak	(100)
Hordeum pusillum (little barley)	Barn Swallow	(1)
	Blue Jay	(1)
	Brown Thrasher	(1)
	Robin	(1)
	Eastern Bluebird	(3)
	Field Sparrow	(1)
Leptochloa filiformis (red sprangletop)	Robin	(1)
Leptoloma cognatum (fall witchgrass)	Roadrunner	(1)
	Robin	(2)
	Eastern Bluebird	(1)(2)(2)
	Bell's Vireo	(3)(2)
	Blue Grosbeak	(2)(1)
Panicum capillare (common witchgrass)	Eastern Phoebe	(1)
Panicum dichotomiflorum (fall panicum)	Eastern Phoebe	(1)(3)
	Robin	(7)
	Eastern Bluebird	(5)
	Red-winged Blackbird	(1)
Panicum clandestinum	Blue Jay	(1)
Panicum sp.	Red-winged Blackbird	(1)

Gramineae (continued)

Paspalum setaceum, var. ciliatifolium (fringeleaf paspalum)	Roadrunner	(2)
	Eastern Phoebe	(1)
	Blue Jay	(4)
	Mockingbird	(3)
	Brown Thrasher	(1)
	Robin	(4)(8)(1)(1)
	Eastern Bluebird	(1)
	Red-winged Blackbird	(1)(1)
	American Goldfinch	(1)
	Lark Sparrow	(1)
Paspalum dilatatum (dallisgrass)	Robin	(1)
Paspalum pubiflorum (hairyseed paspalum)	Eastern Phoebe	(1)
Poa annua (annual bluegrass)	Carolina Wren	(1)
	Mockingbird	(4)
	Robin	(50)(7)(5)
	Eastern Bluebird	(1)(2)
	House Sparrow	(1)
Poa pratensis (Kentucky bluegrass)	Robin	(22)(1)(1)
Poa sylvestris (woodland bluegrass)	Robin	(1)
Schedonnardus paniculatus (tumblegrass)	Eastern Bluebird	(3)
Setaria glauca (yellow bristlegrass)	Robin	(1)
Setaria geniculata (knotroot bristlegrass)	Eastern Phoebe	(2)
	Robin	(1)
Sorghum halepense (Johnson grass)	Barn Swallow	(2)
	Robin	(3)(2)(4)
	Eastern Bluebird	(2)
	Red-winged Blackbird	(1)
	Blue Grosbeak	(1)
	Lark Sparrow	(1)
Sorghum vulgare (sorghum)	Robin	(1)
	Eastern Bluebird	(3)(1)

Gramineae (continued)

Sporobolus asper (tall dropseed)	Eastern Phoebe	(1)
	Eastern Bluebird	(1)
	Dickcissel	(1)
Sporobolus cryptandrus (sand dropseed)	Eastern Phoebe	(1)
	Barn Swallow	(1)
	Blue Jay	(1)
	Robin	(1)(1)(12)
	Eastern Bluebird	(4)(5)(4)
	House Sparrow	(10)
	Lark Sparrow	(1)(1)
Sporobolus vaginiflorus (poverty dropseed)	Scissor-tailed Flycatcher	(1)(1)
	Brown Thrasher	(2)
	Robin	(5)(7)
	Dickcissel	(1)
	Lark Sparrow	(1)(1)
Sporobolus pyramidatus (whorled dropseed)	Eastern Bluebird	(6)
Sporobolus sp.	Brown Thrasher	(1)
Tridens flavus (purple top)	Eastern Bluebird	(1)
Trisetum interruptum (trisetum)	Lark Sparrow	(1)

Cyperaceae

Carex gravida (sedge)	Robin	(2)
Cyperus acuminatus (taperleaf flatsedge)	Red-winged Blackbird	(1)
Cyperus odoratus	Barn Swallow	(1)
	Red-winged Blackbird	(1)(2)(1)(1)
Eleocharis sp.	Red-winged Blackbird	(1)

Juncaceae

Juncus diffusissimus	Red-winged Blackbird	(1)
Juncus interior (inland rush)	Eastern Bluebird	(1)

Juncaceae (continued)		
Juncus marginatus	Red-winged Blackbird	(1)
Juncus torreyi (Torrey rush)	Red-winged Blackbird	(1)
Iridaceae		
Sisyrinchium angustifolium (common blue-eyedgrass)	Robin	(2)
Ulmaceae		
Celtis occidentalis (common hackberry)	Tufted Titmouse	(1)
Ulmus americana (American elm)	Robin Eastern Bluebird	(7)(1)(2) (2)
Moraceae		
Morus niger (black mulberry)	Tufted Titmouse	(70)
Morus sp.	Robin Eastern Bluebird	(9)(36) (8)
Polygonaceae		
Polygonum lapathifolium (curltop smartweed)	Robin	(1)
Rumex crispus (curled dock)	Eastern Bluebird	(1)
Amaranthaceae		
Amaranthus graecizans (tumbleweed)	Robin	(1)
Amaranthus palmeri (Palmer pigweed)	Robin	(2)
Amaranthus tamariscinus (water hemp)	Robin	(1)
Phytolaccaceae		
Phytolacca americana (common pokeberry)	Eastern Bluebird	(1)

Aizoaceae		
Mollugo verticillata (carpetweed)	Robin	(1)
	Eastern Bluebird	(1)
Caryophyllaceae		
Arenaria serpyllifolia (thymeleaf sandwort)	Brown Thrasher	(6)
Cerastium vulgatum (big cerastium)	Robin	(1)
Sagina decumbens (Trailing pearlwort)	Red-winged Blackbird	(1)
Stellaria media (chickweed)	Scissor-tailed Flycatcher	(1)(1)
	Eastern Phoebe	(1)
	Blue Jay	(2)
	Tufted Titmouse	(1)
	Carolina Wren	(187)
	Robin	(16)(1)(8)(1)
	House Sparrow	(1)
	Blue Grosbeak	(1)
	Lark Sparrow	(1)
Cruciferae		
Capsella bursa-pastoris (shepherd's purse)	Blue Jay	(1)
	Robin	(3)(6)
	Eastern Bluebird	(8)(9)
	House Sparrow	(20)
	Lark Sparrow	(1)
Draba brachycarpa (draba)	Robin	(2)
Lepidium austrinum	Yellow-billed Cuckoo	(7)
Lepidium densiflorum (peppergrass)	Blue Jay	(1)
	Brown Thrasher	(1)
	Robin	(1)
	Eastern Bluebird	(13)(2)
	Dickcissel	(2)(2)
	Blue Grosbeak	(6)
Lepidium virginicum (Virginia pepperweed)	Roadrunner	(2)
Lepidium sp.	Robin	(2)(1)(2)
	Blue Grosbeak	(5)

Cruciferae (continued)		
Sibara virginica	Robin	(21)
Leguminosae		
Desmodium sp. (tickclover)	Eastern Phoebe	(1)
Lespedeza stuevei (Stuves lespedeza)	Red-winged Blackbird	(1)
Melilotus alba (white sweetclover)	Eastern Phoebe	(2)
Trifolium repens (white clover)	Robin	(2)
Oxalidaceae		
Oxalis dillenii (common yellow oxalis)	Eastern Phoebe	(1)
Euphorbiaceae		
Croton glandulosus (croton)	Eastern Phoebe	(1)
Euphorbia prostrata (euphorbia)	Robin	(2)
Vitaceae		
Vitis cinerea (wild grape)	Roadrunner	(2)
Violaceae		
Viola kitaibeliana (johnny-jump-up)	Red-winged Blackbird	(1)
Onagraceae		
Oenothera laciniata (cutleaf evening-primrose)	Roadrunner Barn Swallow	(1) (1)
Oenothera speciosa (white evening-primrose)	Eastern Phoebe	(1)

Umbelliferae		
Ammoselinum popei (sand parsley)	House Sparrow	(7)
Anthriscus scandicina (chervil)	Robin	(5)
Chaerophyllum tainturieri (chervil)	Robin	(3)
	Eastern Bluebird	(1)
	Dickcissel	(2)
Daucus pusillus (southwestern carrot)	Bell's Vireo	(1)
Torilis arvensis (hedge parsley)	Robin	(1)
Conium maculatum (poison hemlock)	Robin	(1)
Asclepiadaceae		
Asclepias viridis (green antelopehorn)	Brown Thrasher	(1)
Labiatae		
Hedeoma hispida (rough false-pennyroyal)	Scissor-tailed Flycatcher	(2)
	Brown Thrasher	(1)
	Robin	(1)
	Blue Grosbeak	(10)
	Lark Sparrow	(1)
Lamium amplexicaule (henbit)	Blue Jay	(9)
	Tufted Titmouse	(2)
	Mockingbird	(1)
	Robin	(40)(4)(1)(6)
	Eastern Bluebird	(1)
Solanaceae		
Petunia violacea Lindl. (petunia)	Robin	(1)
Solanum nigrum var. *americanum* (nightshade)	Robin	(1)

Solanaceae (continued)		
Solanum rostratum (buffalobur nightshade)	Robin	(1)
Schrophulariaceae		
Veronica peregrina (purslane speedwell)	Robin	(50)(16)
	Red-winged Blackbird	(2)(14)(3)(1)
Plantaginaceae		
Plantago aristata (bottlebrush plantain)	Dickcissel	(1)
Plantago purshii (wooly plantain)	Scissor-tailed Flycatcher	(2)
	Mockingbird	(2)
	Robin	(5)(1)
	Eastern Bluebird	(1)(5)
	Blue Grosbeak	(2)
Plantago virginica (paleseed plantain)	Scissor-tailed Flycatcher	(4)
	Robin	(4)
	Red-winged Blackbird	(1)(1)
	Blue Grosbeak	(1)
	Lark Sparrow	(1)
Plantago sp.	Scissor-tailed Flycatcher	(6)(4)
	Mockingbird	(2)
	Brown Thrasher	(1)
Rubiaceae		
Diodia teres (rough buttonweed)	Scissor-tailed Flycatcher	(1)
Galium aparine (catchweed bedstraw)	Dickcissel	(1)
Hedyotis crassifolia (bluet)	Eastern Bluebird	(1)
Valerianaceae		
Valerianella radiata (cornsalad)	Robin	(1)
Campanulaceae		
Specularia perfoliata (clasping venus-looking-glass)	Red-winged Blackbird	(1)

Compositae

Achillea lanulosa (yarrow)	Dickcissel	(22)
Artemisa ludoviciana (Louisiana sagewort)	Brown Thrasher	(1)
Aster subulatus (aster)	Robin	(4)
	Dickcissel	(1)
Cirsium undulatum (wavyleaf thistle)	American Goldfinch	(1)
Conyza canadensis (horseweed)	Roadrunner	(6)
	Scissor-tailed Flycatcher	(1)
	Blue Jay	(9)
	Tufted Titmouse	(1)
	Robin	(1)(2)(7)(2)
	Eastern Bluebird	(1)(2)(1)
	Bell's Vireo	(3)
	House Sparrow	(1)
	Red-winged Blackbird	(2)(1)
	Cardinal	(2)
	Blue Grosbeak	(7)
	Dickcissel	(1)
Conyza ramosissima	Scissor-tailed Flycatcher	(12)
Coreopsis tinctoria (plains coreopsis)	Robin	(36)(2)
	Dickcissel	(1)
Elephantopus carolinianus (elephant's-foot)	Cardinal	(1)
Erigeron strigosus (daisy fleabane)	Bewick's Wren	(2)
	Robin	(1)
Evax prolifera (rabbit tobacco)	Scissor-tailed Flycatcher	(15)
	Brown Thrasher	(19)
	Robin	(31)
	Lark Sparrow	(1)
Gaillardia suavis (rayless gaillardia)	Eastern Bluebird	(1)
	Lark Sparrow	(28)
Gnaphalium purpureum (purple cudweed)	Red-winged Blackbird	(1)
Gutierrezia dracunculoides (broomweed)	Eastern Bluebird	(1)

Compositae (continued)

Haplopappus ciliatus (goldenweed)	Robin	(1)(1)
Pluchea purpurascens	Barn Swallow	(1)
Solidago missouriensis (Missouri goldenrod)	Robin	(2)
Sonchus asper (prickley sowthistle)	Brown Thrasher	(1)
	Robin	(4)
	Red-winged Blackbird	(1)
	American Goldfinch	(2)
Taraxacum officinale (common dandelion)	Tufted Titmouse	(4)
	Robin	(6)(2)(3)
	House Sparrow	(1)
	Lark Sparrow	(1)
Taraxacum erythrospermum (smooth dandelion)	Brown Thrasher	(1)
	Robin	(3)
	House Sparrow	(1)
Taraxacum sp.	Robin	(1)
Thelesperma ambiguum (greenthread)	Barn Swallow	(1)