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THREATENED AND ENDANGERED SPECIES REPORTS

02/27/95

DOE-0574-95
DOE-FN ODNR
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REPORT

Department of Energy
Fernald Environmental Management Project
P. O. Box 538705
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FEB 27 1995

DOE-0574-95

Ms. Patricia Jones
Natural Heritage Program
Division of Natural Areas and Preserves
Ohio Department of Natural Resources
Building F, Fountain Square
Columbus, OH 43224-1387

Dear Ms. Jones:

THREATENED AND ENDANGERED SPECIES REPORTS

Enclosed for your review are the seven reports for the species surveys conducted at the U.S. Department of Energy's (DOE) Fernald Environmental Management Project (FEMP). These surveys were conducted to update existing threatened and endangered species survey data and to identify any additional species and/or habitat that may exist at the FEMP. These survey results are being submitted to you to ensure that your agency has the latest information on the FEMP, and to obtain concurrence on the findings of the surveys. We would like to arrange a meeting to discuss the results of the reports and receive preliminary input on the management and mitigation of the species. We will contact you in the next few weeks to arrange a meeting.

Past surveys were conducted at the FEMP to establish a database prior to any remedial activities. In 1986-87, Miami University conducted baseline ecological surveys of the Fernald property (Facemire et al., 1990). Several threatened and endangered species were identified within the Miami University report. These surveys were used as the basis for compiling the list of potentially threatened and endangered plant and animal species at the FEMP. Other species were added as a result of consultation with the U.S. Fish and Wildlife Service, the Ohio Department of Natural Resources (ODNR) and the Natural Heritage Program database. From these sources, a determination was made to survey the FEMP for the following species:

- Indiana bat (*Myotis sodalis*)
- Running buffalo clover (*Trifolium stoloniferum*)
- Mountain bindweed (*Polygonum cilinode*)
- Slender fingergrass (*Digitaria filiformis*)
- Cave salamander (*Eurycea lucifuga*)
- Spring coralroot (*Corallorhiza wisteriana*)
- Sloan's crayfish (*Orconectes sloanii*)

Recycled and Recyclable

To briefly summarize the surveys, good habitat for the federally-listed endangered Indiana bat (*Myotis sodalis*) was designated along Paddys Run and the Storm Sewer Outfall Ditch. Moderate and marginal habitat for the state-listed endangered cave salamander (*Eurycea lucifuga*) was designated in one on-property and one off-property limestone-lined well, with moderate habitat in a ravine in the northeastern section of the FEMP. The state-listed threatened Sloan's crayfish (*Orconectes sloanii*) was confirmed in Paddys Run in the northern section of the FEMP property. Attachment A provides a summary of each species survey.

If you have questions regarding this matter, please contact Pete Yerace at (513) 648-3161.

Sincerely,

Glenn Griffith
for Jack R. Craig
Director

FN:Yerace

Enclosure: As Stated

cc w/o enc:

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c/o Duane Rayle

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Report on the Status of the Sloan's Crayfish (*Orconectes sloanii* Bundy) at the Fernald Environmental Management Project

P.O. 843147

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November 5, 1993

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EXECUTIVE SUMMARY

On September 15, 1993, Dr. F. Lee St. John visited the Fernald Environmental Management Project (FEMP) site to confirm the presence or absence of Sloan's crayfish (*Orconectes sloanii* or *O. sloanii*) in the on-property section of Paddys Run, an intermittent stream which is a tributary of the Great Miami River. This crayfish is a state-listed threatened species in Ohio. Although the stream was dry throughout much of its course, three pooled areas (two on the property and one off property) were found which supported populations of *O. sloanii*. In Paddys Run and other streams which are at the eastern edge of the range of *O. sloanii*, the survival of the species is threatened by habitat destruction and competition with another crayfish species, *Orconectes rusticus* (which was also found in Paddys Run). Because of the intermittent nature of Paddys Run, the upstream portion within the FEMP site is considered only marginal habitat for *O. sloanii*.

INTRODUCTION AND OBJECTIVES

The purpose of the study was to determine if the crayfish, *Orconectes sloanii*, which is a threatened species in Ohio (Ohio Dept. of Natural Resources 1992), is present as part of the natural resources of the FEMP. The presence of other crayfish species was to be noted (per the scope of work), but since collecting specimens for identification in the laboratory was not desired, the identification of species other than *O. sloanii* was not required. The objective then was to determine the presence or absence of *O. sloanii* in the aquatic environment at the FEMP site.

BACKGROUND

DESCRIPTION OF *O. sloanii*:

Figure 1 shows dorsal and ventral views of a typical male crayfish. Females differ in that: 1) the first pair of pleopods (swimmerets) is NOT enlarged and modified for sperm transfer at copulation and 2) between the bases of the third pair of pereiopods (walking legs), there is a dead-end pouch which serves as a sperm receptacle at copulation and stores the sperm until eggs are extruded and fertilized. This structure is called the annulus ventralis. The shape of the annulus varies for different species but is not a definitive characteristic for species identification. The first pair of male pleopods (called gonopods) is a definitive character for species identification in the form I (breeding) males, where it assumes a more rigid and defined shape than in the form II (non-breeding) males. Fortunately, the form I and form II gonopods of *O. sloanii* are distinctive, making field identification relatively easy. Other characteristics used to distinguish one species of crayfish from another are the shape of the chela (pinchers) and the width and length of the areola (Figure 1). Since the survey conducted found only two species of crayfish in Paddys Run, the other being *Orconectes rusticus*, identifying characteristics of both are included in Figures 2a and 2b for future reference.

DISTRIBUTION OF *O. sloanii*:

Bundy (1876) first described *Cambarus sloanii* (now *Orconectes sloanii*) and indicated that its range was southern Indiana and Kentucky. No Kentucky specimens have ever been found, indicating that Dr. Sloan, who reported this to Bundy, was mistaken. St. John (1988) and many others have collected extensively in Kentucky without finding *O. sloanii*. Rhoades (1941) collected the first *Orconectes sloanii* in Ohio from Shakers Creek in Warren County in 1938. Additional Ohio specimens were collected from Butler, Darke, Hamilton, Montgomery, and Preble Counties (Rhoades 1941, 1944). Rhoades (1962) further defined the range of *O. sloanii* in Ohio by listing it as occurring in Butler, Darke, Hamilton, Miami, Montgomery, Preble, Shelby, and Warren Counties. St. John (1988) stated that the species had been extirpated from Miami and Shelby Counties. The range is now known to include parts of Indiana and Ohio (Figure 3). *Orconectes sloanii* is not known to occur anywhere else in the United States beyond the areas of Ohio and Indiana (Figure 3).

NATURAL HISTORY OF *O. sloanii*:

Few crayfish life histories have been documented. This is true for *O. sloanii*; however, the life history may be assumed to be similar to other species of the genus *Orconectes*, such as *O. sanborni*, described by St. John (1976). To summarize, young hatched in the spring of the first year of their life and apparently underwent several closely spaced molts. (Animals with exoskeletons can increase in size only by periodic molting.) The sex of the juveniles was obvious by midsummer because the annulus ventralis, or sperm receptacle, of the female appeared at this time (Figure 1). The first pair of pleopods in males (sperm transfer appendages) became distinctively longer than those of the females. Following the first summer's growth, only two molts occurred in one year, one in the autumn (or late summer) and one in the spring. Both sexes usually reached sexual maturity by the autumn of their second year. At this time, the males molted and became form I (breeding), and the eggs in the females (which also molt at this time) began to increase in size. During the spring molt, the males reverted to form II (non-breeding) until the next autumn molt, when they returned to form I. The maximum life span was found to be 37 months.

HABITAT PREFERENCE OF *O. sloanii*:

Rhoades (1941) described the preferred habitat of *O. sloanii* as being streams with flat bottoms, covered with broken and rounded stones. *Orconectes sloanii* is often found near algal beds and aquatic vegetation. Temperature does not seem to be an important factor in its distribution.

St. John (1991) noted the relative decrease in populations of *O. sloanii* (vis-a-vis populations of another crayfish, *Orconectes rusticus*) in stressed environments such as streams which had been subjected to the effects of urbanization, construction, channelization, and pollution.

In his 1991 study, St. John found that the ratio of *O. sloanii* to *O. rusticus* had actually increased at a site in Hamilton County. This site is in a tributary of the Dry Fork of the Whitewater River, which is adjacent to the entrance of the Miami Whitewater Forest (3.75 km from the FEMP site). He suggested that the relatively protected environment provided by this forest was responsible for the success of the *O. sloanii* population there.

In the author's experience, the best habitat for O. sloanii is a stream with constant (but not necessarily fast) current flowing over a rocky bottom. Algal growth upon and around the rocks is common. Stress to the stream ecosystem (ie., construction projects, siltation and pollution) favors *O. rusticus* to the detriment of *O. sloanii*.

Because crayfish "breathe" via gills located beneath the carapace (Figure 1), any stream siltation may decrease the ability of the animal to survive. Organic pollution, such as sewage, will increase the demand for dissolved oxygen by the decomposing organisms (fungi and bacteria) in the stream, thereby reducing the oxygen available for other stream organisms such as the crayfish populations. Toxic wastes, of course, will also be detrimental to the aquatic organisms, either by killing them directly or by killing other organisms whose decay will deplete the water of dissolved oxygen.

COMPETITION WITH OTHER SPECIES OF CRAYFISH:

Since *O. sloanii* was found only with *O. rusticus* in Paddys Run, this sympatric situation will be addressed. Unfortunately, most studies have shown that ANY species of *Orconectes* crayfish fare poorly in competition with *O. rusticus*. Jezerinac (1982) found that *O. rusticus* was replacing *O. propinquus* in the Chagrin River in northeastern Ohio and suggested that the aggressiveness of *O. rusticus* was a possible cause for this replacement. Butler (1983) discussed the success of *O. rusticus* in competition with *O. sanborni* in Ohio and concluded that *O. rusticus* was more aggressive, grew more rapidly, produced more young, and attained a larger adult size than *O. sanborni*. *Orconectes rusticus* was reported to be replacing *O. propinquus* and *O. virilis* in the Kawartha Lakes region of southern Ontario (Berrill 1978). Capelli (1982) found *O. rusticus* displacing other species of *Orconectes* in northern Wisconsin, but was uncertain of the mechanism responsible for the success of *O. rusticus*. St. John (1991) studied Ohio locations where *O. sloanii* and *O. rusticus* were found together in 1975 through 1977 and showed that, in general, the percentage of *O. sloanii* specimens in recent collections had decreased over the intervening 12 to 14 years. It seems clear that, in an environment subjected to stress (e.g., pollution, siltation and channelization), the O. *sloanii* population will suffer more than the *O. rusticus* population, which may in fact be enhanced.

STATUS OF *O. sloanii*:

Jezerinac (1986) suggested that the crayfish *O. sloanii* be placed on the Ohio list of threatened species. In the absence of *O. rusticus*, greater numbers of *O. sloanii* were found in streams. This suggests that *O. rusticus* competes with and displaces *O. sloanii*.

Additionally, *Orconectes sloanii* is threatened by urban development, stream impoundment, water pollution, and siltation. Combined with competition with the more prevalent *O. rusticus*, *O. sloanii* populations have been declining in Ohio. Because of its limited Ohio distribution, any additional population losses may lead to its elimination in the state.

Paddys Run is at the eastern edge of the range of *O. sloanii*, but at the edge of its range, a species may be either expanding or diminishing in numbers. The *O. sloanii* population appears to be diminishing at the eastern edge of its range in Ohio, as shown by its extirpation from Miami and Shelby Counties in Ohio (St. John, 1988). This seems to be due to habitat destruction and competition from *O. rusticus*. Neighboring populations in Indiana appear to be stable because of minimal habitat alteration. As a result, Ohio has conferred threatened status on *O. sloanii* while Indiana has not (Ohio Dept. of Natural Resources 1992; Indiana Dept. of Natural Resources 1993).

SITE DESCRIPTION AND METHODS

Although the objective of the study was to be qualitative and to determine only the presence or absence of *O. sloanii* at the FEMP site, only two stream species of crayfish were found at the site; since the other species was easily identified in the field as *O. rusticus*, unanticipated quantitative data regarding the ratio of the two species at the sampling sites were obtained. This data may be useful to determine future trends in the survival of these two species in sympatry (species occurring in the same area), especially since *O. rusticus* appears to outcompete *O. sloanii*.

The original survey planned to include collection and identification of crayfish from several sites along the stream within the FEMP boundaries, as well as from the Storm Sewer Outfall Ditch (SSOD). Because of the unusually dry summer weather in the area, the SSOD and most parts of Paddys Run were dry, making crayfish sampling very difficult. However, three pooled areas were found in the creek, two near the bridge of the railroad siding which enters the FEMP site and one downstream (south) from the FEMP boundary at the New Haven Road bridge (Figure 4). At these three sites, *O. sloanii* was obtained by seining the creek with a minnow seine (1.2 x 1.8 m; 0.64 cm mesh). The pooled areas are not the preferred habitat for *O. sloanii*, but were the only places where crayfish might survive while the stream was so dry.

If a comparison of the dynamics of the crayfish populations in Paddys Run with a reference stream was needed, the tributary of the Dry Fork of the Whitewater River at the bridge on New Haven Road just east of the village of New Haven in Hamilton County might be a good choice. This site is near the entrance to the Miami Whitewater Forest. St. John (1991) found populations of both *O. sloanii* and *O. rusticus* in 1977 and 1989. Data from this stream showed an increase in the ratio of *O. sloanii* to *O. rusticus* over the twelve years. This is a location protected from pollution, siltation, and urbanization, which may explain the unusual success of *O. sloanii* in competition with *O. rusticus* here.

RESULTS

It is not surprising that *O. sloanii* might occur in Paddys Run since it has been collected from nearby tributaries of the Great Miami River including Indian Creek, Four Mile Creek, and the Dry Fork of Whitewater River (St. John 1988).

On September 15, 1993, the author visited the FEMP site to check for the presence of the crayfish *O. sloanii* in Paddys Run and the SSOD. Positive identification of crayfish requires breeding form (form I) males so that the gonopods may be identified. Some form I males were found, making the accurate determination of the species possible.

At Site 1, only *O. sloanii* was found. Two females, one breeding form (form I) male and one non-breeding form (form II) male were found. At Site 2, under the bridge of the FEMP railroad siding, 12 specimens of *O. rusticus* were obtained as well as seven *O. sloanii* [1 male (form I), 3 males (form II) and 3 females]. Three sweeps of the seine were used to collect these 19 specimens. At Site 3, north of the railroad bridge, three sweeps of the seine produced two *O. rusticus* and two *O. sloanii* (both male form I). All specimens were identified and returned to the stream.

CONCLUSIONS AND SUMMARY

Much of Paddys Run was dry during sampling in September 1993; however, this does not mean that *O. sloanii* has been extirpated from these portions of Paddys Run (or the SSOD). In studies of *Orconectes nais* in an intermittent stream in Oklahoma, Momot (1966) determined that crayfish with relatively low reproductive rates can be characterized as organisms which repopulate streams by upstream migration rather than by reproduction in-situ. With ephemeral, intermittent streams, upstream movement is the primary means for stream repopulation. This suggests that, as Paddys Run refills with water in the spring, *O. sloanii* will return from downstream pools. Since spring flooding usually results in stream species being swept downstream, repopulation from the other direction, i.e., from headwater areas toward downstream, is unlikely. However, the size and infrequency of the pools which were remaining in Paddys Run in September 1993 suggest that completely repopulating the stream during the period of spring rains is unlikely. In fact, considering the intermittent nature of Paddys Run (as evidenced by its representation as a dotted line on the USGS topographic map and from information provided by FEMP staff), it appears that this stream should be considered as only marginal habitat for *O. sloanii*.

Maintaining a viable population of *O. sloanii* in the intermittent portion of Paddys Run (which appears to include all of the stream within the boundaries of the FEMP site) would require careful management, including the prevention of: a) siltation from soil erosion accompanying construction, b) the introduction of flyash or other flocculent material which is destructive to gill-breathing animals, c) any damming of the stream, and d) the introduction of polluting chemicals. Constant stream flow is desirable. Any condition which degrades the quality of the stream may lead to the success of the *O. rusticus* population to

the detriment of *O. sloanii*. As noted above, *O. rusticus* appears to be more tolerant and may eventually lead to the extirpation of *O. sloanii*, no matter what precautions are taken. Any extremes of the conditions listed above could, of course, result in the elimination of all crayfish from Paddy Run. It might be possible to relocate the crayfish from the portion of Paddys Run within the FEMP site if it becomes necessary to compromise the integrity of the stream in the future. Seining the pools in the autumn would recover some of the crayfish; some are inevitably missed. Only some of those collected would survive the reintroduction process.

The best sites for possible relocation of *O. sloanii* would be an area of Paddys Run farther south, near its confluence with the Great Miami River. Northern sections of Paddys Run are less optimal because of the ephemeral nature of the water flow in this area. The Dry Fork of Whitewater River in Miami Whitewater Forest, where the species is known to occur (as of June 1989), is an alternative stream for relocation. Conditions for its survival are apt to remain more consistent here, due to the protection of this natural area.

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APPENDIX A
FIGURES

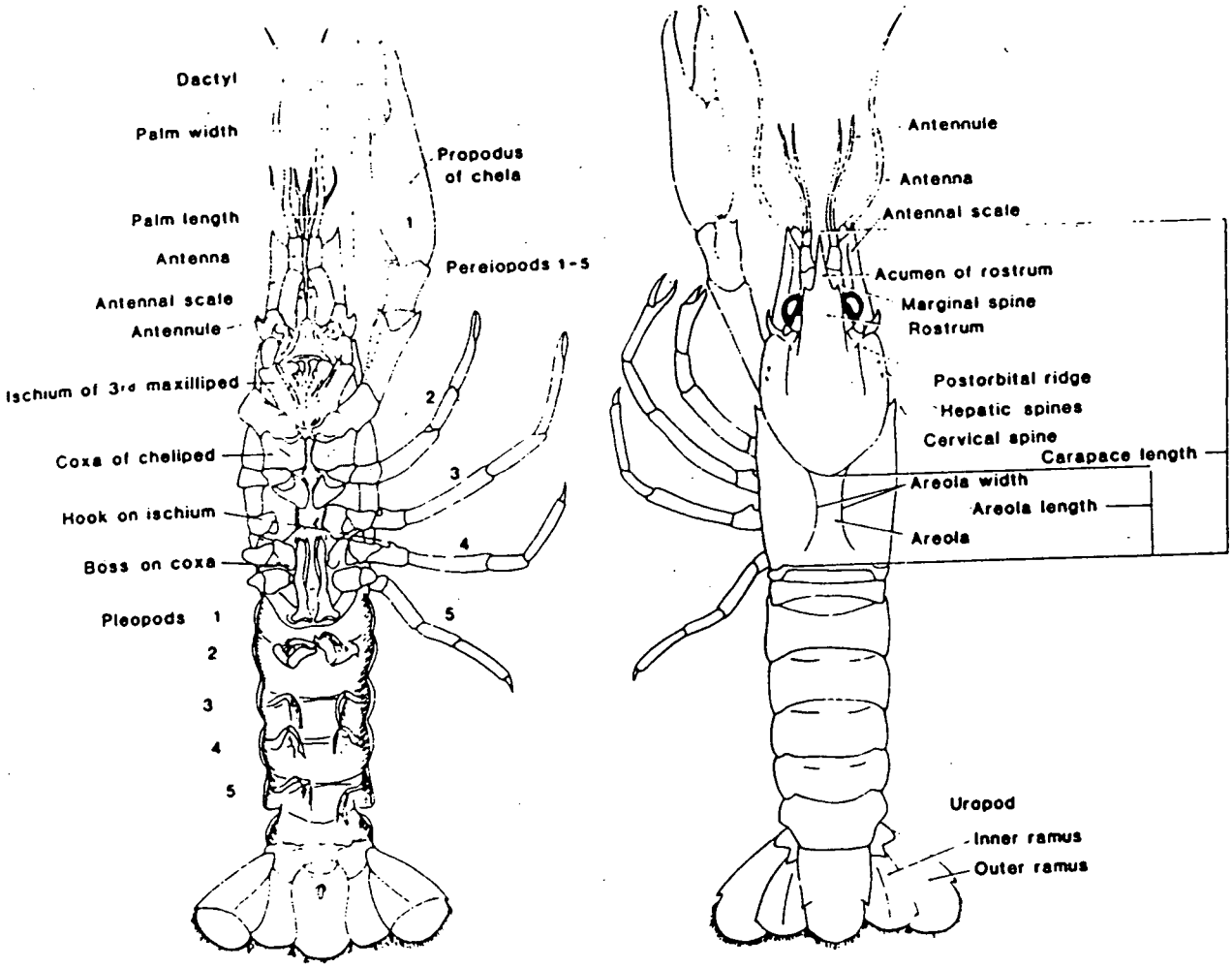

Figure 1: Generalized diagram of crayfish: ventral view on left, dorsal view on right (Hobbs, et al., 1977).

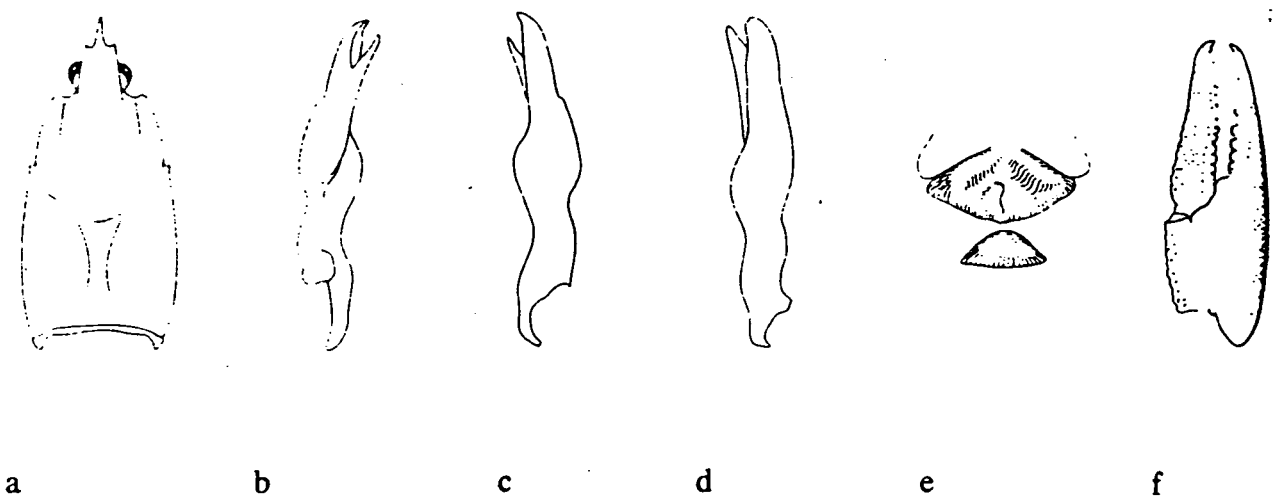

Figure 2a: Identifying characteristics of *Orconectes sloanii* - a. dorsal view of carapace of male, form I; b. mesial view of first pleopod of male, form I; c. lateral view of same; d. lateral view of first pleopod of male, form II; e. annulus ventralis of female; f. dorsal view of chela of male, form I.

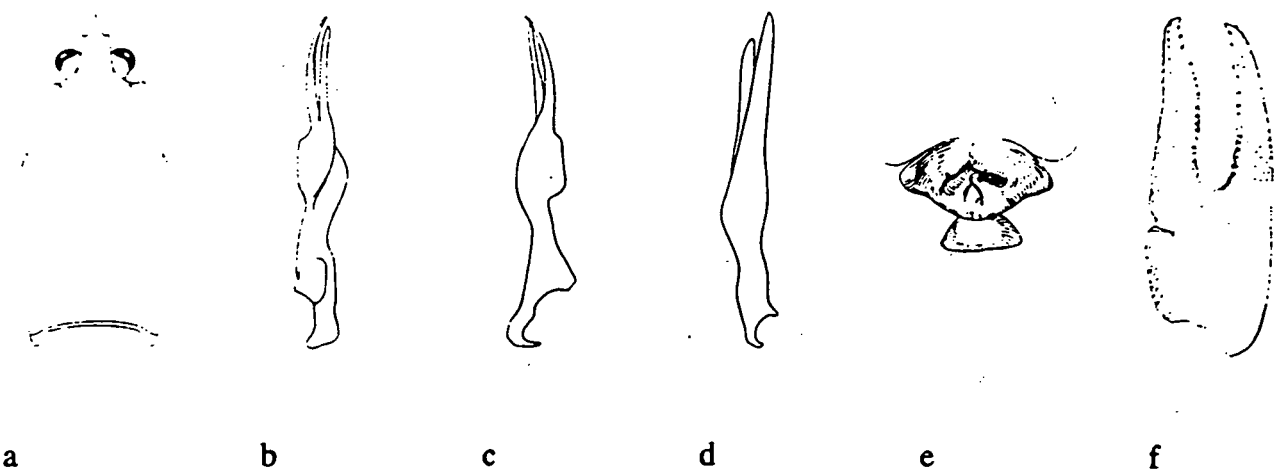

Figure 2b: Identifying characteristics of *Orconectes rusticus*, a, b, c, d, e and f the same as Figure 2a, above.

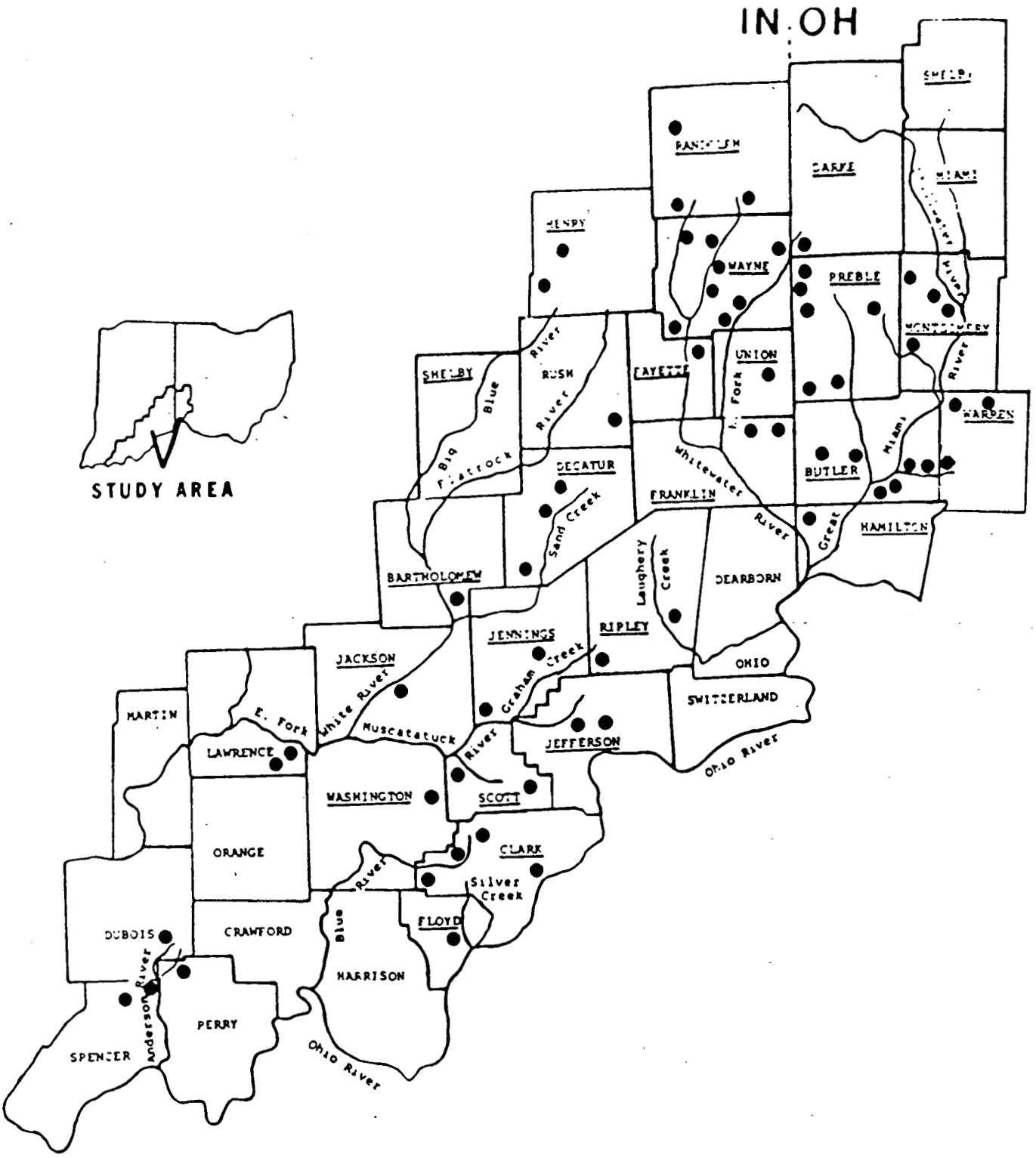

Figure 3: Distribution of the crayfish species *Orconectes sloanii* throughout its entire range (Indiana and Ohio). Each dot represents a collection of crayfish containing specimens of *O. sloanii*, collected by the author from 1975 through 1989 (St. John 1988).

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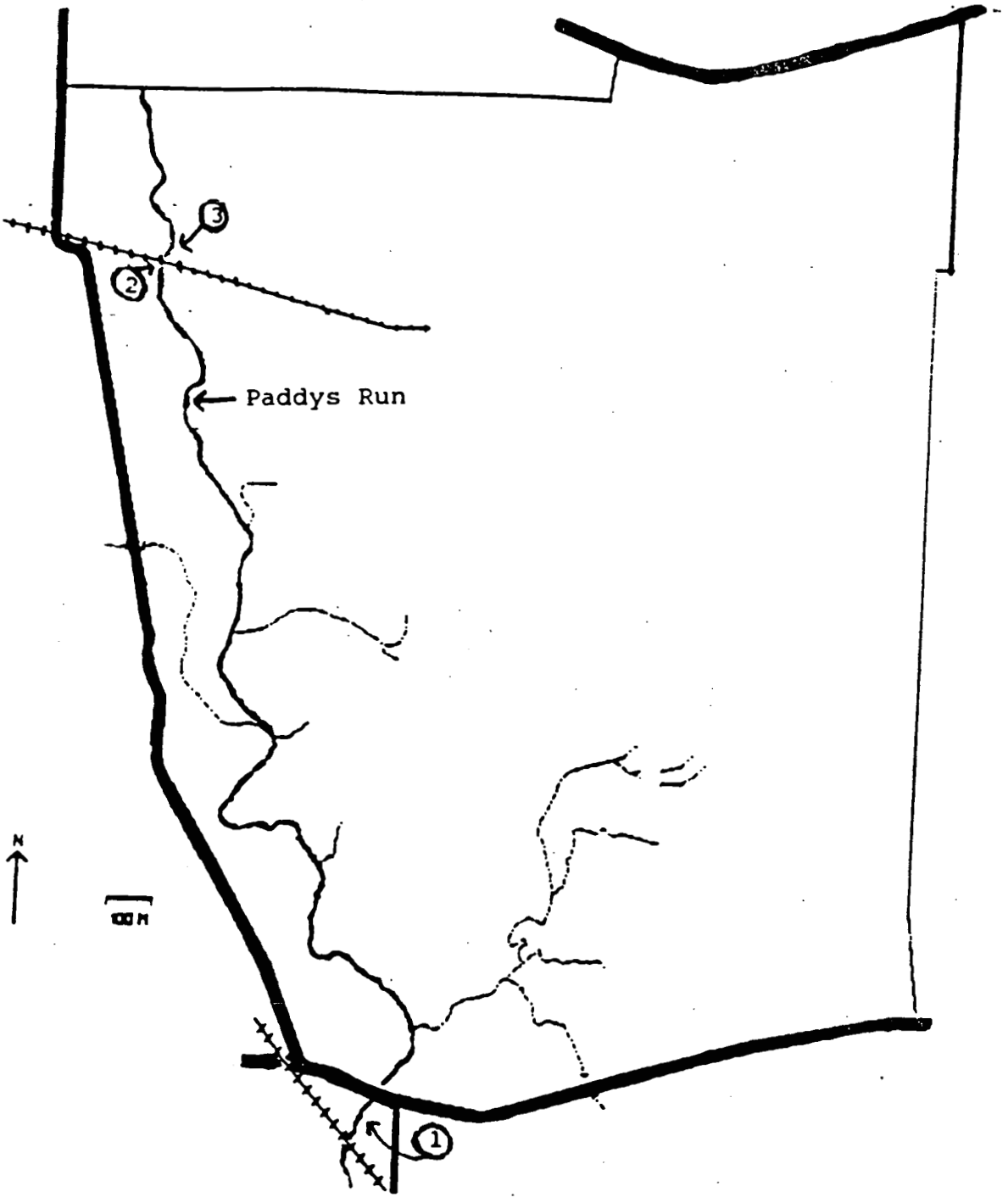

Figure 4: Map of the FEMP site showing the three crayfish collection sites, with numbers in circles (modified from Facemire, et al., 1990.)

Addendum to the Report on the Status of the Sloan's Crayfish, *Orconectes sloanii* (Bundy, 1876), at the Fernald Environmental Management Project (FEMP) (P.O. JM-69471)

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The Ohio State University
Newark, Ohio 43055

June 24, 1994

Proposal No. JM-69471, dated Nov. 5, 1993, reported on the status of Sloan's crayfish, *Orconectes sloanii* (Bundy, 1876), at the Fernald Environmental Management Project (FEMP) site. This crayfish is a threatened species in Ohio. During the survey (September 15, 1993), specimens of Sloan's crayfish were found at three localities within Paddys Run. One of these sites was located off property south of the FEMP boundary. All three localities were pooled areas while the remainder of the creek bed was dry.

It was predicted in the report that the crayfish would repopulate the run and riffle portions of the stream when water returned to the creek bed following spring rains. It was further suggested that (1) this would occur by upstream migration from the pools which had served as refugia during the summer (and, of course, winter) and (2) that, due to the intermittent nature of Paddys Run, completely repopulating the stream following spring rains, but before summer drying, would be unlikely.

On May 21, 1994, the author examined 25 sites along Paddys Run (three of these were off-property), which was flowing throughout the entire section along the FEMP property. The Storm Sewer Outfall Ditch was also surveyed.. Crayfish, where present, were collected by using a minnow seine (1.2 m x 1.8 m; 0.64 cm mesh). They were identified in the field and then returned live to the stream. Seven of the 24 sites yielded crayfish and six of these seven sites yielded specimens of *O. sloanii*. The other crayfish species found in Paddys Run, either alone or in sympatry with *O. sloanii*, was *Orconectes rusticus*, which was also true in the 1993 sampling (Table 1 and Figure 1).

Reference to the 1993 report will show that the two on-property locations where *O. sloanii* was found were two pooled areas, one immediately north and one immediately south of the railroad trestle, in the northwest section of the FEMP property. These correspond to sites 4 and 5 in Figure 1 of this report. The fact that *O. sloanii* was not found at these sites during this survey is not surprising since *O. sloanii* prefers riffles and runs with rocky bottoms. The dry conditions found in September had forced the "survivors" into the less desirable pool habitat where they remained during the summer as well as the winter. Following the spring rains, the species has migrated from the pool refugia to repopulate the runs.

It should be noted that off-property sites in Figure 1 (numbers 23, 24 and 25) are at the same location as site C sampled in 1993, where New Haven Road crosses Paddys Run. The 1993 report map is in error; site 1 should be farther south, beyond the limits of the map.

From the brush and debris caught in vegetation along the banks of Paddys Run, it was obvious that the spring flood(s) preceding the May 21 survey had raised the water level three to four feet above normal and had subjected the stream to a swift current. While crayfish could be dislodged from an upstream pool and redistributed downstream, such a flood current would probably sweep them far downstream. A more likely mode of repopulation would be the slow downstream movement following the cessation of the spring

flooding. The 1993 report, however, cited Momot (1966): "Crayfish, which have a relatively low reproductive rate, should definitely be added to the list of organisms that repopulate streams by upstream migration rather than by reproduction in situ." It is obvious that in Paddys Run, *O. sloanii* is repopulating by migration, but by downstream migration rather than upstream. This is evident by the specimens collected from sites 6 through 10, just downstream from the pools at the railroad bridge. However, this slow downstream repopulation of the stream has currently extended only about 1000 feet from the pool areas. Further downstream movement may well be limited by the annual summer drying of most of the streambed.

The population of *O. sloanii* appears to be localized near the railroad bridge over Paddys Run in the northwest portion of the FEMP site. The crayfish are confined to the permanent pools at this location when the remainder of the stream is dry and they repopulate the stream in the spring (after the floods) by downstream migration. This is a slow process, proceeding this spring only about 1000 feet by May 21. It is anticipated that further downstream migration may well be hindered by the summer drying of the streambed. Although periodic summer rains may temporarily restore water to intermittent portions of Paddy Run, the discontinuous nature of the habitable parts of the stream will preclude any further significant repopulation. To reiterate the 1993 report, Paddys Run is only marginal habitat for *O. sloanii* for the reasons just cited.

Collecting site 21 (Figure 1) is the Storm Sewer Outfall Ditch. Inasmuch as it was dry at the time of the 1993 report, sampling was again attempted for the current report. The Storm Sewer Outfall Ditch was dry again in May 1994, leading to the conclusion that its extreme intermittent nature makes it an unlikely habitat for any species of stream crayfish.

An off-property population of *O. sloanii* seems to be similarly established near where New Haven Road crosses Paddys Run. However, this population does not appear to migrate significantly upstream to include any part of Paddys Run within the FEMP boundaries. For the study of the FEMP property, this population may be disregarded except (1) as it might be influenced by siltation and/or pollution travelling downstream, or (2) as a possible site for relocation of on-property *O. sloanii*, if needed (however, a more suitable relocation site was suggested in the Nov. 5, 1993, report by this author.). Unfortunately, no studies of crayfish relocation projects are known to the author and the success of such an endeavor is uncertain.

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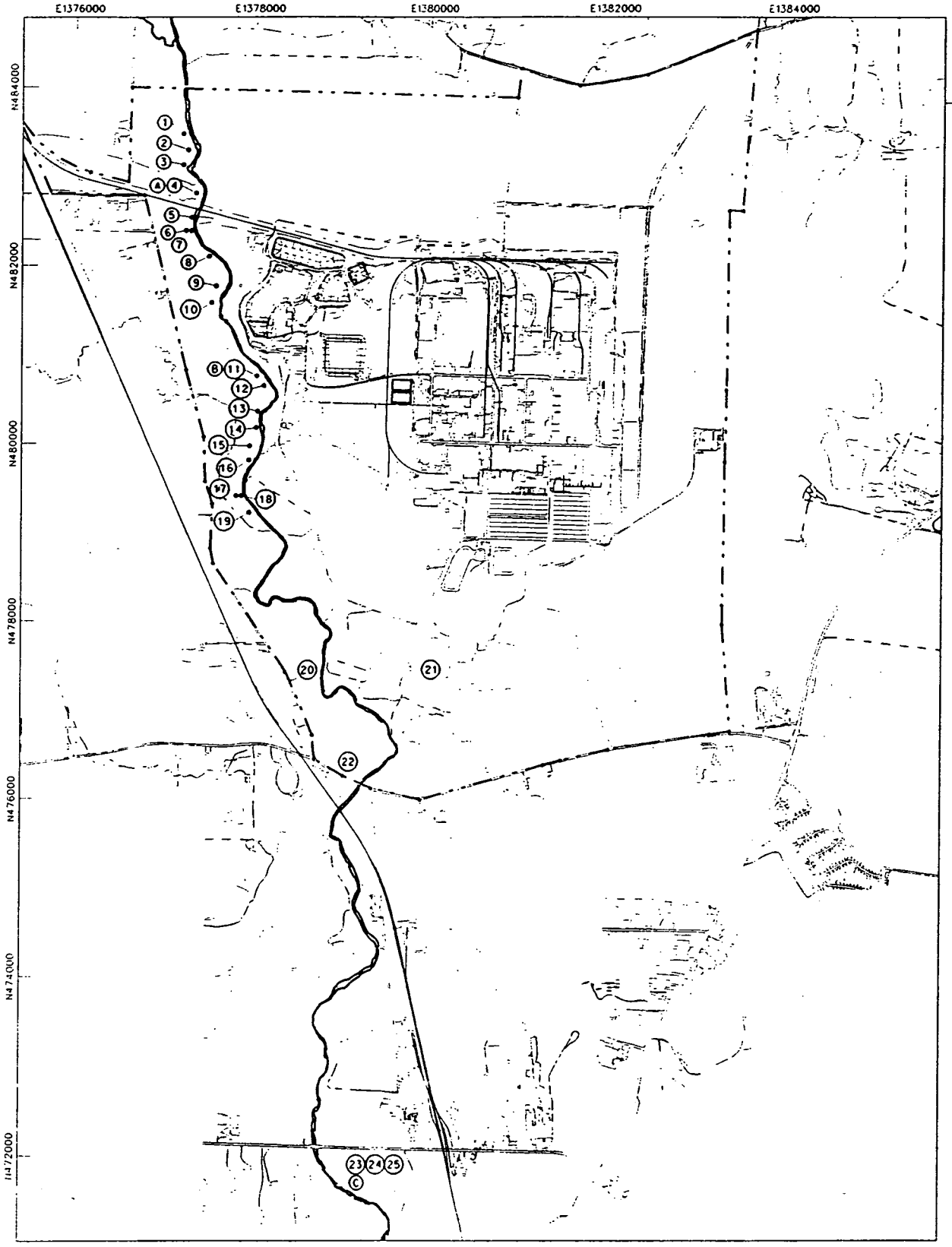
TABLE 1

Collecting Sites	Results
1	no specimens
2	no specimens
3	no specimens
4	no specimens
5	no specimens
6	1 *O. sloanii*
7	3 *O. sloanii*, 3 *O. rusticus*
8	3 *O. sloanii*, 3 *O. rusticus*
9	1 *O. sloanii*, 2 *O. rusticus*
10	1 *O. sloanii*, 2 *O. rusticus*
11	no specimens
12	no specimens
13	no specimens
14	no specimens
15	no specimens
16	no specimens
17	2 *O. rusticus*, 1 unidentified juvenile
18	no specimens
19	no specimens
20	no specimens
21	no specimens
22	no specimens
23	2 *O. sloanii*, 1 *O. rusticus*
24	no specimens
25	no specimens

FILE NAME /res2233/fish.dgn 8x11 grid5 5-25-94 GES STATE PLANAR COORDINATE SYSTEM 1927



LEGEND:

— · · — · ·	FEMP BOUNDARY
A-C	1993 SAMPLING LOCATIONS
1-25	1994 SAMPLING LOCATIONS

SCALE

1500 750 0 1500 FEET

6799

REPORT ON THE STATUS OF THE CAVE SALAMANDER (*EURYCEA LUCIFUGA*) AT THE FERNALD ENVIRONMENTAL MANAGEMENT PROJECT

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Executive Summary

During August through October 1993, efforts were made to locate potential habitat and populations or individuals of the state endangered cave salamander (*Eurycea lucifuga*) at the Fernald Environmental Management Project (FEMP). Off-property locations were also investigated. The nearest known cave salamander population was found one kilometer (km) north of the FEMP property during a 1988 study and was used as a control for the current study. Following the movements of this species is difficult because the larvae migrate through subsurface water between fissures in limestone. A subsurface geological feature known as the New Haven Trough, where porous silts and clays replace limestone, may inhibit normal larval migration through subsurface water at the FEMP.

In southwest Ohio, adult cave salamanders inhabit limestone areas where groundwater sources open to the surface in the form of intermittent streams, springs, wells, spring houses, and fissures between layers of exposed rock. Two such locations were found at the FEMP. One small, relatively dry ravine near the northern border of the FEMP property was determined to be poor habitat for cave salamanders. The second, a limestone-lined well (Well No. 1124) on a former home site, was more suitable, offering crevices between rocks above the water line in which adults could hide and a deep pool of water for reproduction and larval development. Although no adult or larval cave salamanders were found on FEMP property during this survey, suitable habitat was identified.

Within a radius of seven kilometers of the FEMP, there are known populations of cave salamanders to the north, south, southwest, and east. Well No. 1060, off property but adjacent to the southern border of the FEMP on Willey Road, offers suitable habitat for cave salamanders. An unidentified salamander fitting the description of a postmetamorphic cave salamander was seen in this well and described by a groundwater technician.

Additional survey efforts during periods of optimal cave salamander activity could provide more conclusive evidence about the presence or absence of populations or individuals on FEMP property. If populations or individuals are found on FEMP property in the future, strategies for remediation might include financial support to protect habitat of known populations in the vicinity of the FEMP. This is preferable to relocation of any individuals to other areas.

Introduction

The objectives of this study were to delineate potential habitat for the state endangered cave salamander and to locate cave salamander populations on U.S. Department of Energy (DOE) property at the Fernald Environmental Management Project (FEMP). Field work began on August 27, 1993 and was concluded by October 10, 1993. This was in accordance with Fernald Environmental Restoration Management Corporation (FERMCO) schedule of deliverables (P.O.#942291). Across most of their range, cave salamanders usually inhabit the twilight zones of caves, which are absent in southwest Ohio; here, the species is typically associated with intermittent limestone streams and ravines that have access to subterranean waterways.

Study Location Description

The FEMP property is located in both Hamilton and Butler Counties on 425 hectares. The western edge of the FEMP property is drained by Paddys Run, a third order stream that approximately parallels the FEMP's western border. Drainage of the eastern half of the property is limited since it is situated on the first terrace north of the Great Miami River floodplain creating wet meadows and some wetland habitats. The former Production Area offers no suitable cave salamander habitat, nor do the extreme southern and eastern edges. Along the northern edge of the FEMP, a pine plantation is located adjacent to a disturbed deciduous wood lot. Although this deciduous wood lot (bordered to the north by State Route 126) slopes steeply, there is only one very small ravine which offers potential cave salamander habitat. Exposed limestone on the valley wall offers access to fissures in the bedrock, which is typical southwest Ohio cave salamander habitat. The margins of Paddys Run were investigated in 1988 (Davis 1988) and designated as potential habitat, based on published descriptions of cave salamander habitat across their entire range (Minton 1972; Conant 1975). However, additional life history information (Juterbock 1986) and experience in the field indicates that small limestone ravines provide optimal habitat in southwest Ohio. The current study led to the conclusion that the habitat is not suitable due to a lack of surface limestone. The reason there is no surface limestone present is because of a subsurface geological feature known as the New Haven Trough in which limestone was replaced by silts and clays during the last glaciation. One other location on the FEMP property offers potential cave salamander habitat. Well No. 1124 (Cone House Well) is situated at a former home site in the field east of the east access road. Its walls are lined with 30-45 centimeters of limestone, which could provide suitable cover for adult cave salamanders and has ample water for their reproduction and larval development. Potential habitat for cave salamanders is shown in Figure 1 (Appendix A).

Natural History of the Cave Salamander (*Eurycea lucifuga*)

Description

The cave salamander is bright orange dorsally and marked with small randomly placed, irregularly shaped black spots (Figure 2, Appendix A). Typically, the venter is yellowish and unspotted. The body and head are slightly compressed dorsoventrally to allow it to slip into narrow rocky crevices, and the eyes appear to protrude beyond what might be expected for a salamander of comparable size. Minton (1972) reported 12 to 14 costal grooves for Indiana specimens, and Pfingsten and Downs (1989) reported 14 or 15 for Ohio specimens. The tail is 51 to 60 percent of the total body length and is prehensile, allowing cave salamanders to actively climb about cave walls (Minton 1972). None of the spots on the tail fuse to form chevrons as they do in the closely related longtail salamander (*Eurycea longicauda*) (Figure 3, Appendix A). These species are sufficiently similar that confusion may occur in the identification, but the tail pattern is conclusive. Male cave salamanders from southwest Ohio average approximately 60 mm, snout-vent length, and females average 62 mm. The largest known specimen was 181 mm total length (Conant and Collins 1991). Males are also distinguished by elongated cirri at the base of their nasolabial grooves and a rounded mental gland (Figure 4). Postmetamorphs are typically more olive with black speckling and the characteristic dorsoventrally flattened appearance. Larvae are lemon yellow with liberally pigmented throats and pigmentation on the ventral surface of the hind feet and on the belly beyond the level of limb insertion. The dorsum has paired light spots and a pale middorsal stripe. Like all stream-dwelling salamander larvae, the tail fin ends at the base of the tail. The number of costal grooves is 13 to 16, and the number of gill slits is four (Brandon 1964). Metamorphosis occurs at around 60 mm total length in Indiana (Minton 1972); in Ohio, Juterbock (1986) reports that metamorphosis occurs between 27 and 33 mm snout-vent length.

Reproduction

Because reproduction occurs underground, little is known about the reproductive behavior of cave salamanders. Females do not lay their first clutch of eggs until they are four years old. Eggs are attached individually to the undersides of submerged rocks by a pedicel (Myer 1958). The number of females with large ova found in Hamilton County increased from 20 percent in May to 100 percent of individuals by July (Juterbock 1986). Egg-laying lasts from October to May with probable wide variation among populations (Hutchinson 1956). Hatchlings are seven to ten mm in total length. Developmental rates are probably influenced by the availability of small invertebrates as forage in the subterranean habitat of the larvae. Most larvae metamorphose in six to nine months, although some may not transform for more than one year (Rudolph 1978).

Range

The cave salamander is known from limestone areas from Virginia westward to Missouri, Kansas, and Oklahoma. North to south distribution extends from Georgia and Alabama to Illinois, Indiana, and extreme southwest Ohio (Figure 5, Appendix A) (Conant and Collins 1991). Exceptions to habitation of limestone areas includes cypress swamps in southern Illinois near rocky bluffs (Smith 1961) and crystalline caves in northeastern Georgia (Banta and McAtee 1906).

In Ohio, cave salamanders are known in only three counties (Figure 6, Appendix A). Daniel (1984) reported them from Adams County based on historical data, but found no specimens from the same sites. Two southwest Ohio counties, Hamilton and Butler, have numerous recently documented cave salamander populations (Davis and Miller 1985; Juterbock 1986; Davis 1988; Davis and Krusling 1989a; Pfingsten and Downs 1989; Davis and Krusling 1990; Davis, et al.,1991; Rubin 1992; Davis and Krusling 1993). Populations in southwest Ohio are at the edge of the species' range. They do not inhabit caves; however, they do inhabit narrow recesses and crevices in limestone areas. The Butler County populations are approximately on the same latitude as the northernmost populations reported by Minton (1972) in Indiana. However, Minton does report two individuals from different sites farther north in Indiana. In southwest Ohio, the Mill Creek Valley seems to form a barrier that limits cave salamander distribution to the western halves of both Butler and Hamilton Counties (Figure 7). Consequently, Butler County populations represent the northeastern edge for this species' distribution. Genetic variation for a species increases in populations farther from the center of its range. Therefore, populations located at the periphery of a species' range represent genotypic diversity for the species. It is for this reason that cave salamanders in Ohio are listed as endangered.

Habitat

Most adult cave salamanders are found in the twilight zones of limestone caves and under rocks in springs and spring-fed streams. Although no caves are known in southwest Ohio, the solubility of limestone does create small subterranean waterways and crevices through which cave salamanders move. Being adapted to cave life, cave salamanders find the small limestone seeps common in southwest Ohio adequate to meet their habitat requirements.

Hutchinson (1956) reported finding adult cave salamanders as much as 12 m above cave floors, some in rock crevices, and others hanging only by their prehensile tail. Larvae live in subterranean waterways and are seldom seen in surface waters, although they occasionally show up in spring-fed streams and cave streams where they emerge from below ground. During drought periods, adults move into subterranean recesses. Subterranean movements of larvae may be important to species dispersal and cause adults to surface in unexpected places. They have been found in cellars and under stones on dry hillsides (Minton 1972;

Davis and Krusling 1990). Sink holes and wells may also provide suitable habitat for adult cave salamanders according to Paul M. Daniel (personal communication), as do the rock foundations of spring houses (Davis and Krusling 1989b). Juterbock (1986) suggests that population size may be related to the extent of subterranean water supplies.

Diet

Several studies have analyzed the diet of cave salamanders. Dipterans, mites, ticks, lepidopterans, pseudoscorpions, small annelids, and small mollusks are consumed by adults (Hutchinson 1956; Juterbock 1986). Studies on larval diet have not been conducted. Other salamander larvae of the genus *Eurycea* are known to consume small aquatic arthropods, especially copepods, chironomid larvae, and plecopteran nymphs (Minton 1972; Pfingsten and Downs 1988).

Seasonal Activity

Surface activity for adults peaks during May and June when temperatures are warm in combination with high moisture levels. Adults are more resistant to desiccation than many other adult *Eurycea,* but, during the drier parts of July and August, they are difficult to find at the surface (Juterbock 1986). During this dry season, postmetamorphic individuals come to the surface to feed. Recently transformed individuals are found more commonly than adults from mid-summer through September. Juterbock found adults active at the surface through November. According to Paul J. Krusling (personal communication), adults in wells at Miami Whitewater Forest are active into the late fall. Likewise, in spring houses, where humidity is constantly high and temperatures stable, adults are active from early spring to late fall (Davis and Krusling 1989a).

Methods and Materials

An initial reconnaissance survey was conducted on foot and by car on August 27, 1993. During this survey, habitats with potential for cave salamander populations were noted and assessments were made to determine which habitats would be monitored during subsequent visits to the study site. Between August 27, 1993 and October 10, 1993, seven days in the field, on- and off-property, were spent identifying potential cave salamander habitat, looking for individuals and/or populations of cave salamanders, and looking for signs of cave salamander surface activity. A population located approximately 1 km north of FEMP property near the Christian Road water tower was used as a control (Figure 1, Appendix A). This population was identified in 1988 in a limestone ravine at what was formerly the Ross Trails Girl Scout Camp (Davis 1988). The property has since been sold to a private land owner who granted permission to access the control location for the purpose of this study.

The control population was used to assess the suitability of surface conditions for cave salamander activity. If individuals were found active above ground at the control location but not at the FEMP habitat locations for at least four visits, then it would be assumed that none exist on the property. However, if no individuals were found at the control location and none were found on FEMP property, then it was concluded that conditions were not optimal for cave salamanders, and accurate conclusions could not be drawn. The main survey method used at the control location and the potential habitat in the ravine along the northern woodlot on the FEMP property was the general search-and-seize method described by Karns (1986). This method allows for the development of species lists and identification of the locality of populations, but does not sample for other ecological data.

A search for wells and cisterns with limestone on former home sites on property revealed one such well. Well No. 1124 was examined as potential cave salamander habitat. A hand-dug well that does not reach the aquifer, the well is lined with loosely mortared limestone. The distance from ground level to the water's surface is 8 m. The diameter of the well is approximately 2 m, and the water is 5.5 m deep. The limestone lining continued to the well's floor. An off-property well, Well No. 1060, was also examined (Figure 1, Appendix A). It is limestone-lined with no mortar between the rocks and is about 1.5 m in diameter. The water's surface was about 4 m from ground level, and the water was approximately 30 cm deep. Because cave salamander larvae move great distances through subterranean water systems, their potential presence (or the presence of adults) in Well No. 1060 might suggest that larvae or adults have moved from the southwest where populations exist at Miami Whitewater Forest and the wooded hillsides southwest of the intersection of New Haven Road and Crosby Road (Davis and Krusling 1993). In Fairfield Township, Butler County, Ohio, a population (voucher specimen is accessioned at the Cincinnati Museum of Natural History, CSNH 2900) is known from an abandoned spring house foundation on East Miami River Road. The nearest known suitable habitat is approximately 4 km southwest on the land owned by and south of Procter and Gamble's Miami Valley Laboratories on East Miami River Road in Colerain Township, Hamilton County. No cave salamanders have been located there. The nearest known specimen (CSNH 3028) came from approximately 10 km southwest of the Fairfield population on East Miami River Road, 5 km north of Harrison Avenue.

Well No. 1124 was examined with the aid of an Electronic Eye 4-Inch Down Hole Camera. Observations were recorded on VHS videotape and examined on a 25-inch color monitor. The monitor was divided into four sections, and each section was viewed individually for any signs of adult cave salamanders between rocks and for larvae in the pool of water at the bottom of the well. Well No. 1060 was well illuminated and sufficiently shallow to examine with a flashlight and unaided eye.

A WILDCO 2400 ml Petite Ponar Grab was used to obtain a sample of sediment from the floor of Well No. 1124 on October 12, 1993. The surface and interface zones of the sediment samples were examined for macroinvertebrates that might serve as cave salamander larvae forage. Similarly, a North's Teflon Bailer was used to collect a one liter sample of

water from the interface zones of Well No. 1124 on October 4, 1993. Twenty 10 ml samples of this water were observed at 10X for suspended macroinvertebrates, particularly copepods, which might serve as forage for cave salamander larvae. Water temperature, pH, and dissolved oxygen were measured and recorded. The percentage of oxygen in the air above the water was also measured and recorded.

Results

At this time, it is inconclusive to determine whether or not cave salamanders inhabit the FEMP. Only two specimens were found at the control location where a stable population existed as recently as 1988. During the 1988 study in which the control population was located, all field work was completed by July because of severe drought. The summer of 1993 has been the harshest drought year since 1988. As a result of having salamander surveys done during the two driest years in recent history, it is highly recommended that a follow-up survey be performed during May and June 1994. Warm, late spring and early summer rains cause cave salamander surface activity to peak.

Five visits were made to look for cave salamanders in the north woodlot ravine, but no individuals were found. Although the conditions proved too dry each time, there were several crevices between rock layers that appeared to open underground. Visits to the FEMP were timed such that they would follow significant rainfall. Adult cave salamanders are typically active when the substrate is sufficiently wet to keep their venter moist (Juterbock 1986). Considering that insufficient moisture was found in the ravine, even after substantial precipitation, the habitat was considered marginal.

The down-hole camera did not reveal any adult or larval cave salamanders, but showed that Well No. 1124 contains invertebrates that would be suitable forage for cave salamander larvae. Numerous small amphipod-like or isopod-like arthropods were seen moving about the floor of the well and on the pipes that were suspended one to two meters above it. Additionally, small worm-like larvae were found in the mud sample taken from the interface zone of the water and substrate in the well. Although not identified, they appeared to be midge larvae, an important constituent of other *Eurycea* larvae (Pfingsten and Downs 1989). Copepods and related arthropods were not found in the water sample taken from Well No. 1124, but there did appear to be small suspended invertebrates recorded with the down hole camera.

Water and air conditions inside Well No. 1124 were suitable for both adult and larval cave salamanders (Table 1, Appendix A). Although none were seen in the well, additional video footage allowing for a view between the rocks might be more conclusive. The technique used for the current study shined bright lights into the well as the camera was lowered. Cave salamanders shun light, and it may be advantageous to keep lights off until the camera is completely lowered into the well.

During the current study, no individuals were located in Well No. 1060. Further investigation of this well during the season of peak cave salamander activity may substantiate their presence. Cindy Melroy and Leslie Williams (FEMP groundwater technicians) have seen unidentified salamanders species beneath the cover of Well No. 1060 (personal communication). Leslie Williams described a specimen seen in 1992 as 1.5 inches long and olive green in color. She did not recall any black spotting on the specimen.

Discussion

The presence of the state endangered cave salamander in the vicinity of the FEMP property at the former Ross Trails Girl Scout Camp is significant because this location represents the northern edge of the species' distribution. The genotypes from the edges of a species' range are diverse in comparison to those in the main body of the range. Only two cave salamanders were seen during the current study. Both were observed at the control location on September 10, 1993. Visits were made to Miami Whitewater Forest (MWF) and Newberry Wildlife Sanctuary (NWS) where populations are large and individuals are easily found in wells (MWF) and in a spring pool (NWS). None were seen at either locality, suggesting that the drought conditions during the summer of 1993 made conditions inhospitable for cave salamander activity at the surface. Although nonconclusive evidence was found that no cave salamanders inhabit the FEMP property, the suitability of Well No. 1124 for larval development and the report of the unidentified salamander larva in Well No. 1060 support the possibility that they may exist there.

Even though other local salamander species are known to inhabit wells and spring houses, the individual described from Well No. 1060 fits the description of a postmetamorphic cave salamander. Recently transformed longtail salamanders are bright gold, and two-lined salamander postmetamorphs are yellow and gold. Neither appears olive green such as the salamander described by Leslie Williams. At 1.5 inches, cave salamander postmetamorphs are olive green in color. The habitat and description suggest that cave salamanders may inhabit Well No. 1060; however, positive identification is needed for conclusions to be drawn. Two-lined salamanders (*Eurycea cirrigera*) have been observed in well foundations near the Bolton Water Works Plant in Butler County (Davis and Krusling 1989b). Longtail salamanders (*Eurycea longicauda*) are also commonly found in the rock walls of such structures. In such situations, these species are found in wells and spring houses located in wooded areas. Adults probably move into the wells from the surrounding woods. Well No. 1060 is isolated on a home site surrounded by pasture, small industry, and tilled fields. The nearest wooded areas are about 0.5 km away. It is not likely that adult salamanders could move across such terrain to this well. Under most circumstances, a logical explanation would be larval migration through subterranean water systems. However, the presence of porous silts and clays associated with the New Haven Trough, rather than fissured limestone, prevents larval migration from occurring through this area.

The nearest known cave salamander population to Well No. 1124 is the control population at the former Ross Trails Girl Scout Camp. Streams draining the camp flow south and beneath State Route 126 before changing course and flowing to the east. At one point, one of these streams flows within 0.25 km of Well No. 1124. Historically, it is possible that cave salamanders may have migrated from this stream to Well No. 1124. The secretive behavior of cave salamanders makes them difficult to locate. Considering the drought of the latter portion of the summer of 1993, additional field work should be conducted during the spring to try to locate populations in the potential habitat areas examined during this study and all limestone-lined wells in the vicinity of FEMP property.

Identifying populations of threatened and endangered species is a necessary task. Cave salamanders are on the Ohio Endangered Species list because the southwest corner of the state is at the periphery of their range. If a cave salamander population were found on the FEMP property in the future, decisions might need to be made about protecting them. Optimally, under any circumstance, the way to protect a population of any species is to protect its habitat. If the habitat cannot be protected, several other measures might be considered. Entire populations, or significant portions of them, have been repatriated (Dodd and Seigel 1991). Habitats have been created in some repatriation efforts; individuals are simply relocated in others. There is always a risk of disturbing established gene pools when individuals from one population are mixed with another. Populations at carrying capacity should never have individuals from outside sources added; otherwise, a trophic level imbalance will result. Since cave salamanders live in habitats that are usually not disturbed, populations are probably at or close to carrying capacity. Caves and subterranean ecosystems are delicate. Energy flow is supported by the limited supply of organic matter entering from the surface. The added burden of introduced individuals would probably upset balances in this system of limited energy flow much more easily than in systems at the surface. Therefore, if cave salamanders are located at the FEMP property, their habitat on property should be isolated and protected. No attempt should be made to move them to another locality. Creating an artificial habitat is virtually impossible since larval development is directly linked to underground water systems.

Recognizing that habitat preservation on property probably will not be possible, alternative measures to compensate for a population lost at the FEMP should be established. An effective plan might be to financially support the preservation of other known cave salamander habitats. This might be accomplished by establishing wildlife sanctuaries where cave salamanders are known to exist. The Land Management Department of the Hamilton County Park District has been diligent about protecting cave salamander populations. The Metro Parks of Butler County could manage properties purchased or financially supported to protect cave salamanders in Butler County. Cooperative efforts with either park district could establish long-term management plans anywhere in the two counties.

Acknowledgments

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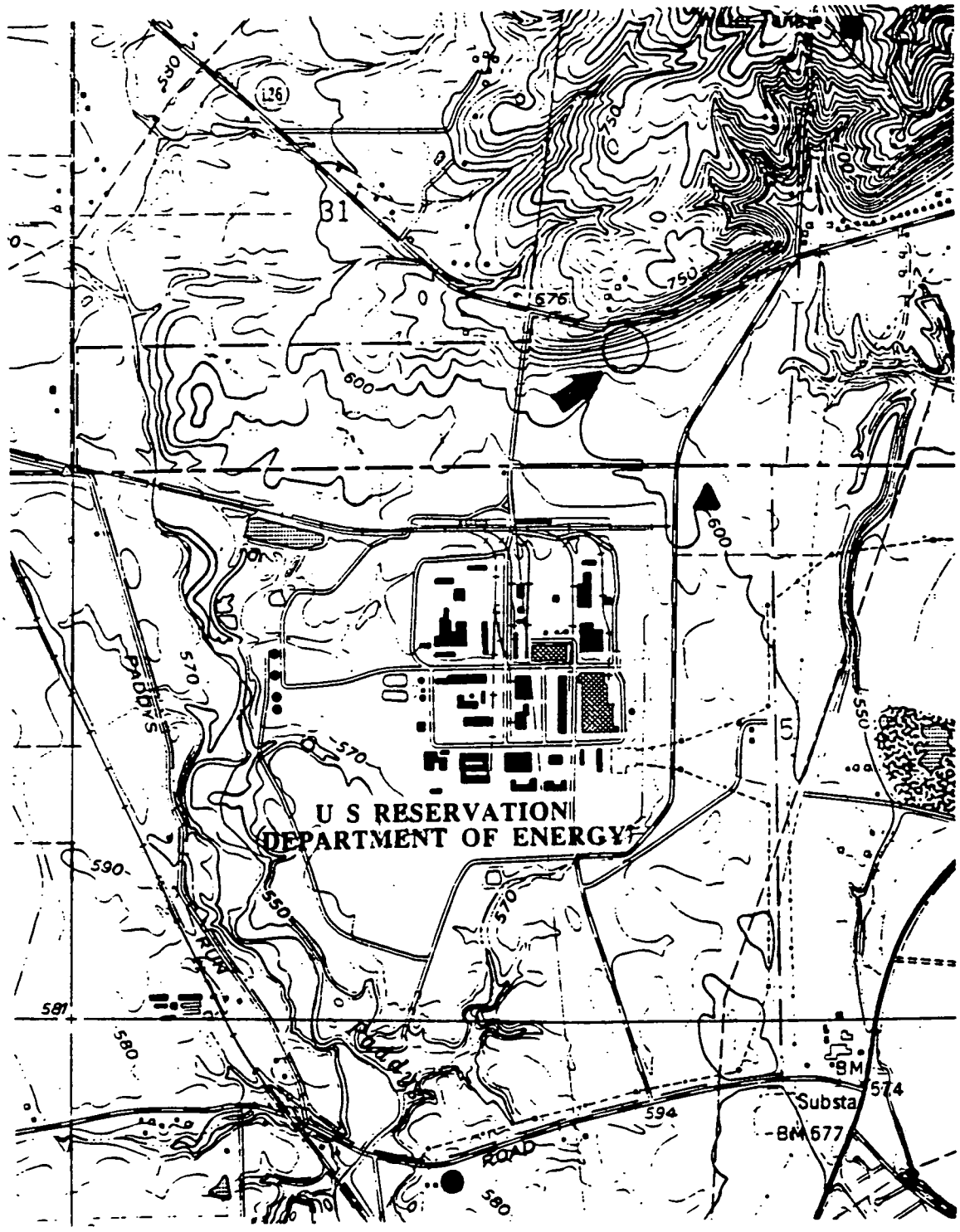
Appendix A
Figures and Table 1

Figure 1. Potential cave salamander habitat on FEMP property at Fernald, Ohio, Well No. 1060 (off-property), and location of control population.



▲ Well 1124
■ Control Population
● Well 1060
○ Potential Habitat

Figure 2. The cave salamander (*Eurycea lucifuga*) is characterized by randomly placed, irregularly shaped black dots on an orange background. The eyes bulge from the slightly compressed head.

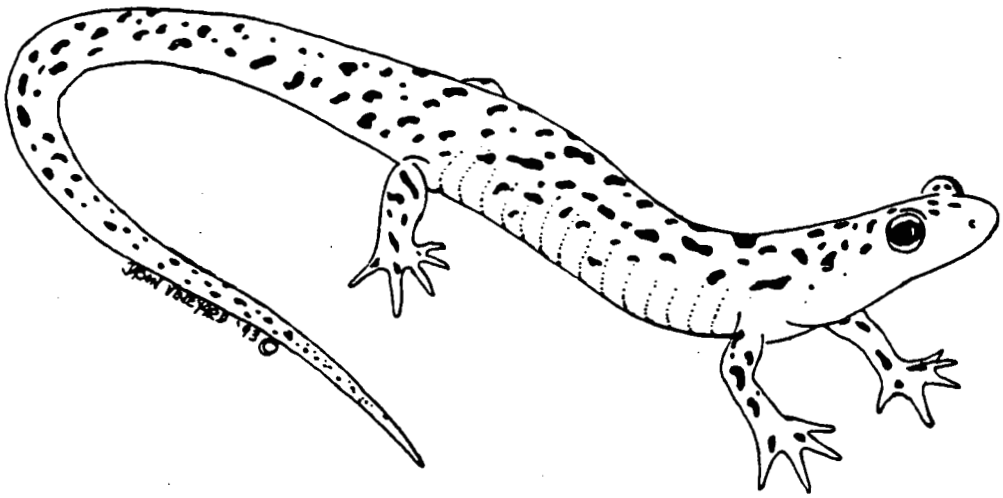
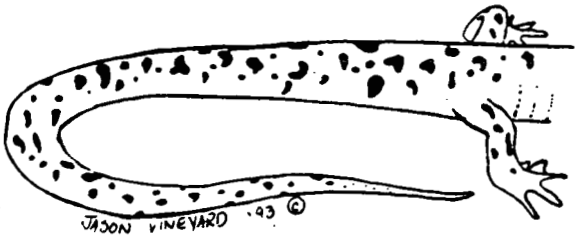


Figure 3. The spots on the cave salamander's tail (a) do not fuse to form chevrons like those of similar longtail salamander (*Eurycea longicauda*)(b).

a



b

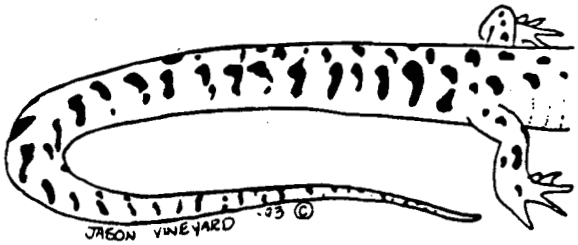


Figure 4. Male cave salamanders have elongated cirri at the base of the nasolabial groove on the upper lip (a) and a rounded mental gland on the chin (b).

a

b

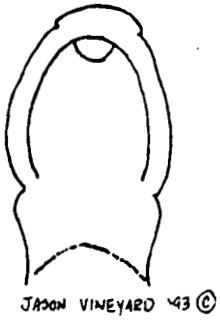


Figure 5. Range of the cave salamander. Southwest Ohio is on the northern limit of the cave salamander's range (modified from Conant and Collins 1991 and Pfingsten and Downs 1989).

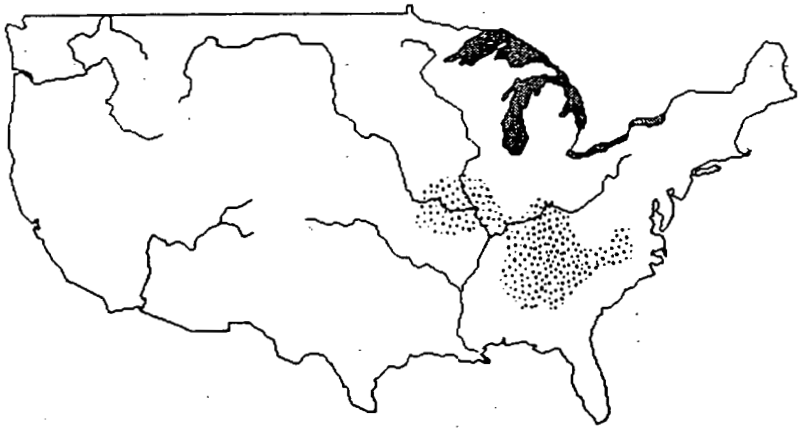


Figure 6. Cave salamander populations are known from Butler and Hamilton Counties in southwest Ohio and from Adams County in south-central Ohio.

Figure 7. Townships in Butler and Hamilton Counties, Ohio with known cave salamander populations. All known localities are west of the Mill Creek Valley.

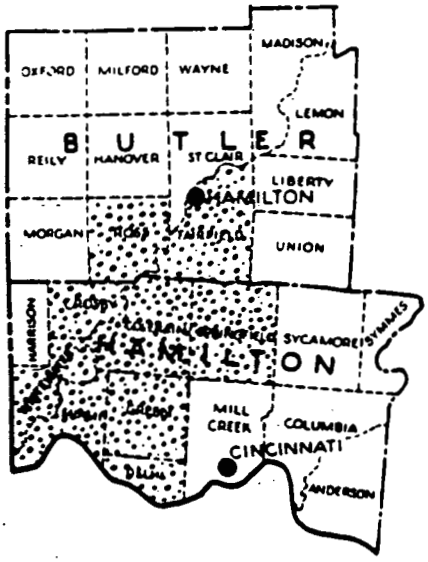


Table 1. Water and Air Conditions in Well 1124.

Parameter	Value
Dissolved Oxygen (air)	20.3%
Dissolved Oxygen (water)	3.65%
pH	6.77
Temperature	12.8°C
Depth (well)	8 m
Water Depth	5.5 m

Appendix B
Field Notes

August 27, 1993

Reconnaissance survey - Jeff Davis, Becky Bixby, John Homer

> Paddys Run Road 1 km north of Willey Road. Forested hillside on FEMP property falls from 590 feet to 550 feet. One open ravine with limited exposed limestone. Appears too dry to support cave salamanders at the surface. Marginally suitable habitat.
> Deciduous wood lot along northern border of FEMP property. Hillside falls from 700 feet to 650 feet. One small ravine with 10 to 15 m of open limestone. Very dry under rocks, but numerous openings into underground crevices are found beneath rocks. Suitable habitat if more water is available.
> Oak-hickory flatwoods behind Neiman's Nursery was surveyed, but no suitable habitat was found.
> Woodlots east side of Paddys Run were surveyed but no suitable habitat was identified.

September 10, 1993

Control site - Jeff Davis, Becky Bixby - Sunny, 70°F

> Redback salamanders (*Plethodon cinereus*) too numerous to count in ravine under rocks, logs, and other debris. Adults and juveniles, all redback phase.
> Two adult cave salamanders (*Eurycea lucifuga*) at control site. One missing its tail; the other backed into a crevice.
> One subadult green frog (*Rana clamitans*) under stone in ravine at control site.

Deciduous Wood Lot (north woods on site) - Jeff Davis, Becky Bixby

> Very dry, no cave salamanders, no redback salamanders.

Well No. 1124 - Cone House Well

> Ample water for reproduction and larval development.
> Limestone lined with mortar between rocks.
> Approximately 30 feet to water's surface.

September 20, 1993

Control site - Jeff Davis, Becky Bixby - two days after substantial rainfall, 65°F

>Redback salamanders (*Plethodon cinereus*) too numerous to count. Adults and juveniles all redback phase.
>No cave salamanders.
>Still too dry.

September 28, 1993

Well No. 1124 - Jeff Davis, Becky Bixby, John Homer

>Electronic Eye 4-Inch Down Hole Camera was used in conjunction with video cassette recorder to examine the crevices between rocks in well wall for adults and water for larvae and larva food items.

Control Site - Jeff Davis, Becky Bixby, John Homer - Sunny, 65°F

>Two days after rain. Still too dry.
>Saw six redback salamanders (*Plethodon cinereus*) five adults, one juvenile, all redback phase.

Deciduous Woodlot (north woods on property) - Jeff Davis, Becky Bixby, John Homer

>Very dry, no cave salamanders, no redback salamanders.

October 4, 1993

Well No. 1124 - Jeff Davis, Becky Bixby, Paul Daniel

>Examined well walls with aid of a flashlight. No cave salamanders.

Control Site - Jeff Davis, Becky Bixby, Paul Daniel - Sunny, 72°F.

>Saw eleven redback salamanders (*Plethodon cinereus*) all adults, ten redback phase, one leadback phase.
>Two juvenile green frogs (*Rana clamitans*) beneath stones in ravine bed.
>No cave salamanders.

Deciduous Wood Lot (north woods on-site) - Jeff Davis, Becky Bixby, Paul Daniel

>Very dry, no cave salamanders, no redback salamanders.

October 6, 1993

Well No. 1124 - Jeff Davis, Becky Bixby, QA personnel

> Water sample taken by groundwater technician using one liter bailer. Sample to be observed later.
> Well walls observed with the aid of a flashlight. No cave salamanders seen.

Well No. 1060 - Jeff Davis, Becky Bixby, QA personnel

> Well examined with the aid of a flashlight. No cave salamanders were seen. Salamanders have been seen in this well before by FERMCO personnel. Very probable that cave salamanders use this well.

Control Location - Jeff Davis, Becky Bixby, QA personnel

> Four redback salamanders observed.
> No cave salamanders.
> Extremely dry.

Deciduous Wood Lot (north woods on property) - Jeff Davis, Becky Bixby

> Very dry, no cave salamanders, no redback salamanders.

Miami Whitewater Forest Reservoir Wells - Jeff Davis, Becky Bixby - Sunny, 65°F

> Objective was to see if cave salamanders were active at a locality where they are active during most of the year; none found.

October 8, 1993

Newberry Wildlife Sanctuary - Jeff Davis, Becky Bixby - Sunny 68°F

> Objective was to see if cave salamanders were active at a locality where they have been observed through November on a regular basis; none found.

Appendix C
Salamander Diversity in Vicinity of FEMP Property

Salamanders In The Vicinity of FEMP Property

Historically, 17 species of salamanders have been reported from Hamilton and Butler Counties (Pfingsten and Downs 1989). In recent years, a series of herpetological surveys, supported largely by the Hamilton County Park District, have documented active populations of twelve species (Table 1A) (Davis 1988; Krusling et al., 1991a; Krusling et al., 1991b; Davis et al., 1992; Rubin 1992).

Rarely does species richness match that of the region that immediately surrounds the FEMP property. Within one km of FEMP property boundaries, especially to the north and to the west, ten species of salamanders are known (Figure 1A). Included among these are cave salamanders and the only documented Hamilton County population of marbled salamanders (*Ambystoma opacum*) (Davis and McCarty 1993). Only two other regional marbled salamander populations have been documented. One of these populations is approximately 40 km to the east in southwest Warren County, Ohio (King 1935), and the other was recently discovered some 50 km to the southwest in Ohio County, Indiana (Krusling and Ferner 1993).

Four salamander species of the family Ambystomatidae have been documented in Hamilton and Butler Counties during recent surveys. Very rarely do more than two species inhabit the same wood lot and share the same breeding pond. A remnant pin oak-hickory swamp forest adjacent to FEMP property along Paddys Run Road and south of the Hamilton-Butler County border is the only known site in southwest Ohio where all four species of Ambystomatids share a breeding site (Figure 2A) (Davis et al., 1992). Such sites are probably rare anywhere. Salamander species diversity in the immediate vicinity of the FEMP property is unusually high and merits further investigation to establish which environmental factors are so favorable there. In another on-site study, Facemire et al. (1990) reported only two amphibian species, the American toad (*Bufo americanus*) and the spring peeper (*Pseudacris crucifer*). Although no endangered salamanders are known at this location, the rarest Hamilton County species, the marbled salamander, occurs there and no where else within the county's borders. Cave salamanders are abundant at the southwest Ohio sites where they exist. The swamp forest habitat is unique to the region, and the fact that at least four species, in addition to the marbled salamander, inhabit it is noteworthy. Members of the family Ambystomatidae are known as "mole salamanders" because of their burrowing behavior. Some individuals, that breed in the swamp forest ponds during spring and fall may spend the rest of the year burrowed in the soils of FEMP property. These early spring breeding salamanders will move hundreds of meters to their selected breeding site. Spotted salamanders were observed on Paddys Run Road in March 1992.

The site directly north of FEMP property, where longtail salamanders, two-lined salamanders, redback salamanders (*Plethodon cinereus*), and dusky salamanders (*Desmognathus fuscus*) have been found (Figure 1A), is equally important. Together, these two sites illustrate species richness for a small area that is unmatched in any

literature and former local surveys.

In recent years, much publicity has been given to the apparent decline in global amphibian populations (Baringa 1990; Phillips 1990). Baseline data must be obtained if amphibian populations are to be monitored in the future. The area immediately around the FEMP property has proven quite valuable in the collection of this important baseline data. Efforts should be made to survey the entire region, including the FEMP property, in the very near future. A Declining Amphibian Populations Task Force has recently been established to look at historical population trends and to monitor known populations. Because amphibians are important bio-indicator species, a sound environmental management plan should consider these species.

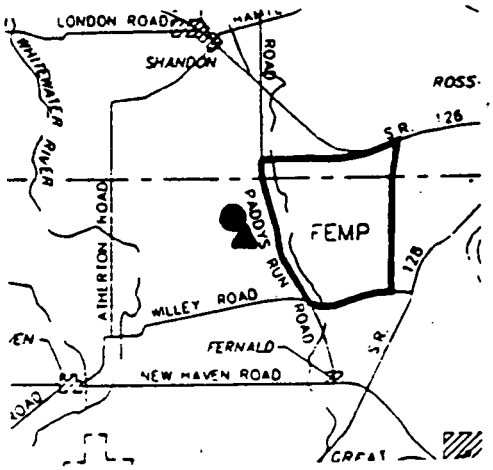
Appendix C
Figures and Table 1A

Table 1A. Historic and recent salamander species of Hamilton and Butler Counties in southwest Ohio.

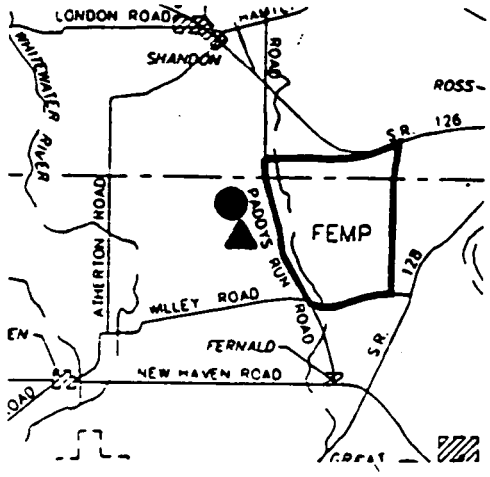
Recent species are in bold print.

Scientific Name	Common Name
Ambystoma barbouri	**Streamside Salamander**
Ambystoma jeffersonianum	**Jefferson Salamander**
Ambystoma maculatum	**Spotted Salamander**
Ambystoma opacum	**Marbled Salamander**
Ambystoma tigrinum	Tiger Salamander
Cryptobranchus alleganiensis	Hellbender
Desmognathus fuscus	**Dusky Salamander**
Eurycea cirrigera	**Two-lined Salamander**
Eurycea longicauda	**Longtail Salamander**
Eurycea lucifuga	**Cave Salamander**
Gyrinophilus porphyriticus	**Spring Salamander**
Necturus maculosus	Mudpuppy
Notophthalmus viridescens	Eastern Red-spotted Newt
Plethodon cinereus	**Redback Salamander**
Plethodon glutinosus	**Slimy Salamander**
Plethodon richmondi	**Ravine Salamander**
Pseudotriton ruber	Red Salamander

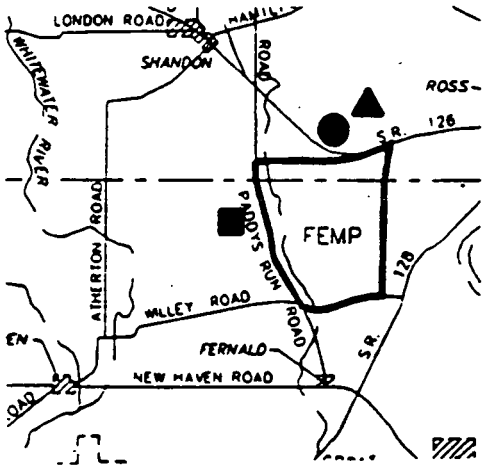
Figure 1A. Localities of ten salamander species' populations known within one km of FEMP property.



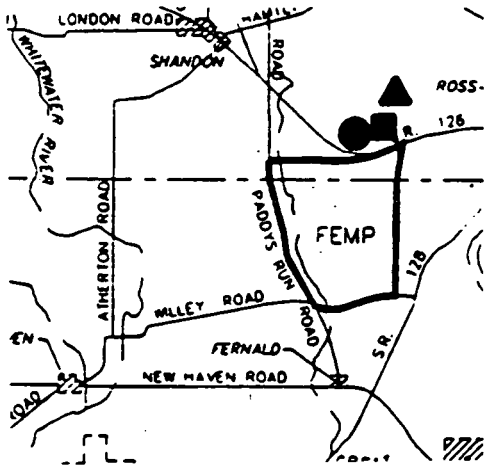
● *Ambystoma barbouri*
▲ *Ambystoma opacum*



● *Ambystoma jeffersonianum*
▲ *Ambystoma maculatum*

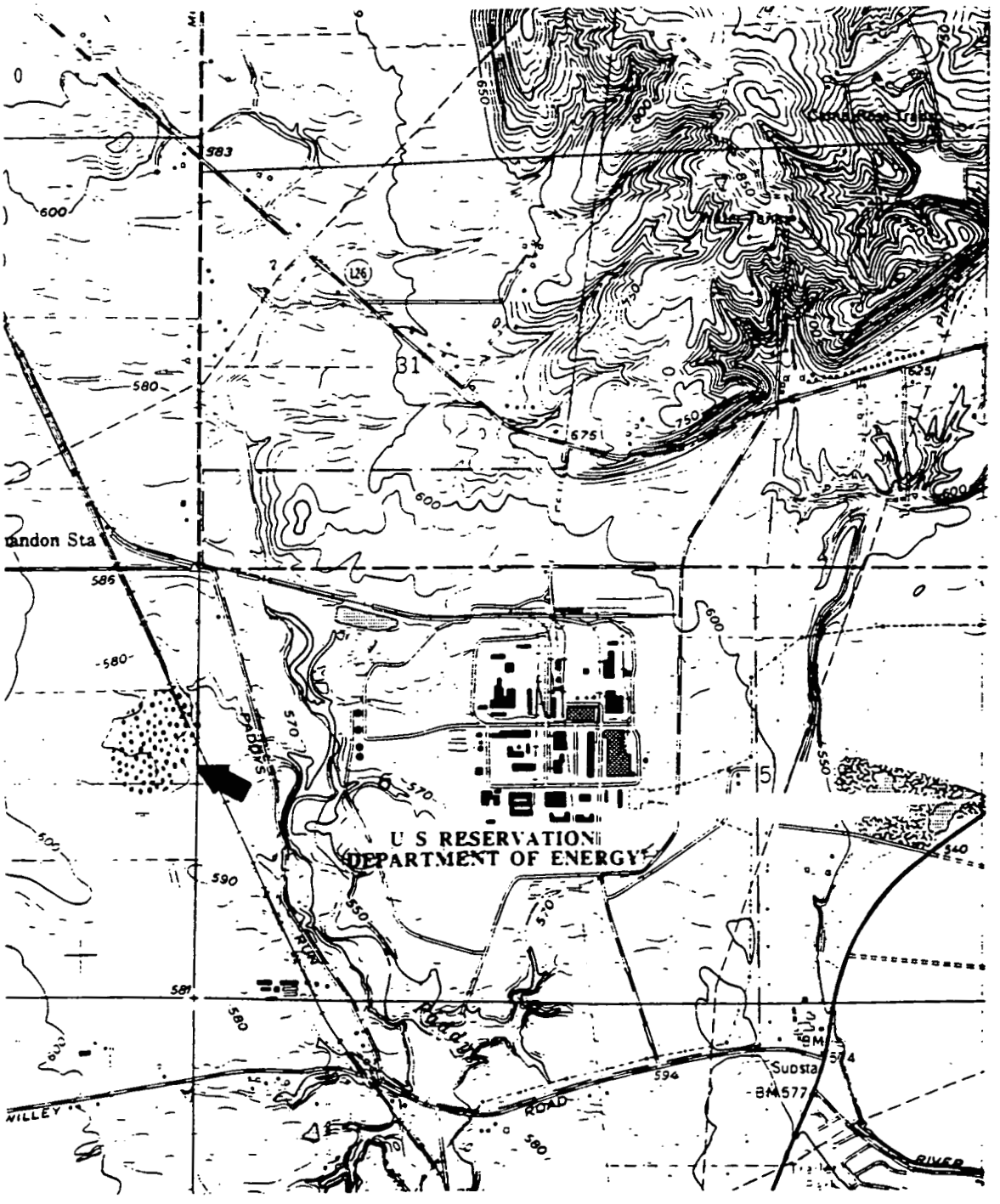


● *Desmognathus fuscus*
■ *Plethodon richmondi*
▲ *Plethodon cinereus*



● *Eurycea cirrigera*
■ *Eurycea longicauda*
▲ *Eurycea lucifuga*

Figure 2A. Location of a pin oak - hickory swamp forest where at least four Ambystomatid salamander species share habitat and breeding sites. This site is adjacent to FEMP property on Paddys Run Road.



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SURVEY OF BATS AND SEARCH FOR ENDANGERED BAT SPECIES, PARTICULARLY THE INDIANA BAT (MYOTIS SODALIS), AT THE FERNALD ENVIRONMENTAL MANAGEMENT PROJECT (FEMP), HAMILTON AND BUTLER COUNTIES, OHIO

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REPORT TO
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CINCINNATI, OHIO 45253-8704

GRANT, CONTRACT, AND LOAN ADMINISTRATOR
MARK GREEN
CONTROLLERS OFFICE
INDIANA STATE UNIVERSITY
TERRE HAUTE, IN 47809

ISU FEDERAL ID # 35-600-1670

812-237-3553

16 JULY 1994

SURVEY OF BATS AND SEARCH FOR ENDANGERED BAT SPECIES, PARTICULARLY THE INDIANA BAT (MYOTIS SODALIS), AT THE FERNALD ENVIRONMENTAL MANAGEMENT PROJECT (FEMP), HAMILTON AND BUTLER COUNTIES, OHIO

ABSTRACT: Eleven samplings for bats were made at ten sites in the summer of 1994 (site 7 was netted twice) at the Fernald Environmental Management Project (FEMP), Hamilton and Butler Counties, Ohio. The main purpose was to sample for the Indiana bat, a federally endangered species. Sampling was by mistnetting, supplemented by bat detector. Efforts were made to locate areas with trees with loose or dead bark or with hollow trees as these types of trees may serve as sites for maternity colonies. Sampling occurred along Paddys Run, and tributaries that appeared to be good habitats or flyways for bats. No endangered or threatened bats were netted; however, 29 bats of three species were taken, including 18 big brown bats, 8 red bats, and 3 little brown bats.

INTRODUCTION

Eleven species of bats are considered to be inhabitants of Ohio (Gottschang, 1981): four species of Myotis including M. lucifugus (little brown myotis), M. sodalis (Indiana myotis) M. septentrionalis (northern myotis), and Myotis leibii (small-footed myotis), four other species of social bats including Pipistrellus subflavus (eastern pipistrelle), Eptesicus fuscus (big brown bat), Nycticeius humeralis (evening bat), and Plecotus rafinesquii (Rafinesque's big-eared bat): and three species of solitary bats, Lasionycteris noctivagans (silver-haired bat), Lasiurus cinereus (hoary bat) and L. borealis (red bat).

Two additional species, Myotis grisescens (gray myotis) and Tadarida brasiliensis (Brazilian free-tailed bat) have been taken in Ohio. However, both are considered to be of accidental occurrence rather than residents of the state.

Two of the species resident in Ohio are not likely to occur at the FEMP; Rafinesque's big-eared bat and the small-footed myotis. Each is known from only one county in Ohio; the small-footed myotis is from Erie County in north central Ohio, and the big-eared bat from Abrams County in south central Ohio. Both species are rare and are candidates for federal listing. Their current status in Ohio should be investigated. The one individual of Myotis leibii known from Ohio is the type specimen for the species. It was taken by Audubon and Bachman (1851). Two individuals of the big-eared bat were taken in two separate caves in Green Township, Abrams County, one in March 1953, and the other in December 1960 (Gottschang, 1981).

Thus, nine of the 11 species of bats recognized as residents of Ohio are candidates for occurrence at the FEMP, and all nine have been previously taken in the general area of Hamilton and

Butler counties, the counties in which FEMP is located. The little brown myotis has been taken in Hamilton and Butler counties, the big brown bat, red bat, hoary bat, evening bat and pipistrelle in Hamilton County, and the silver- haired bat, northern myotis, and Indiana myotis in Clermont County, the next county to the east of Hamilton County.

The least likely of the nine species to occur at the FEMP is the evening bat. The evening bat has apparently declined in the northern part of its range. For example, eleven colonies of this species were known from Indiana 30 years ago and were distributed roughly along the major southern rivers in Indiana, the Ohio and the Wabash. All of the original 11 colonies are now gone. There is only one known colony in Indiana (Whitaker and Gammon, 1988), and as of this writing, it could be gone. Although the evening bat is currently unlisted in Ohio, it could be scarce or even extirpated in this state; however, no recent data are available. It should probably be state listed. The silver-haired bat is a spring and fall migrant and undoubtedly passes through the FEMP, probably in some numbers at that time. However, it should not be present at the base or even in Ohio at all in the summer. However, one individual was taken on 24 June 1988, in a bat survey by Advanced Sciences, Inc. (ASI) in the summer of 1988 (see description below), and one was taken by us on June 3, 1994, at Wright-Patterson Air Force Base in Greene County, Ohio. Most silver-haired bats pass through Indiana and Ohio in the spring from mid-April through May, and again in the fall from late August through early November.

A survey of bats was carried out in the summer of 1988 in the vicinity of the FEMP by ASI (DOE 1993 FINAL, March, 1993), with 13 sampling sites along the Great Miami River and Paddys Run. A total of 63 bats of five species was taken: eight Indiana myotis, one little brown myotis, 32 big brown bats, 21 red bats and one silver-haired bat. All individuals of the Indiana myotis were taken to the northeast of the FEMP along Banklick Creek, a tributary of the Great Miami River. The presence of this number of Indiana myotis, especially the five females, indicates the presence of a maternity colony in the immediate vicinity of the sampling site. Three of the 13 sites were actually on the FEMP, all on Paddys Run, (ASI sites I, IV and VII). Site I was near the northern border of Hamilton County, and was netted on 24 June, 1988 (one silver-haired and two red bats were taken). At Site IV (just north of Willey Road netted on 30 June, 1988), 2 red bats were taken. Site VII was located in Butler County, north of the railroad tracks. It was netted on 9 August 1988 and yielded 12 big brown bats and six red bats. Thus three species have previously been taken at the FEMP, red, big brown and silver-haired bats.

THE SPECIES

Information is summarized below on the various species known or likely to occur at the FEMP, mostly from Gottschang (1981), and Mumford and Whitaker (1982).

SPECIES OF PARTICULAR INTEREST.

Myotis sodalis Indiana bat.

STATUS: FEDERALLY ENDANGERED

The Indiana bat forms maternity colonies under the loose bark of trees. It hibernates in large numbers in a very few caves. Barbour and Davis (1969) found bats of this species at a number of Ohio localities. The bats had been previously banded by Barbour and Davis in two Kentucky cave hibernacula. This indicated that Indiana bats were moving to the north and east from their winter quarters. Evidence of a maternity colony of Indiana bats was found at Banklick Creek in 1988, only about two miles northeast of the FEMP. This species could easily occur at the FEMP.

OTHER SPECIES

Myotis lucifugus. The little brown myotis could be present at the FEMP. Only one individual was taken in the 1988 survey, but not on the FEMP itself. This species forms maternity colonies usually in buildings and it migrates to caves to hibernate.

Myotis septentrionalis. The northern myotis is often referred to as Keen's myotis, Myotis keenii. However, Keen's myotis is currently recognized as a separate species which occurs only in the west. The northern myotis could occur at the FEMP. It usually forms relatively small maternity colonies under the loose bark of trees in summer or sometimes in buildings. In winter, it is solitary, with most individuals hibernating in tiny cracks or other hidden places in caves or mines.

Nycticeius humeralis. The evening bat is not not listed, but should be considered for state endangered status. It forms maternity colonies in buildings. It is not known where this species hibernates, but we suspect it may be in hollow trees along larger streams to the south. It could be present at the FEMP; however, we suspect it may have declined in Ohio. Its status in Ohio needs to be investigated.

Pipistrellus subflavus. The pipistrelle is the smallest bat in Ohio and could easily occur at the FEMP. It forms small maternity colonies in buildings or in hollow trees. In winter it is a solitary hibernator in caves and mines.

Eptesicus fuscus. In summer, the big brown bat forms maternity colonies usually in buildings or other human-made structures. A few big brown bats hibernate in caves and mines, but most individuals hibernate in buildings. There are usually not more than 1 to 10 in any one building, although a few buildings that have been available for a long time have larger numbers (Whitaker and Gummer, 1993). This is one of the most common bats in Ohio and is the only species that hibernates in buildings in Ohio. A total of 32 individuals of this species was taken during the 1988 study, 12 of them at the FEMP.

Lasiurus borealis. The red bat is solitary, but is one of the most common bats in Ohio. It hangs among foliage in summer and migrates south where it probably hibernates in trees in winter. The northern edge of the hibernating range is probably just north of the FEMP. A total of 21 individuals of this species was taken in the 1988 survey, ten of them at FEMP.

Lasiurus cinereus. The hoary bat is the largest bat of Ohio and is one of the most colorful. Like the red bat, it hangs in foliage in the daytime in summer, but it migrates far south for the winter. It is probably present at the FEMP, but is quite uncommon; therefore it is not likely not to be taken in a limited survey.

Lasionycteris noctivagans. The silver-haired bat is a distinctively colored migratory species. It migrates through FEMP in spring and fall but should not be present in summer, although one individual was taken at the FEMP on June 24 in the 1988 survey. It is difficult to explain the presence of this bat at the FEMP at that time, but presumably it was a very late migrant. This species has its young in trees to the north of Ohio, then moves south to hibernate. Little is known of specific sites, but a very few individuals hibernate in caves and mines and some may hibernate in trees.

OBJECTIVES OF PROJECT

The principal objectives of this project were:

1. To locate populations of the federally endangered Indiana myotis, Myotis sodalis.

2. To accumulate further information on the bat community present at the FEMP.

3. To make management recommendations for the FEMP concerning bats.

MATERIALS AND METHODS

The FEMP was visited on April 13, 1994 to determine where mistnetting would take place. Much good habitat was found along

Paddys Run and its tributaries. Mistnetting was recommended for ten sites and site numbers were assigned at that time. Two of the recommended sites were in the Storm Sewer Outfall Ditch entering Paddys Run from the northeast. The other eight sites were in the main stream: four in the northern half, two above and two below the railroad bridge, and four in the southern half of the FEMP property. The sites were primarily in or near areas with large dead standing trees, especially those with loose bark or which were hollow. Actual mistnetting sites were selected in areas that appeared suitable as bat flyways, as well as areas over which canopy occurs, since mistnets do not work well unless they extend upward to a canopy. If no canopy is present the bats generally sense and fly over the net. Mist netting for Indiana bats should occur between May 15 and August 15, since some of the bats begin to disperse and head for the hibernaculae in late August.

Mistnetting was carried out between June 6 and July 11, 1994 on Fernald property. Sampling at each site was carried out from dusk to midnight or later, depending on results. One, two, or three seven foot high nets were placed one above the other to reach the canopy. Three net lengths were available, 18, 30, and 42 feet, although 30 foot nets were used at all sites. The nets were on a pulley system on telescoping aluminum poles, so that nets could be raised and lowered to remove bats.

Data recorded at each site included type of habitat, water depth and permanence, type bottom, species and size of trees, and whether there were hollow trees or trees with loose bark in the vicinity.

In addition to the mistnets, bat detectors were used during all sampling to detect echolocation calls in the vicinity of the net. This allows one to determine bat activity during the netting. The number of calls heard on the detector during each sampling was recorded, which gave an assessment of how well the nets were doing in relation to bat activity. Numerous calls on the detector, but no bats in the net would indicate that the nets should be repositioned. Some species of bats can be identified at least part of the time by their high frequency calls, particularly red, evening and big brown bats, so some species-specific data can be accumulated using the bat detector. Detection for bats often occurred above and below the site to determine relative bat activity. Also, the bat detectors can be used to sample areas of marginal habitat or areas with little canopy for bat activity to see if netting should be attempted there.

RESULTS

No endangered or threatened bats were recorded at the FEMP during the present study.

Twenty-nine bats were netted, but only three species were represented: 18 big brown bats, Eptesicus fuscus, 8 red bats, Lasiurus borealis, and 3 little brown myotis, Myotis lucifugus

(Table 1). These numbers were somewhat lower than expected, especially since the general terrestrial habitat for bats appeared to be quite good. Ten sites were sampled for a total of 11 times along Paddys Run and its tributaries (Figure 1). Eight of the sites including the one sampled twice (site 7) were on Paddy's Run and two were on the Storm Sewer Outfall Ditch. Data for each net site are given in Appendix 1.

DISCUSSION

The most probable reason bat numbers and diversity are low at the FEMP is that most of Paddys Run becomes completely dry early in the summer and remains that way throughout most of the time during the year when bats are active. It contains water only after major storms. It is a fairly large stream (averaging about 25 feet in width) and if not dry, it should be an excellent foraging habitat for bats.

Evidence that this assessment is correct was obtained during this study and also during the 1988 assessment by ASI; in both studies the larger numbers of bats were taken from the upper portion of Paddys Run, the only portion that contains water all year. During this study, 23 bats were taken in three samples at four locations upstream (sites 6, 7 and 8 (mean = 5.75), and six were taken at seven locations downstream (mean = 0.86). In the ASI sampling, 18 bats were taken at the one upstream site, and five bats were taken at the two downstream sites (mean = 2.5).

Thus, these data appear to indicate that there are relatively few bats present at the FEMP suggesting that it is because much of the stream is dry most of the year.

The 1988 ASI sampling effort resulted in more bats per sample (23 in three samples, mean= 7.6), than were taken in the present study (29 bats in 11 samples, mean = 2.6). Part of this difference was because ASI obtained one sample in August after the young of the year had entered the population (the ASI sample contained 9 immature individuals), whereas the entire 1994 sample was taken before the young were volant. ASI netted three species including 12 big brown bats, 6 red bats and one silver-haired bat. We also netted three species, including 18 big brown bats, 8 red bats and 3 little brown myotis. Thus, four species of bats have been taken to date at the FEMP.

Additional sampling may eventually turn up at least occasional specimens of four other species at the FEMP, the northern myotis, the Indiana myotis, the hoary bat, and the pipistrelle.

MANAGEMENT RECOMMENDATIONS

1. INDIANA BATS. Indiana bats were taken by ASI about two miles from the FEMP in 1988, but none were taken by ASI or during the present study at the FEMP. However, this species most often uses

larger trees with loose bark in riparian areas for maternity roosts. Plenty of this type of woodland exists at the FEMP along Paddys Run and in the Storm Sewer Outfall Ditch. There appears to be no reason why this bat could not take up residence there in the future, especially as the trees continue to age. The best habitat is that above the railroad bridge where water remains all year. That area should certainly be saved, but care should be taken to retain as much of the riparian woods as possible.

Bat box installations have been suggested as a potential mitigative measure favorable to Indiana bats. My recommendation is that the trees, especially the larger trees be retained in so far as possible. If the trees can be saved, I would recommend that bat boxes not be used because a) plenty of potential roost trees already exist at the FEMP, b) Indiana bats usually roost under loose bark of trees, thus are very unlikely to use bat boxes, and c) bat boxes would detract from the natural nature of the habitat.

If it is essential that existing larger trees are to be removed over extensive areas, then the FEMP might consider some experimental mitigative measures to improve habitat for Indiana bats in those areas. However, I would not use bat houses as currently understood. Rather, I would suggest simulating the loose bark under which maternity colonies are normally found. Shingles or perhaps even tree bark could be used to produce simulated "loose bark" on smaller trees or even on poles in the areas from which larger trees have been removed. The upper parts of the "loose bark" should be enclosed in such a way that water does not leak into the simulated roost. Since bats regulate their body temperatures by moving about within the roost, the simulated roosts should be built to surround the tree or pole to maximum temperature variation within the roost. The simulated roosts should be in a position where they get quite a bit of sun during the day.

2. OTHER SPECIES OF BATS. Bats are the major predators on night flying insects. They help control many pest species of insects and in addition help to maintain the "balance of nature," i.e. current food web interactions. The big brown bat feeds heavily on cucumber beetles, and larval cucumber beetles are the corn rootworms, one of the most important agricultural pests in this country. Most species of bats in Ohio other than the big brown bat are probably declining because of loss of habitat and perhaps use of pesticides. Therefore, other species of bats may well become threatened or endangered in the future. Because bats are such important predators of insects (especially the big brown bat), and because their populations are declining, the FEMP should attempt to protect all bats, not just those that are currently listed as endangered or threatened.

3. RIPARIAN HABITAT. Wetlands and riparian habitat have been greatly reduced over the past century. Excellent riparian habitat exists along the length of Paddys Run on the FEMP property. This

entire area should be left basically undisturbed as much as possible. It provides good habitat for many species of terrestrial plants and animals besides bats. This is especially true for the FEMP property north of the railroad on Paddys Run, which provides excellent habitat for many aquatic and terrestrial animals as well as for bats.

4. WOODLANDS AND OTHER NATURAL HABITATS. The great majority of natural habitat in the Cincinnati area and in Ohio has been developed or cleared as agricultural land over the past century. Therefore, every opportunity should be taken to save as much remaining natural habitat as possible. The FEMP has a good deal of natural habitat, and it is recommended that as much of it as possible be retained in its natural state. This will help to protect endangered and threatened species currently present or that might be present in the future, and would also help save other species from becoming endangered or threatened.

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Table 1. Summary of information on bats netted at ten sites (11 samples) at the Fernald Environmental Management Project (FEMP), Hamilton and Butler counties, Ohio, June 6 to July 11 1994.

Site	*E. fuscus*	*L. borealis*	*M. lucifugus*	TOTAL
1	0	0	0	0
2	0	0	0	0
3	2	0	0	2
4	1	0	0	1
5	0	2	0	2
6	0	1	1	2
7a	6	1	0	7
7b	8	3	1	12
8	1	0	1	2
9	0	0	0	0
10	0	1	0	1
	18	8	3	29

Table 2. Summary of data on bats netted at 10 sites (11 samples) during the present study (1994) and from 3 sites netted by ASI (1988) at the FEMP.

	Sites with species		Bats	
	No.	%	No.	No./ sample
BATS NETTED IN 1994 IN 11 SAMPLES				
E. fuscus. Big brown bat.	5	45.4	18	1.6
L. borealis. Red bat.	5	45.4	8	0.7
M. lucifugus. Little brown myotis.	3	27.3	3	0.3
BATS NETTED IN 1988 IN 3 SAMPLES				
E. fuscus. Big brown bat.	1	33.3	12	4.0
L. borealis. Red bat.	3	100	10	3.3
L. noctivagans	1	33.3	1	0.3

APPENDIX 1. Collection sites at Fernald Environmental Management Project (FEMP), Hamilton and Butler Counties, Ohio, June 6 to July 12, 1994

The entire length of Paddys Run and the Storm Sewer Outfall Ditch appear to be suitable habitat for the Indiana bat. There are plenty of large trees present, with a number of species, including cottonwood, sycamore, oaks and maples, some of which have loose bark. However, much of Paddys Run dries up early in the summer, probably greatly reducing insect populations which would otherwise be present. Information on individual sites is given below.

Site #1. Upper Storm Sewer Outfall Ditch. Shandon Quadrangle. R1 T1. Section 6. 6994 x 43513; 30 x 14 ft. mistnet. 7 June 1994. Temp: 58-56 degrees. 8:30PM to midnight. Stream 20 feet wide, but dry at sampling. Riparian area heavily wooded including large trees.

No bats captured.
No bats detected in about 1 hour.

Site #2. Lower Storm Sewer Outfall Ditch. Shandon Quadrangle. R1 T1. Section 7. 6993 x 43511. 30 x 14 ft. mistnet. 7 June 1994. Temp: 58-56 degrees. 8:30PM to midnight. Stream 12 feet wide, but dry at sampling. Riparian area heavily wooded including large trees.

No bats captured.
only two bats detected, *E. fuscus*.

Site #3. Paddys Run. about 100 yards upstream from Willey Road and cement bridge. Shandon Quadrangle. R1 T1. Section 7. 6990 x 43509. 30 x 14 ft. mistnet. 12 July, 1994. Temp: 58-56 degrees. 8:30 to 12:30PM. Stream 30 feet wide, but dry at sampling. Shore heavily wooded including mixed species of large trees, including sycamore, cottonwood and hackberry.

Eptesicus fuscus	male	10:20
Eptesicus fuscus	male	10:20

only 3 bats detected in about one hour.

Site #4. Paddys Run by Inactive Fly Ash Pile. Shandon Quadrangle. R1 T1. Section 6. 6988 x 43514. 30 x 14 ft. mistnet. 6 June, 1994. Temp: 75 degrees. 8:30PM to 12:15. Stream 25 feet wide, but dry at sampling. Shore heavily wooded including large trees.

Eptesicus fuscus	female	10:25

8 calls heard, all Eptesicus.

Site #5. Paddys Run north of K-65 silos. Shandon Quadrangle. R1 T1. Section 6. 6987 x 43516. 30 x 21 ft. mistnet. 11 July, 1994. Temp: 75-65 degrees. 8:30PM to 12:30. Stream 25 feet wide, but dry at sampling. Shore heavily wooded including large trees. Flood lights at the K-65 Silos somewhat hampered netting here.

Lasiurus borealis	male	10:25
Lasiurus borealis	female	11:00

9 calls heard on detector, 2 Eptesicus, 1 probably Myotis, rest probably red bat.

Site #6. Paddys Run at railroad trestle. Shandon Quadrangle. R1 T1. Section 6. 6984 x 43527. 30 x 14 ft. mistnet. 8 June, 1994. Temp: 68 degrees. 8:30PM to 12:30. Stream 25 ft. wide, to 6 feet deep. Shore semi-wooded including large trees.

Myotis lucifugus	female	10:40PM
Lasiurus borealis	male	11:10PM

29 calls heard on detector.

Site #7. Paddys Run above trestle at north boundary of FEMP property. Shandon Quadrangle. T 3N R 2E. Section 31. 6984 x 43532. Stream above trestle retains water most of time. Shore with open woods including large trees, ash, sycamore, honey locust and others.

Sample 1. 30 x 20 ft. mistnet. 9 June 1994. Temp: 75-65 degrees. 8:30PM to 12:45. Stream 25 feet wide, 8 inches deep.

Eptesicus fuscus	female	10:10
Eptesicus fuscus	female	11:40
Eptesicus fuscus	escaped	11:46
Eptesicus fuscus	female, pregnant	12:00
Lasiurus borealis	female	12:20
Eptesicus fuscus	escaped	11:30
Eptesicus fuscus	male	11:40

27 calls heard on detector.

Sample 2. 42 x 24 ft. mistnet. 14 July 1994. Temp: 80 degrees. 9:00PM to 1:00AM. Stream 25 feet wide, 8 inches deep.

Myotis lucifugus	female	10:20
Eptesicus fuscus	female, lact.	10:30
Eptesicus fuscus	female pregn.	10;38
Lasiurus borealis	male,	10:50
Lasiurus borealis	male,	11:00
Eptesicus fuscus	female, lact.	11:20
Lasiurus borealis	male	11:45
Eptesicus fuscus	male	12:00
Eptesicus fuscus	female pregn.	12:15
Eptesicus fuscus	female, lact	12:25
Eptesicus fuscus	female, pregn.	12:30
Eptesicus fuscus	female, pregn.*	12:40

*only one embryo.
23 calls, mostly big brown bat.

Twelve big brown bats and 6 red bats were taken at this site on 9 August 1988 by ASI (ASI #VII).

Site #8. Paddys Run above railroad trestle and below site 7. Shandon Quadrangle. T 3N R2E. Section 31 6984 x 43530. 30 x 14 ft. mistnet. 9 June 1994. Temp: 75-65 degrees. 8:30PM to 12:15. Stream 25 feet wide, 1 foot deep. Stream above trestle retains water most of time. Bank with open woods including large trees such as ash, sycamore, black locust and others.

Eptesicus fuscus	male	11:40
Myotis lucifugus	female, lactating	10:40PM

8 calls on detector in 1 hour.

Site #9. Paddy's Run 100 yds below trestle. Shandon Quadrangle. R1 T1. Section 6. 6985 x 43525. 30 x 14 ft. mistnet. 8 June 1994. Temp: 68 degrees. 8:30PM to 12:00. Stream 20 feet wide, 1 foot deep. Stream above trestle retains water most of time. Shore with open woods including large trees, ash, sycamore, honey locust and others.

No bats taken
None heard on detector from dusk to 10PM.

Kingfisher captured in net.

Two red bats and one silver-haired bat were netted at or near this site in 1988 by ASI (ASI site #1).

Site #10. Paddy's Run at old cement bridge at lower end of FEMP. Shandon Quadrangle. R1 T1. Section 7. 6989 x 43507. 30 x 14 ft. mistnet. 12 July 1994. Temp: 68 degrees. 8:30PM to 12:00. Stream 20 feet wide, but dry at sampling. Shore with open woods including large trees, ash, sycamore, honey locust and others.

<u>Lasiurus</u> <u>borealis</u> male 10:25

Two red bats were netted at or near this site on 30 June, 1988 by ASI (ASI site #IV).

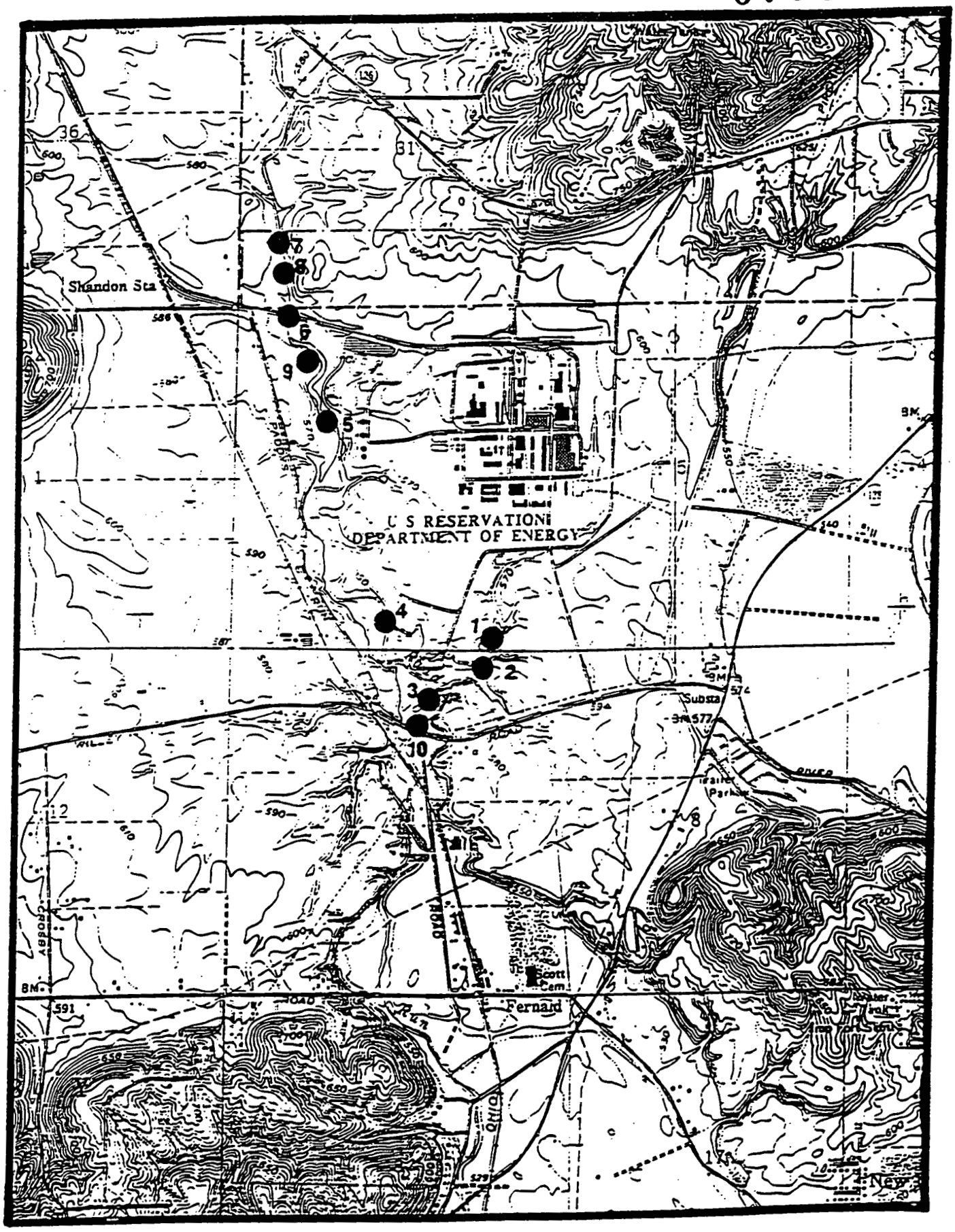

Figure 1. Sites netted for bats in 1994 at the Fernald Environmental Management Project (FEMP), Hamilton and Butler Counties, Ohio.

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FERNALD ENVIRONMENTAL
MANAGEMENT PROJECT

RESULTS OF SURVEYS FOR
SLENDER FINGER-GRASS

PREPARED BY:

RUST Environment & Infrastructure Inc.
PROJECT NO. 72740.000

November 2, 1994

000070

RUST ENVIRONMENT & INFRASTRUCTURE

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November 2, 1994

Ms. Becky Bixby
FERMCO
P.O. Box 398704
Cincinnati, Ohio 45239-8706

Regarding: Field Surveys for Slender Finger-grass at the FEMP Site
Project No. 72740.000

Dear Ms. Bixby:

RUST Environment & Infrastructure Inc. (RUST) has completed field surveys at the Fernald Environmental Management Project (FEMP) property in order to determine the presence or absence of Slender Finger-grass (*Digitaria filiformis*), a state endangered species. Under the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) regulations (Section 121), FEMP actions must meet the substantive requirements of the Federal Endangered Species Act of 1973, the Ohio Revised Code of 1975, the Ohio Division of Wildlife Order of 1976, and the Ohio Endangered Plant Law of 1978. The survey was conducted in accordance with our Proposal No. CP-3205 dated March 24, 1994.

Upon completion of the field surveys, RUST initially identified a population of Slender Finger-grass growing along the vehicle path to ground water monitoring wells located in the northern woodlands at the FEMP property. Representative specimens of this population were subsequently sent to the Ohio Department of Natural Resources (ODNR) Division of Natural Areas and Preserves for verification as *Digitaria filiformis*. Mr. Greg Schneider, a botanist with ODNR, determined that the specimens were *Digitaria ischaemum* (Smooth Crabgrass) based on the presence of a winged rachis (the main axis of the inflorescence) on the specimens. Since this contradicted the initial identification of the specimens, the specimens were also sent to Dr. John Thieret, a professor of botany at Northern Kentucky University for identification. Dr.

Thieret confirmed ODNR's determination that the specimens are *D. ischaemum* based on the non-erect growth, presence of a winged rachis, and dark brown mature spikelets.

Although marginally suitable habitat does exist at the FEMP site for Slender Finger-grass near the Inactive Flyash Pile, the running track and in additional openings in the northern woodlands; other species of *Digitaria* (*D. sanguinalis and D. ischaemum*, not *D. filiformis*) were observed in these areas.

Should you have any questions or comments regarding any of the information provided in this report, please feel free to contact the undersigned.

Respectfully submitted,

RUST Environment & Infrastructure Inc.

Karen A. Fields

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Staff Biologist

Reviewed by:

Allan M. Hale

Allan M. Hale, Ph.D.
Senior Ecologist

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Species Identification and Taxonomic Information I

1.0 INTRODUCTION

Slender Finger-grass (*Digitaria filiformis*) is a state endangered species of crabgrass. Under the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) regulations (Section 121), the Fernald Environmental Management Project (FEMP) must meet the substantive requirements of the Federal Endangered Species Act of 1973, the Ohio Revised Code of 1975, the Ohio Division of Wildlife Order of 1976, and the Ohio Endangered Plant Law of 1978. As such, RUST Environment & Infrastructure, Inc. (RUST) has completed field surveys at the FEMP property in order to determine the presence or absence of Slender Finger-grass at the property.

Slender Finger-grass blooms from August through October in Ohio. The preferred habitat of Slender Finger-grass is in full sun, in sandy and/or sterile soils. In a 1986 survey of the FEMP property conducted by Miami University, this species was reported to occur in the riparian habitats at the site. Thus, RUST conducted field surveys for this species in the riparian woodlands (along Paddys Run and in the northern woodlands) and in the Inactive Flyash Pile, since it represents a habitat with sterile, sandy soils. Surveys for Slender Finger-grass were conducted by three biologists from RUST on August 23 and 24, 1994.

2.0 SURVEY METHODS

Prior to conducting the field sampling, each of the team members were given taxonomic descriptions of Slender Finger-grass and identifying characteristics of the species. Examples of this information are provided in Appendix I.

On August 23, 1994, the northern pine plantation, the northern woodland area, and the riparian areas along Paddys Run were surveyed for Slender Finger-grass in conjunction with a similar

survey being conducted for Mountain Bindweed (*Polygonum cilinode*), a state endangered plant species. One suspected population of Slender Finger-grass was observed growing along the vehicle path to groundwater monitoring wells located in the northern woodland. This population consisted of several hundred individuals. No other suspected populations of Slender Finger-grass were observed in any of the areas surveyed. A representative sample of this suspected population of Slender Finger-grass was photographed and a specimen was collected for positive taxonomic identification.

On August 24, 1994, the Inactive Flyash Pile, the southern pine plantation, the riparian areas near the Storm Sewer Outfall Ditch, and the running track were surveyed for Slender Finger-grass. Suspected populations of Slender Finger-grass were observed in one area of the Inactive Flyash Pile and near the running track. Representative specimens were collected from each of these populations for positive taxonomic identification. No other suspected populations of Slender Finger-grass were observed in any of the areas surveyed.

Since several specimens from the FEMP property appeared to have the distinguishing characteristics of the species, *Digitaria filiformis*, Ms. Pat Jones of the Ohio Department of Natural Resources (ODNR), Division of Natural Areas and Preserves, was contacted by RUST on August 25, 1994 to determine the location of voucher specimens of this state endangered species. Ms. Jones indicated that the largest voucher collection for *D. filiformis* could be found in the Ohio State University Department of Biological Diversity Herbarium. On August 29, 1994, a representative from RUST visited the herbarium curated by Dr. Richard L. Stuckey (Professor Emeritus, Botany, Ohio State University), and individually viewed all available *D. filiformis* specimens for later comparison with the FEMP samples. Based on these observations, RUST identified three different species of *Digitaria* to be growing at the site including *D. serotina, D. sanguinalis,* and *D. filiformis*.

RUST's taxonomic validation of *Digitaria filiformis* followed the specific morphologic characteristics of the species as listed in Radford et. al., 1968, which include: culms in small tufts; slender and erect growth, 10 to 60 centimeters (cm.) in height; lower sheaths pilose; upper sheaths glabrous; blades erect and 5 to 15 cm. long; racemes unequal, erect and in groups of 1 to 5; spikelets 1.5 to 1.7 millimeters (mm.) long; second glume and sterile lemma pubescent with short capitellate hairs; the glume shorter than the spikelet; and the fertile lemma dark brown. All specimens collected from the FEMP property were pressed and mounted for future reference.

Since a state endangered plant species was identified as occurring at the FEMP property, the pressed specimens collected by RUST were sent to the ODNR Division of Natural Areas and Preserves for verification. Upon review of these specimens, Mr. Greg Schneider, a botanist with ODNR, determined that the specimens labeled as *Digitaria filiformis* and *Digitaria serotina* are actually *Digitaria ischaemum*, Smooth Crabgrass. This determination was based upon the fact that each of the specimens sent to ODNR had a fascicled rachis (the main axis of the inflorescence was winged); since *D. filiformis* is the only species of *Digitaria* that does not have a winged rachis, ODNR determined that the specimens were *D. ischaemum*.

Since ODNR's identification did not confirm RUST's initial identification, the specimens were also sent to Dr. John Thieret, a professor of botany at Northern Kentucky University, for identification. Dr. Thieret confirmed ODNR's determination that the specimens are actually *D. ischaemum* based on the non-erect growth, presence of a winged rachis, and the mature spikelets being dark brown in color.

3.0 RESULTS AND CONCLUSIONS

Several populations of crabgrass were observed during the surveys conducted in August 1994 at the FEMP property. Through verification procedures with the ODNR Division of Natural Areas and Preserves and local experts, these populations were determined to consist of two separate species of crabgrass, *Digitaria sanguinalis* and *Digitaria ischaemum*, both of which are common species in Ohio. Although marginally suitable habitat does exist for Slender Finger-grass near the Inactive Flyash Pile, the running track, and additional openings in the northern woodlands, *Digitaria filiformis* was determined not to occur in these areas.

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6799

OHIO ENDANGERED AND THREATENED VASCULAR PLANTS

Abstracts of State-Listed Taxa

Edited by Rober. M. McCance, Jr.
James F. Burns

Division of Natural Areas and Preserves
Department of Natural Resources
Columbus, Ohio

1984

Richard F. Celeste, Governor

Lt. Gov. Myrl H. Shoemaker, Director

000078

DIGITARIA FILIFORMIS (L.) Koel.
Slender Finger-grass

FAMILY: Gramineae (Poaceae).

HABIT: Herbaceous, erect, caespitose annual, 0.5-10 dm.; flowering August-October.

SIMILAR SPECIES: Three species of Digitaria occur in Ohio, two of which are very common. This species differs from the others by penduncle characters and its generally erect habit. This species superficially resembles members of Paspalum.

TOTAL RANGE: FL to TX and Mex., n. to s. NH, MA, NY, s. MI, IL, and IA.

STATE RANGE: There is a post-1960 record from Washington County. There are pre-1960 records from Hocking, Jackson, Montgomery, Muskingum, Pickaway, and Ross counties.

STATE STATUS: 1980-Endangered, 1982-E, 1984-E.

HABITAT: In full sun in sterile sandy soils.

HAZARDS: Grazing; overshading by woody species as a result of succession.

RECOVERY POTENTIAL: Unknown, but probably good due to its weedy nature.

INVENTORY GUIDELINES: Mature flowering material, with underground parts, is needed for identification. Note density of basal tufts.

COMMENTS: This species is likely more common than the records indicate, and intensive searching should find additional locations.

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MANUAL OF THE GRASSES OF THE UNITED STATES

A. S. Hitchcock

Second Edition
Revised by AGNES CHASE

IN TWO VOLUMES

VOLUME TWO

DOVER PUBLICATIONS, INC.
NEW YORK

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2. **Trichachne califórnica** (Benth.) Chase. COTTONTOP. (Fig. 824.) Culms erect from a knotty swollen felty-pubescent base, 40 to 100 cm. tall; leaves numerous, the sheaths glabrous to sparsely pilose; blades mostly less than 12 cm. long, 3 to 5 mm. wide, from nearly glabrous to densely puberulent; panicle mostly 5 to 10 cm. long, the few racemes usually 3 to 5 cm. long, occasionally longer, erect or nearly so: spikelets approximate, excluding the hairs 3 to 4 mm. long, the white to purplish hairs much exceeding them, often spreading, the middle internerves of the sterile lemma glabrous. ♃ (*T. saccharata* Nash.)—Plains and dry open ground, Texas and Oklahoma to Colorado, Arizona, and Mexico; South America.

3. **Trichachne pátens** Swallen. (Fig. 825.) Culms tufted, erect, 40 to 90 cm. tall; sheaths more or less papillose-pilose, the lowermost densely felty-pubescent; blades 5 to 15 cm. long, 1 to 4 mm. wide, scabrous; panicle 10 to 18 cm. long, the racemes stiffly ascending or spreading; spikelets remote, 4 mm. long, densely silky, the hairs exceeding the spikelet; frui 3 mm. long, acute. ♃ —Dry fields, prairies, and roadsides, Texas.

4. **Trichachne hitchcóckii** (Chase) Chase. (Fig. 826.) Culms tufted and branching at base, leafy below, slender, 30 to 50 cm. tall; sheaths and blades nearly glabrous to puberulent, sometimes densely so toward base, the blades 2 to 5 cm. long, 2 to 3 mm. wide; panicle long-exserted, 6 to 10 cm. long, the few racemes 3 to 4 cm. long, mostly rather remote and erect; spikelets 2.5 to 3 mm. long, densely silky-villous, the prominent nerves not hidden, the grayish hairs not exceeding the spikelet. ♃ —Dry plains, Texas; northern Mexico.

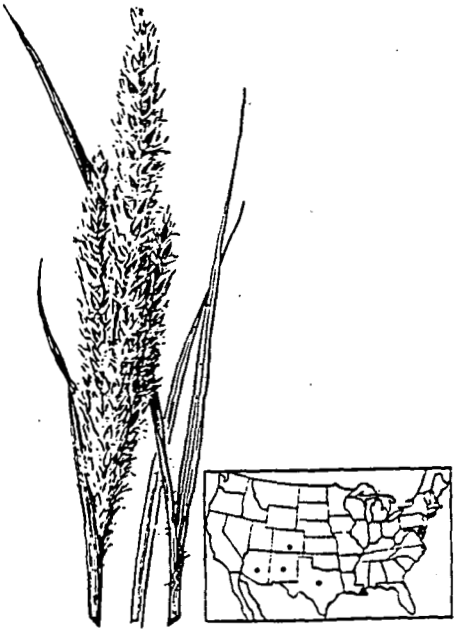

FIGURE 824.—*Trichachne californica*. × 1. (Hitchcock 13608, Tex.)

129. DIGITÁRIA Heister. CRABGRASS

(*Syntherisma* Walt.)

Spikelets in twos or threes, rarely solitary, subsessile or short-pediceled, alternate in 2 rows on one side of a 3-angled winged or wingless rachis; spikelets lanceolate or elliptic, nearly planoconvex; first glume minute or wanting; second glume equaling the sterile lemma or shorter; fertile lemma cartilaginous, the hyaline margins pale. Annual or perennial, erect to prostrate, often weedy grasses, the slender racemes digitate or approximate on a short axis. Type species, *Digitaria sanguinalis*. Name from Latin *digitus*, finger, alluding to the digitate inflorescence of the type species.

The species are in the main good forage grasses. *Digitaria sanguinalis*, the common crabgrass, is a weed in cultivated soil. In the Southern States, where it produces an abundant growth in late summer on fields from which crops have been gathered, it is utilized for forage and is sometimes cut for hay. This species and *D. ischaemum* are common weeds in lawns. They form a fine green growth at first but start late and die in the fall.

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1a. Rachis winged or flat-margined, the margin as wide as the central rib; plants annual, creeping at least at base.
Rachis bearing scattered long fine hairs (these rarely wanting); spikelets narrow, acuminate, nearly glabrous ..... 2. D. HORIZONTALIS.
Rachis not bearing hairs; spikelets elliptic, acute, pubescent.
Plants perennial, stoloniferous ..... 7. D. LONGIFLORA.
Plants annual. Culms erect or decumbent spreading.
Sheaths glabrous; fertile lemma brown.
Spikelets 2 mm. long, 1 mm. wide, the hairs or most of them capitellate. 3. D. ISCHAEMUM.
Spikelets 1.5 to 1.7 mm. long, about 0.6 mm. wide, the hairs not capitellate.
Sterile lemma with 5 distinct nerves; spikelets sparingly pubescent, 1.7 mm. long; fertile lemma light brown; racemes, if more than 2, not digitate. 4. D. FLORIDANA.
Sterile lemma with 3 distinct nerves; spikelets distinctly pubescent, 1.5 mm. long, fertile lemma dark brown, racemes usually all digitate. 5. D. VIOLASCENS.
Sheaths pilose or villous; fertile lemma pale.
Spikelets 1.5 to 1.7 mm. long; pedicels terete, glabrous ..... 6. D. SEROTINA.
Spikelets 2.5 to 3.5 mm. long; pedicels angled, scabrous ..... 1. D. SANGUINALIS.
1b. Rachis wingless or with a very narrow margin (see also *D. horizontalis*), triangular; plants not creeping (except in *D. texana*), annual or perennial.
2a. Fertile lemma pale or gray.
Plants annual, decumbent and rooting at base. Spikelets 3 mm. long, glabrous or nearly so ..... 8. D. SIMPSONI.
Plants perennial.
Spikelets densely or sparsely villous; racemes 5 to 10.
Spikelets 2.8 to 3.5 mm. long, sparsely to densely villous ..... 14. D. RUNYONI.
Spikelets 2 to 2.5 mm. long, rather sparsely villous ..... 13. D. TEXANA.
Spikelets glabrous to obscurely appressed-pubescent on the internerves; racemes 2 to 5, some of them naked at base for 1 to 1.5 cm.
First glume broad, hyaline, minute but obvious; spikelets 3.2 mm. long, glabrous. 15. D. PAUCIFLORA.
First glume obsolete or nearly so; spikelets 2.5 to 2.8 mm. long, obscurely to obviously appressed-pubescent.
Racemes 2 to 4; culms ascending from a curved base; sheaths papillose-pilose. 16. D. SUBCALVA.
Racemes 5 to 10; culms erect; sheaths conspicuously villous. 17. D. ALBICOMA.
2b. Fertile lemma dark brown. Plants erect or at least not rooting at the decumbent base; annual or sometimes apparently perennial.
Second glume and sterile lemma glabrous (see also *D. laeviglumis* under *D. filiformis*). 12. D. GRACILLIMA.
Second glume and sterile lemma capitellate-pubescent.
Spikelets 2 to 2.5 mm. long ..... 10. D. VILLOSA.
Spikelets 1.5 to 1.7 mm. long.
Blades folded or involute, flexuous ..... 11. D. DOLICHOPHYLLA.
Blades flat ..... 9. D. FILIFORMIS.

1. Digitaria sanguinális (L.) Scop. CRABGRASS. (Fig. 827.) Plant branching and spreading, often purplish, rooting at the decumbent base, the culms sometimes as much as 1 m. long, the flowering shoots ascending; sheaths, at least the lower, papillose-pilose; blades 5 to 10 mm. wide, pubescent to scaberulous; racemes few to several, 5 to 15 cm. long, rarely longer, digitate, with usually 1 or 2 whorls a short distance below; spikelets about 3 mm. long; first glume minute but evident; second glume about half as long as the spikelet, narrow, ciliate; sterile lemma strongly nerved, the lateral internerves appressed-pubescent, the hairs sometimes spreading at maturity (*D. fimbriata* Link); fertile lemma pale. ⊙ —Fields, gardens, and waste places, a troublesome weed in lawns and cultivated ground throughout the United States at low and medium altitudes, more common in the East and South; temperate and tropical regions of the world. Native of Europe. A specimen with nearly glabrous sheaths and inflorescences of 2 racemes collected by

FIGURE 826.—*Trichachne hitchcockii*. Plant, × 1; epikelet and floret, × 10. (Type.)

Tracy in Mississippi, said to be introduced, has been erroneously referred to *Syntherisma barbatum* (Willd.) Nash (*Digitaria barbata* Willd.).

DIGITARIA SANGUINALIS var. CILIÁRIS (Retz.) Parl. Sterile lemma, pectinate-ciliate, the stiff cilia 1.5 mm. long. Along railroad, Berks County, Pa. Waif from Asia.

2. Digitaria horizontális Willd. (Fig. 828.) Resembling *D. sanguinalis*, the culms more slender, the racemes mostly subracemose, very slender, lax, the rachis scarcely winged, bearing scattered long fine spreading hairs (these rarely wanting); spikelets narrow, about 2 mm. long; first glume minute or obsolete; second glume half as long as the spikelet. ⊙ (*Syntherisma setosum* Nash; *S. digitatum* Hitchc.)—Waste places, southern and central Florida; ballast. Mobile, Ala.; tropical regions of North America and South America.

3. Digitaria ischaémum (Schreb.) Schreb. ex Muhl. SMOOTH CRABGRASS. (Fig. 829.) Erect or usually soon decumbent-spreading, resembling *D. sanguinalis* but not so coarse or tall; foliage glabrous, bluish or purplish; racemes mostly 2 to 6, 4 to 10 cm. long, the rachis with thin wings wider than the midrib; spikelets about 2 mm. long; first glume hyaline, obscure; second glume and sterile lemma as long as the dark fertile lemma, pubescent with capitellate hairs. ⊙ (*Syntherisma humifusum* Rydb.)—Waste places, often a troublesome weed in lawns. Quebec to Georgia, west to Washington and California; introduced from Eurasia. The first glume is so thin as to be apparently wanting. DIGITARIA ISCHAEMUM var. MISSISSIPPIÉNSIS (Gattinger) Fernald. Taller, the racemes mostly 5 to 7, often 10 or even 15 cm. long; first glume often more easily seen. ⊙ —Maryland, Indiana, Illinois, Virginia, Tennessee, South Carolina, and Georgia.

4. Digitaria floridána Hitchc. (Fig. 830.) Culms tufted, decumbent at base, 20 to 30 cm. tall; foliage glabrous except for a few long hairs around the mouth of the sheath; blades 4 to 7 cm. long, 3 to 6 mm. wide; racemes 3 or 4, rather distant on the axis, 3 to 6 cm. long, the rachis wings wider than the midrib; spikelets 1.5 to 1.7 mm. long, rather sparingly pubescent; first glume wanting; second glume and sterile lemma about as long as the light-brown fertile lemma. ⊙ —Sandy pine woods, Florida (Hernando County). The inflorescence resembles that of *D. filiformis*, but the rachis is winged; the spikelets are smaller than those of *D. ischaemum*.

5. Digitaria violáscens Link. (Fig. 831.) Annual or apparently perennial; culms numerous in a tuft, spreading at base, slender, 10 to 40 cm. tall; leaves mostly clustered near the base, the sheaths glabrous; blades flat, mostly less than 5 cm. long, 3 to 6 mm. wide, the upper culm blade distant, reduced; racemes slender, 2 to 5, usually 2 or 3, digitate or some-

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FIGURE 827.—*Digitaria sanguinalis*. Pla views of spikelet, and floret, × 10. Kans.)

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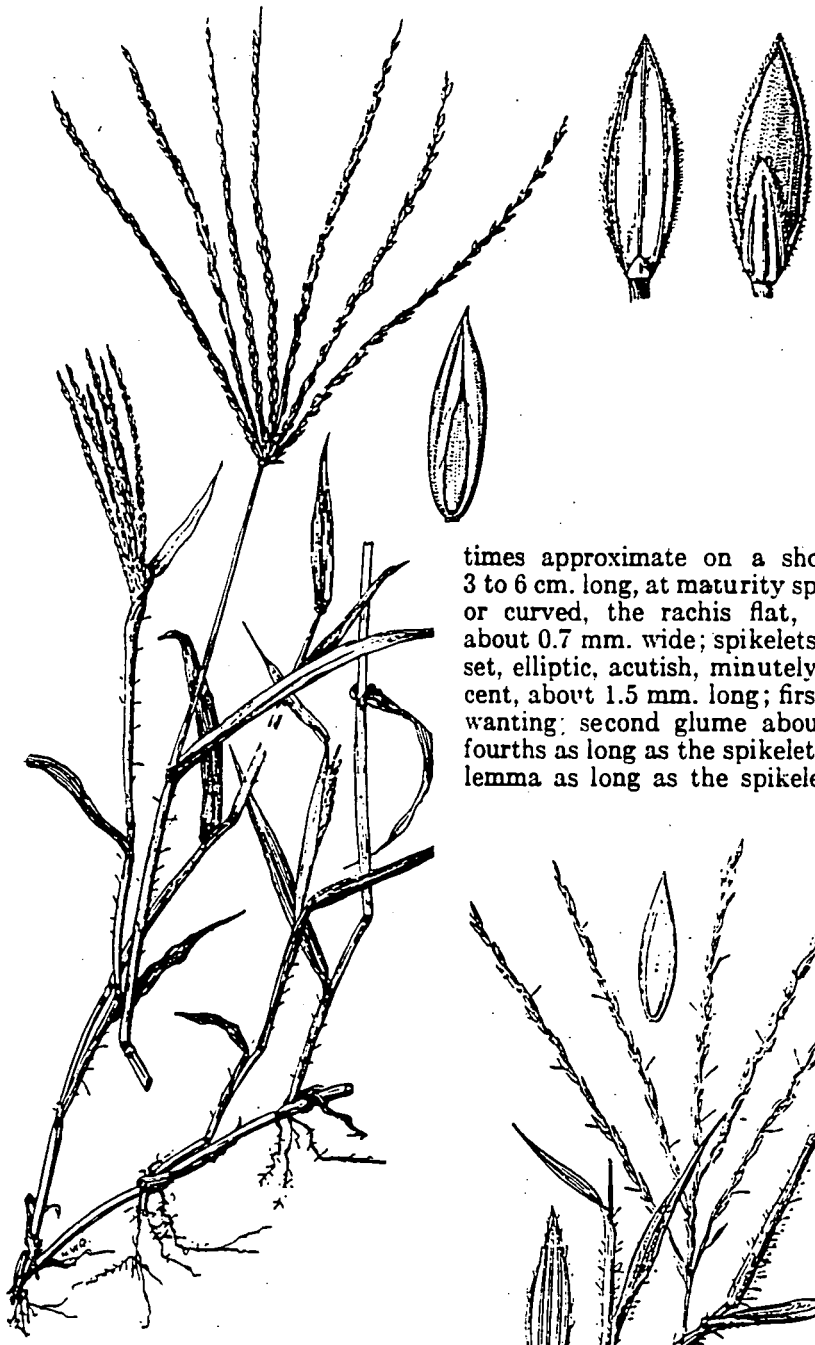

FIGURE 827.—*Digitaria sanguinalis*. Plant, × ½; two views of spikelet, and floret, × 10. (Norton 566, Kans.)

times approximate on a short axis 3 to 6 cm. long, at maturity spreading or curved, the rachis flat, winged, about 0.7 mm. wide; spikelets closely set, elliptic, acutish, minutely pubescent, about 1.5 mm. long; first glume wanting; second glume about three fourths as long as the spikelet; sterile lemma as long as the spikelet, with

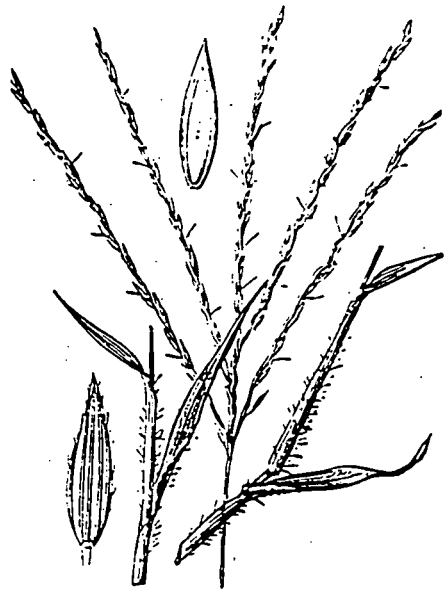

FIGURE 828.—*Digitaria horizontalis*. Plant, × 1; spikelet and floret, × 10. (Nash 996, Fla.)

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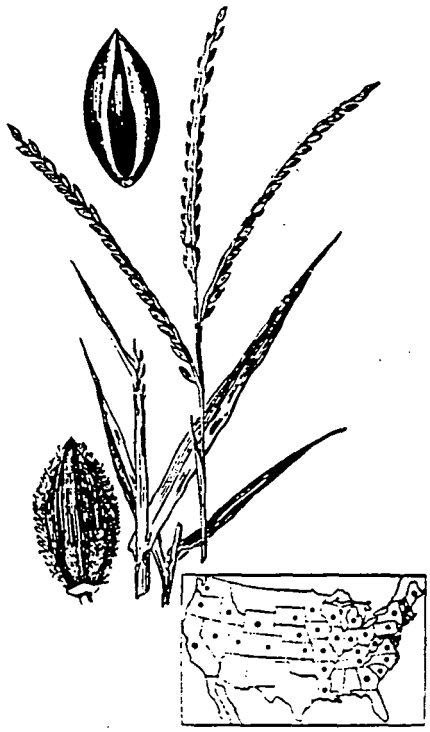

FIGURE 829.—*Digitaria ischaemum*. Plant. × 1; spikelet and floret. × 10. (Jones 1761, Vt.)

FIGURE 830.—*Digitaria floridana*. Plant. × 1; spikelet and fertile floret. × 10. (Type.)

FIGURE 831.—*Digitaria violascens*. Pa views of spikelet, and floret. × 10. Ala.)

three distinct nerves and 1 or 2 obscure pairs; fertile lemma acute, dark brown at maturity. ⊙ ♃ —Open pineland in sandy soil, Indiana and Kentucky; Georgia and Florida to Arkansas and Texas; tropical America; tropical Asia.

6. **Digitaria serótina** (Walt.) Michx. (Fig. 832.) Creeping, sometimes forming extensive mats; flowering culms ascending or erect, 10 to 30 cm. tall; leaves crowded on the creeping culms, the blades short; sheaths villous; blades 2 to 8 cm. long, 3 to 7 mm. wide; racemes usually 3 to 5, slender, often arcuate, 3 to 10 cm. long, the rachis with thin wings wider than the midrib; spikelets pale, about 1.7 mm. long; first glume wanting; second glume about one-third as long as the sterile lemma, both finely pubescent; fertile lemma pale. ⊙ —Pastures and waste places, Coastal Plain, Pennsylvania to Florida and Louisiana; Philadelphia (ballast); Cuba.

7. **Digitaria longiflóra** (Retz.) Pers. (Fig. 833.) Stoloniferous; culms ascending, 20 to 40 cm. tall, glabrous; sheaths glabrous; ligule membranaceous, 1 mm. long; blades 1 to 4 cm. long, 3 to 5 mm. wide, flat, glabrous; racemes 2 to 4, 3 to 8 cm. long, usually curved, the rachis flat, 0.5 to 0.8 mm. wide; spikelets 1.5 mm. long, elliptic, minutely pubescent. ♃ —Ditches and sandy ground, southern Florida; tropical regions of the Old World; introduced in the American Tropics.

8. **Digitaria simpsóni** (Vasey) Fernald. (Fig. 834.) Resembling *D. sanguinalis* in habit; sheaths papillose-pilose, those of the innovations compressed-keeled; blades not more than 6 mm. wide, softly pilose; racemes 4 to 8, ascending, pale, 8 to 12 cm. long, the triangular rachis narrowly margined; spikelets about 3 mm. long; first glume hyaline, obsolete or nearly so; second glume and sterile lemma finely 7- to 9-nerved, glabrous or very obscurely pub e exceeding the pale, slightly fertile lemma. ⊙ —Sa Florida, rare; Isla de Pi

9. **Digitaria filifórmis** (Fig. 835, *A*.) Culms in s slender, usually erect, 10 tall, rarely taller, those of unequal; lower sheaths upper mostly glabrous; bl usually 5 to 15 cm. long more robust plants), 1 wide; racemes mostly 1 to erect or ascending, mostly 10 cm. long, somewhat d fascicled; spikelets 1.5 t long; first glume wanti glume and sterile lemma with short capitellate h times nearly glabrous, shorter than the spikelet; ma dark brown, slightly ⊙ —Sandy fields and s ground, New Hampshir and Oklahoma, south Texas, and Mexico. A

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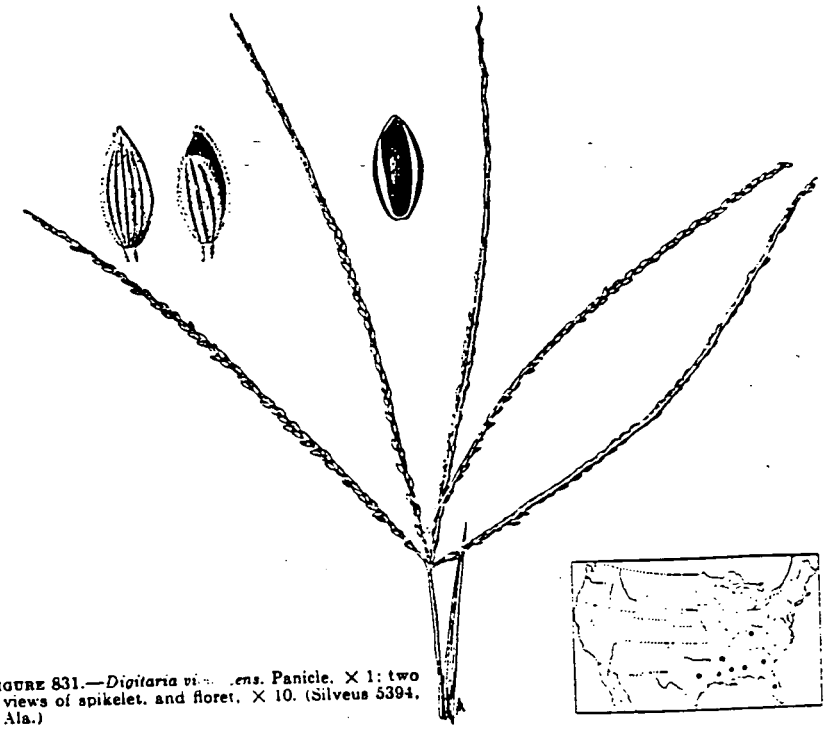

FIGURE 831.—*Digitaria vi... ens.* Panicle, × 1; two views of spikelet, and floret, × 10. (Silveus 5394, Ala.)

or very obscurely pubescent, barely exceeding the pale slightly apiculate fertile lemma. ⊙ —Sandy fields, Florida, rare; Isla de Pinos, Cuba.

9. Digitaria filifórmis (L.) Koel. (Fig. 835, *A*.) Culms in small tufts, slender, usually erect, 10 to 60 cm. tall, rarely taller, those of a tuft very unequal; lower sheaths pilose, the upper mostly glabrous; blades erect, usually 5 to 15 cm. long (longer in more robust plants), 1 to 4 mm. wide; racemes mostly 1 to 5, unequal, erect or ascending, mostly less than 10 cm. long, somewhat distant, not fascicled; spikelets 1.5 to 1.7 mm. long; first glume wanting; second glume and sterile lemma pubescent with short capitellate hairs, sometimes nearly glabrous, the glume shorter than the spikelet; fertile lemma dark brown, slightly apiculate. ⊙ —Sandy fields and sterile open ground, New Hampshire to Iowa and Oklahoma, south to Florida, Texas, and Mexico. A form with

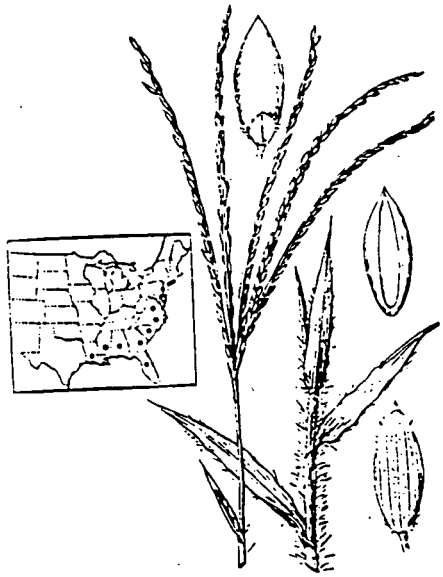

FIGURE 832.—*Digitaria serotina.* Plant, × 1; two views of spikelet, and floret, × 10. (Tracy 4653, Miss.)

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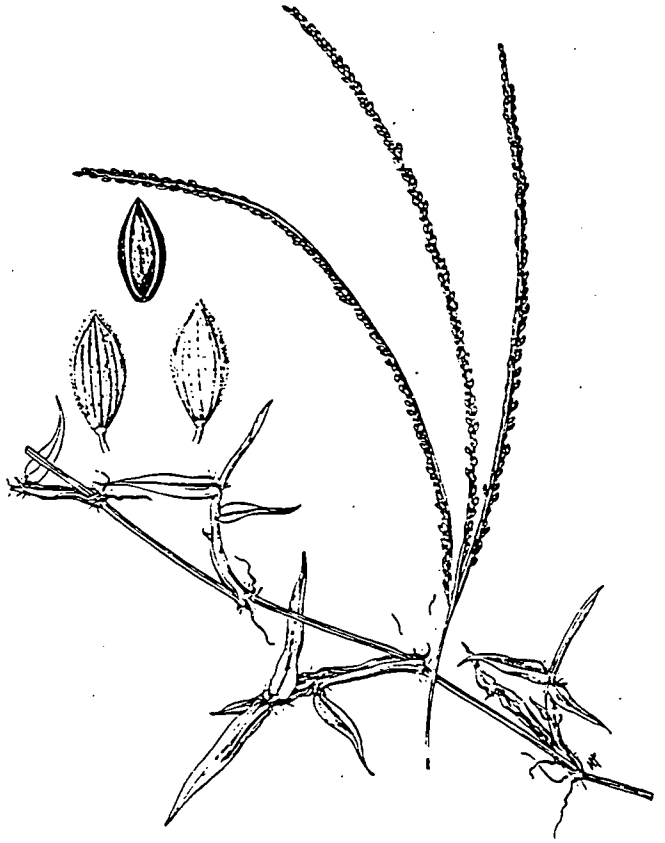

FIGURE 833.—*Digitaria longiflora*. Plant. × ½. Stolon and panicle. × 1; spikelet and floret. × 10. (Silveus 4405, Fla.)

glabrous spikelets from Manchester, N. H., has been described as *D. laeviglumis* Fernald (835, *B*.).

10. Digitaria villósa (Walt.) Pers. (Fig. 836.) Perennial at least in the Southern States, in large tufts, purplish at base; culms 0.75 to 1.5 m. tall, rarely branching; sheaths, at least the lower, grayish villous, sometimes sparsely so; blades elongate, 3 to 6 mm. wide, often flexuous, from softly pilose to nearly glabrous; racemes 2 to 7, narrowly ascending, rarely somewhat spreading, very slender, usually 15 to 25 cm. long, rather distant, often naked at base, sometimes interrupted; spikelets 2 to 2.5 mm. long, usually densely pubescent with soft capitellate hairs, the hairs longer than in *D. filiformis*, and sometimes only obscurely capitellate, the spikelets otherwise very like those of *D. filiformis*. ♃ —Sandy fields and woods, Maryland to Missouri, south to Florida and Texas; Cuba, Mexico. This species and *D. filiformis* seem to intergrade to some extent. Plants from peninsular Florida with less strongly pubescent sheaths, 2 to 4 elongate racemes, and spikelets with longer hairs have been distinguished as *D. leucocoma* (Nash) Urban.

11. Digitaria dolichophýlla Henr. (Fig. 837.) Slender wiry perennial, 50 to 115 cm. tall; blades elongate, folded or involute, flexuous, about 1 mm. wide; racemes mostly 1 to 3, erect, 5 to 20 cm. long, usually 10 to 20 cm., very slender, loosely flowered; spikelets about 1.5 mm.

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♃ (Has been confused with
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barrens and open ground, southe
Florida; Cuba, Puerto Rico.

12. Digitaria gracíllima (Scrib
Fernald. (Fig. 838.) Perennial
dense tufts; culms 60 to 100 cm. t
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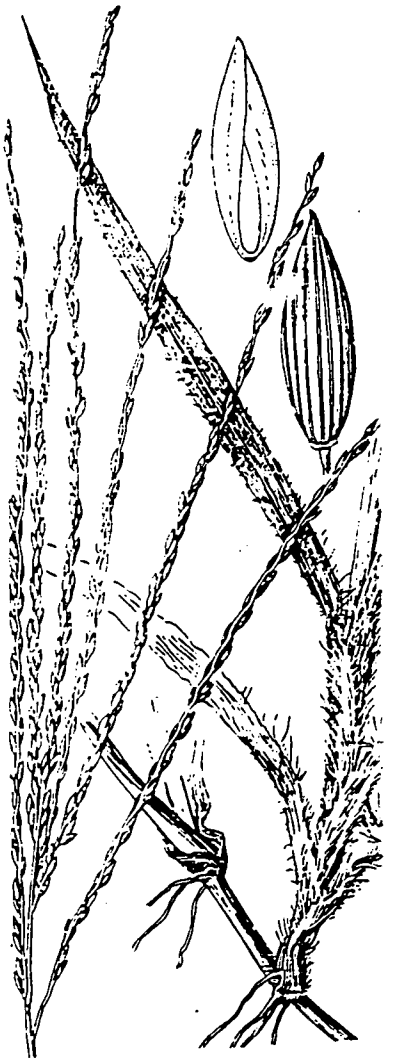

FIGURE 834.—*Digitaria simpsoni*. Plant. × 1
let and floret. × 10. (Curtiss 6422, Fla.

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long, the capitellate hairs rather stiff and appressed; fruit dark brown. ♃ (Has been confused with *D. panicea* (Swartz) Urban.)—Moist pine barrens and open ground, southern Florida; Cuba, Puerto Rico.

12. Digitaria gracíllima (Scribn.) Fernald. (Fig. 838.) Perennial in dense tufts; culms 60 to 100 cm. tall, erect; lower sheaths appressed-villous; blades elongate, 1 to 2 mm. wide, often involute, more or less flexuous; racemes mostly 2 or 3, distant (rarely as many as 5 and fairly approximate), very slender; spikelets rather remote, relatively long pediceled, about 2.3 mm. long, glabrous; first glume ob-

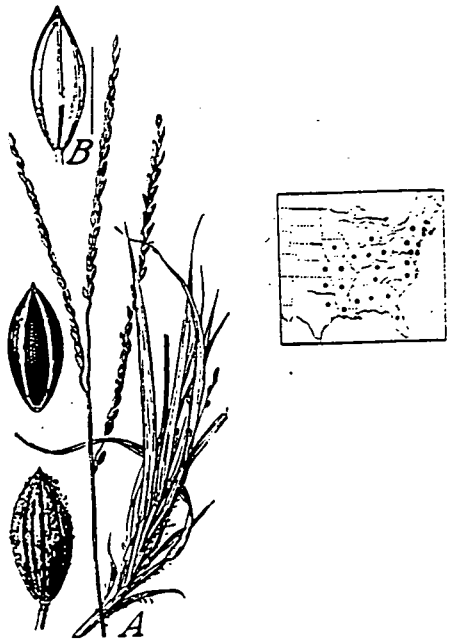

FIGURE 835.—*A. Digitaria filiformis.* Plant, × 1; spikelet and floret, × 10. (Bissell, Conn.) *B. D. laevigatum.* Spikelet, × 10. (Type coll.)

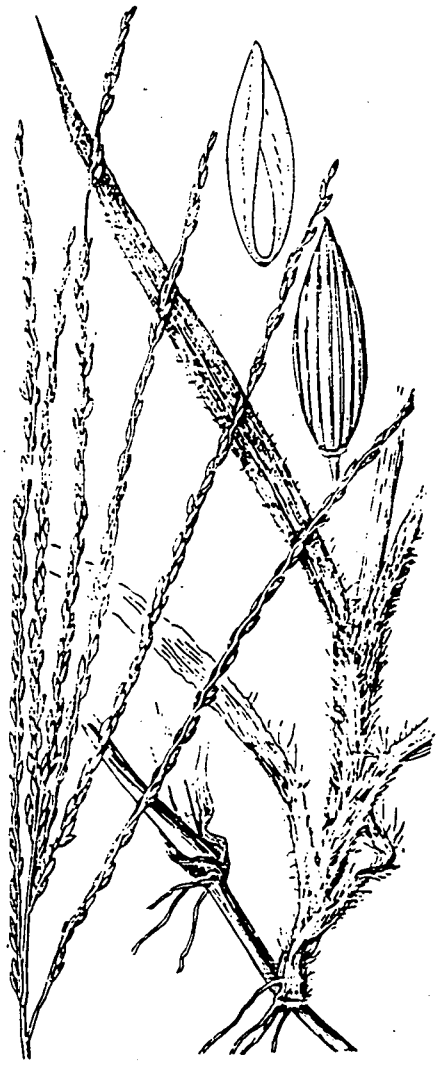

FIGURE 834.—*Digitaria simpsoni.* Plant, × 1; spikelet and floret, × 10. (Curtiss 6422, Fla.)

FIGURE 836.—*Digitaria villosa.* Plant, × 1; spikelet and floret, × 10. (Curtiss 5300, Fla.)

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scurely capitellate, the e very like those of —Sandy fields and nd to Missouri, south Texas; Cuba, Mexico. D. *filiformis* seem ome extent. Plants ar Florida with less scent sheaths, 2 to 4 and spikelets with been distinguished *a* (Nash) Urban.

dolichophýlla Henr. er wiry perennial, l; blades elongate, olute, flexuous, about emes mostly 1 to cm. long, usually ery slender, loosely elets about 1.5 mm.

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MANUAL OF THE VASCULAR FLORA OF THE CAROLINAS

ALBERT E. RADFORD

HARRY E. AHLES

C. RITCHIE BELL

THE UNIVERSITY OF NORTH CAROLINA PRESS
CHAPEL HILL

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long, sterile lemma 1-3 nerved, glaucous, obtuse, 3-4 mm long; fertile lemma and palea nerveless or faintly nerved, papillose, obtuse, 3-4 mm long. Grain dark red, broadly ellipsoid, 2.8 mm long. (n = 60, 80) Aug.-Oct. Low woods, roadsides and fields; pied. and cp. [Va., Ga., Fla., Ala., Miss., Tenn., Ky.] Includes *P. difforme* Le Conte—S; *P. floridanum* var. *glabratum* Engelm.

75. DIGITARIA Heister CRAB GRASS

Annuals; internodes glabrous. Leaves cauline; blade margins cartilaginous, scaberulous; sheath margins usually scarious; ligules membranous. Racemes racemose, ascending; rachis usually winged, scaberulous. Spikelets plano-convex, ellipsoid, acute. First glume usually absent. 2nd glume villous on nerves and margins, acute, sterile lemma 5-7 nerved, acute; fertile lemma and palea nerveless, cartilaginous, glabrous, acute; fertile lemma margins flat, hyaline. Grain whitish to brownish, ellipsoid. These plants are our worst field and garden weeds.

Rachis trigonous, not distinctly winged	1. *D. filiformis.*
Rachis not trigonous, distinctly winged.	
Sheath glabrous	2. *D. ischaemum*
Sheath pubescent.	
Spikelets 2.8-3.2 mm long	3. *D. sanguinalis.*
Spikelets 1.5-1.8 mm long	4. *D. serotina.*

1. **D. filiformis** (L.) Koeler. Cespitose annual; culms 3-12 dm tall, nodes glabrous. Blades to 15 cm long, 2-4 mm wide, papillose-hirsute and scaberulous above, glabrous or occasionally pilose to hirsute beneath; sheaths papillose-hirsute; ligules erose to lacerate, 0.5-1 mm long. Racemes 2-7, ascending, 3-12 cm long; rachis trigonous, wingless, scaberulous. Spikelets 1.8-2.5 mm long; pedicels scaberulous, 0.5-3 mm lo Second glume 5-nerved, 1.2-1.5 mm long, sterile lemma margin ciliate, 1.8-2 mm long; fertile lemma and palea purple, papillose lined, 1.8-2 mm long. Grain 1-1.2 mm long. (n = 18) Sept.-Oct. Sandy fields, roadsides.

1a. var. **filiformis.*** Spikelets 1.8-2 mm long; plant 3-7.5 dm tall. Scattered throughout. [Va., Ga., Fla., Ala., Miss., Tenn., Ky.] *Syntherisma filiforme* (L.) Nash—S.

1b. var. **villosa** (Walter) Fernald. Spikelets 2-2.5 mm long; plant frequently more than 1 m tall. Pied. and cp. [Va., Ga., Fla., Ala., Miss., Tenn.] *Syntherisma villosum* Walter—S.

2. **D. ischaemum** (Schreber) Schreber ex Muhl. Cespitose to decumbent annual; culms 1.5-6 dm tall, nodes glabrous. Blades to 14 cm long, 2-7 mm wide, glabrous on both surfaces or sparsely pilose; sheaths glabrous; ligules 1-2.5 mm long. Racemes 2-6, ascending, 2-9 cm long; rachis wing scaberulous, 1 mm wide. Spikelets 1.5-2.2 mm long, in groups of 2 or 3; pedicels minutely scaberulous angled, 0.5-2 mm long. Second glume usually 3-nerved, 1.8-2.2 mm long; sterile lemma slightly villous, 1.8-2.2 mm long; fertile lemma and palea purple, papillose lined, 1.8-2.2 mm long. Grain 1.2-1.4 mm long. (n = 18).

2a. var. **ischaemum**. Spikelets 1.8-2.2 mm long. July-Oct. Fields and lawns; throughout. [Va., Ga., Ala., Miss., Tenn., Ky., W.Va.] *Syntherisma ischaemum* (Schreber) Nash—S.

2b. var. **violascens** (Link) Radford. Spikleets ca. 1.5 mm long. Sept.-Oct. Sandy woods and roadsides; cp. [Ga., Fla., Ala., Miss., Ky.] *D. violascens* Link—G.

3. **D. sanguinalis** (L.) Scopoli.* Cespitose, mat-forming annual freely rooting at the lower nodes; culms 2-7 dm tall, lower nodes pilose, upper glabrous. Blades to 16 cm long, 1-16 mm wide, pubescent or puberulent above, scaberulous beneath, occasionally papillose-hirsute basally; sheaths papillose-hirsute; ligules erose, 2-3 mm long. Racemes 3-9, ascending, 2-16 cm long; rachis wing 0.8-1 mm wide, scaberulous. Spikelets 2.8-3.2 mm long, in 2 or 4 rows; pedicels scaberulous angled, 0.5-2 mm long. First glume triangular, glabrous, acute, 0.5 mm long, 2nd glume 5-nerved, 2.8-3.2 mm long; sterile lemma margins villous, 2.8-3.2 mm long; fertile lemma and palea purplish, papillose lined, 2.8-3.2 mm long. Grain 2-2.2 mm long. (n = 18, 24, 27) July-Oct. Fields, roadsides and waste places; throughout. [Va., Ga., Fla., Ala., Miss., Ky., W.Va.] *Syntherisma sanguinale* (L.) Dulac.—S.

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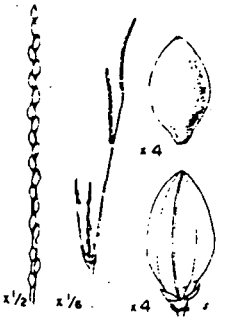
4. **D. serotina** (Walter) tall, nodes appressed pubescent. I sheaths villous; ligules 1-2.5 mm scaberulous, 0.8 mm wide. Spikel mm long. Second glume absent or villous, 1.5-1.8 mm long; fertile l long. Oct. Sandy woodlands, rare; Miss.] *Syntherisma serotinum* Wal

76. BR

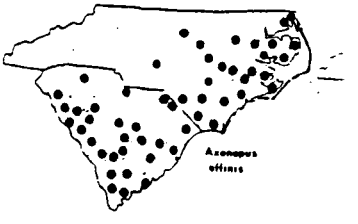
1. **B. platyphylla** (Grisel nodes; culms 3-6 dm tall, nodes an 5-14 mm wide, glabrous on both s papillose-pilose, margins ciliate; li ascending, 4-8 cm long; rachis wi spikelet. Spikelets ovoid, not plan setose, 0.5-1 mm long. First glume 2nd glume and sterile lemma 7- sterile palea scarious; fertile lemm long. Grain yellowish, broadly ell Co., N.C., Beaufort, Dillon, Richl

77. AXO

Rhizomatous perennials usu low cauline; blades glabrou n bo glabrous, margins glabrous; ngule jugate; rachis trigonous, wingless.



Brachiaria platyphylla



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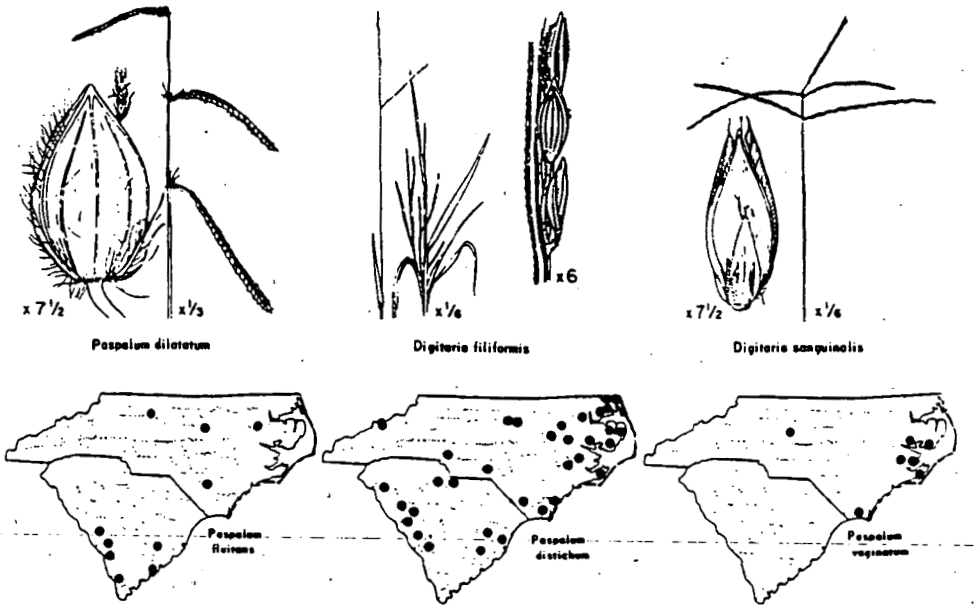
long; rachis wing scaberulous, 1 mm wide. Spikelets orbicular, 2.5-3 mm broad, in 2 rows; pedicels scaberulous, 1-1.5 mm long. Second glume 3-nerved, glabrous, 2.5-3 mm long, sterile lemma 5-nerved, glabrous, 2.5-3 mm long; fertile lemma and palea nerveless, slightly papillose, 2.5-3 mm long. Grain yellowish, suborbicular, 2 mm broad. (n = 20) June-Aug. Fields, meadows and roadsides; throughout. [SE.] Includes *P. longipilum* Nash, *P. circulare* Nash—S; *P. laevi* var. *circulare* (Nash) Fernald—F.

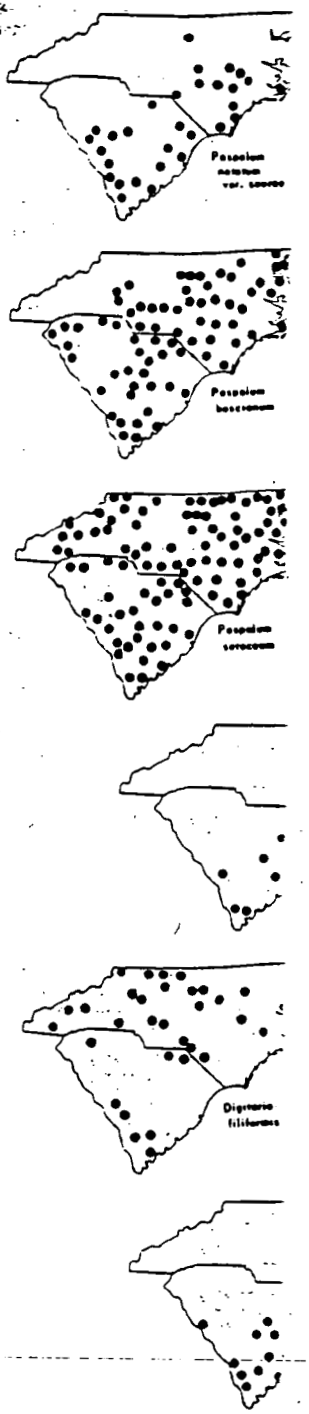
14. P. praecox Walter. Erect perennial from short rhizomes; culms 6-9 dm tall, nodes and internodes glabrous. Blades to 20 cm long, 1.5-4 mm wide, glabrous or villous on both surfaces, occasionally pilose basally above; sheaths glabrous, villous or sparsely papillose above, margins smooth; ligules 2-2.5 mm long. Racemes 3-5, racemose, ascending, 2-6 cm long; rachis wing scaberulous, 1-1.2 mm wide. Spikelets broadly obovoid to suborbicular, flattish, 2.2-3.2 mm long, in 4 rows, 2 rows rudimentary; pedicels scaberulous angled, 0.1-1 mm long. Second glume and sterile lemma 3-nerved, yellowish green, margins scarious, obtuse, 2.2-3.2 mm long; fertile lemma and palea nerveless, papillose, obtuse, 2.2-3.2 mm long. Grain brownish, broadly ellipsoid, flat, 2 mm long. (n = 10, 20) Savannahs and low pinelands; cp.

14a. var. **praecox.** Sheaths and blades glabrous or sparsely papillose. May-July. [Va., Ga., Fla., Ala., Miss.].

14b. var. **curtisianum** (Steudel) Vasey. Sheaths and blades villous or hirsute. June-Oct. Savannahs and low pinelands; cp. [Va., Ga., Fla., Ala., Miss., Tenn., Ky.] *P. lentiferum* Lam.—S.

15. P. floridanum Michaux. Coarse perennial from stout rhizome; culms 5-15 dm tall, nodes and internodes glabrous. Blades to 40 cm long, 1-15 mm wide, glabrous on both surfaces; sheaths glabrous, occasionally pubescent apically, margins glabrous; ligules membranous, 1-2 mm long. Racemes 2-7, racemose, ascending, [illegible] 3 cm long; rachis scaberulous, 1-2 mm wide. Spikelets suborbicular or broadly ellipsoid, 3-4 mm long, in 4 rows or by abortion 3 or 2; pedicels scaberulous, 1-2 mm long. Second glume 5-7 nerved, glaucous, obtuse, 3-4 mm





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BULLETIN OF THE OHIO BIOLOGICAL SURVEY
New Series

Volume 7 Number 1

6799

A DESCRIPTIVE KEY TO THE GRASSES OF OHIO BASED ON VEGETATIVE CHARACTERS

By

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5. Culms submersed or floating or prostrate on wet soil and rooting at nodes, short or as much as 1 m long; ligule and auricles 1-3 (5) mm long; sheaths of floating branches inflated, glabrous or hairy; blades usually not more than 1 cm wide and 10 cm long but sometimes considerably wider and longer; annual. ***Paspalum fluitans*** (Ell.) Kunth

   Four counties along the Ohio River; panicle 1-1.5 dm long, of many bladelike branches that are wider than the 2 rows of attached spikelets; spikelets about 1.8 mm long, minutely hairy; first glume absent, the second as long as the spikelet; August-October.

5. Growing in dry or moist open places, not in water or very wet soil; culms ascending or rarely erect, or ascending from a decumbent base, sometimes prostrate, sometimes rooting at lower nodes.

   6. Perennial, not weedy; culms short to moderately tall, much branched, leafy, ascending from a knotty decumbent base, the base often with feltlike pubescence; internodes short, the lower often 2-3 cm long, the upper somewhat longer; whole plant often a rather large bunch; lower sheaths often pubescent; blades 2-6 mm wide, mostly less than 1 dm long, the bases often asymmetric; ligule and vertical auricles 1-1.5 mm long, usually higher on one side than on the other and extending horizontally farther on one side than on the other. ***Leptoloma cognatum*** (Schult.) Chase, fall witchgrass.

      Open sandy soil, dry fields; 8 northern and 6 south-central counties; panicle diffuse, one-third the height of the plant or more, at maturity breaking away as a tumbleweed; spikelets 2.5-3 mm long, narrow, solitary at ends of capillary branchlets, each with 1 perfect floret and an additional lemma; sterile lemma and second glume minutely hairy, the first glume absent or very small; hyaline margins of lemma of perfect floret enclosing the palea; July-October.

   6. Annual, weedy; culms spreading or ascending from a decumbent base, sometimes, especially when crowded, erect or nearly so, sometimes prostrate, usually rooting at lower nodes; internodes several to many, usually short; foliage often tinged with blue or purple; sheaths loose or inflated, mostly shorter than internodes, with pale longitudinal lines (visible when sheath is removed and held to light); blades 2-8 (10) mm wide, often with pale or purple edge; ligule 1-3 mm long. Species of ***Digitaria***, crabgrass.

      Waste places, lawns, cultivated fields, and gardens; general and abundant; inflorescence a panicle of spikelike racemes clustered at or near summit of peduncle, sometimes all or most of them in one or two whorls; spikelets 2-3 mm long, each with 1 perfect floret and an additional lemma; first glume minute or sometimes absent.

      7. Nodes, sheaths, and blades more or less hairy, the hairs, at least some of them, papilla-based; blades 4-8 (10) mm wide, 4-15 cm long; culms sometimes to 1 m long, especially when prostrate, but often much shorter. ***Digitaria sanguinalis*** (L.) Scop., crabgrass.

         Second glume half as long as the pale or green lemma; first glume minute; June-frost.

      7. Plants glabrous or with a few straggling hairs, the hairs not papilla-based; blades 2-4 (6) mm wide, 2-10 cm long; culms usually short. ***Digitaria ischaemum*** (L.) Scop., smooth crabgrass.

         Second glume as long as the dark lemma; first glume sometimes absent or vestigial; July-frost.

7. Blades 1-4 mm wide, sometimes pubescent near base; ligule 1-1.5 mm long, minutely toothed; sheaths, at least the lower, with papilla-based hairs that are sometimes prominent; culms slender to very slender, short to moderately tall, in small tufts, sometimes branched at base or lower nodes, usually erect, those of a tuft unequal in length; foliage and panicle not red; annual. ***Digitaria filiformis*** (L.) Koel.

   Sandy or sterile open ground; 9 counties, mostly southern: inflorescence of 1 to several spikelike racemes attached along a rachis, not fascicled; spikelets 1.5-2 mm long, with 1 perfect floret plus an additional lemma, often in 3's on the axis of the raceme; first glume absent; second glume and slightly longer sterile lemma short-pubescent: fertile lemma and palea dark, elliptic; hyaline margins of lemma overlapping the palea; August-October.

7. Blades 3-10 mm wide; ligule 1-3 mm long, either laciniate-toothed, the teeth ending in hairs, **OR** entire and often brown.
   8. Blades acuminate to aristate at tip; ligule 1-2 mm long, laciniate-toothed, the teeth ending in hairs; sheaths papillose-pubescent, often sparsely so, the hairs slender and sometimes deciduous, the small papillae remaining; culms short to tall, erect or sometimes bent and branched below; foliage and panicle usually red or purple; annual. ***Leptochloa filiformis*** (Lam.) Beauv., red sprangletop.

      Open or shaded areas, sometimes a weed in states farther south; Adams and Gallia counties; apparently rare in Ohio; panicle half the height of the plant, lance-ovoid, of many spikelike branches attached along the rachis; spikelets small, few flowered; lemma 1-1.5 mm long, pubescent on nerves; July-October.

   8. Blades acuminate; ligule 1-3 mm long, entire, often brown; sheaths keeled, the uppermost sometimes inflated; sheaths and blades glabrous to pubescent on surface and margin, the hairs sometimes papilla-based; foliage green; perennial. ***Panicum palum laeve*** Michx. (Incl. ***P. longipilum*** Nash and ***P. circulare*** Nash) (See p. 62).

4. Culms without cormlike bases; plants glabrous or more or less pubescent but without velvety or papillose pubescence.
   5. Blades prow-shaped at tip, the tip often so slender that its shape may not be noticeable without magnification; blades 1-3 (4) mm wide; perennial.
      6. Basal tufts present; culms usually slender, short to moderately tall, pubescent or puberulent, sometimes only below the nodes and below the panicle; sheaths, at least the lower ones, pubescent or puberulent; blades pubescent, puberulent or glabrous, sometimes folded or rolled in drying; ligule 0.5-2 mm long, truncate. ***Koeleria cristata*** (L.) Pers., junegrass.

         Koelaria cristata is an illegitimate name. Names used by authors in recent years have included ***K. macrantha*** (Ledeb.) Schultes, ***K. nitida*** Nutt., and ***K. pyramidata*** (Lam.) Beauv.

         Dry prairies, open woods, sandy soil; 3 counties along western Lake Erie and Greene County; panicle shining, narrow and spikelike, silvery green, the rachis pubescent; spikelets 4-5 mm long; June-August.

      6. Culms in small tufts, mostly short and slender, erect or bent at base; plants glabrous; blades sometimes rolled, the tips slender;

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Manual of Vascular Plants of Northeastern United States and Adjacent Canada

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and

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The New York Botanical Garden

D. VAN NOSTRAND COMPANY

NEW YORK CINCINNATI TORONTO LONDON MELBOURNE

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78. DIGITARIA Heist. Crab grass. Spikelets 1-fld, single or in clusters of 2 or 3 on unequal pedicels on one side of an elongate rachis; first glume minute or lacking; second glume a third to fully as long as the spikelet, conspicuously 5–7-nerved: fertile lemma cartilaginous with hyaline margins, acute, often shining, usually faintly marked with longitudinal rows of minute pits; ours annual, branched from the base, with few–several terminal, digitate or approximate, spike-like, one-sided racemes. (*Syntherisma.*) (B&B I, 203.)

Culms rooting at the lower nodes; rachis 0.5–1 mm wide, broadly winged, the wings as wide as or wider than the central rib.
  Second glume a third to half as long as the white to stramineous or pale brown fertile lemma.
    Spikelets 2.4–3 mm; pedicels triquetrous, scabrous. ..... 1. *D. sanguinalis.*
    Spikelets 1.5–1.7 mm; pedicels terete, glabrous. ..... 2. *D. serotina.*
  Second glume three-fourths to fully as long as the dark brown or purple-black fertile lemma.
    Second glume as long as the spikelet; hairs of the spikelet capitellate. ..... 3. *D. Ischaemum.*
    Second glume three-fourths as long as the spikelet; hairs not capitellate. ..... 4. *D. violascens.*
Culms erect or ascending; rachis slender, triquetrous, very narrowly winged. ..... 5. *D. filiformis*

1. **Digitaria sanguinalis** (L.) Scop. Decumbent or prostrate, much branched, rooting at the nodes, usually 3–6 dm; blades 4–10 cm × 5–10 mm, pilose; racemes 3–6 in each of 1–3 whorls, 5–15 cm; rachis 1 mm wide, broadly winged, scabrous on the margins; pedicels triquetrous, scabrous; spikelets 2.4–3 mm; first glume minute, often deciduous, the second half as long as the spikelet; sterile lemma usually scabrous on the 5 strong nerves; fertile lemma greenish-brown. Native of Europe, now cosmopolitan and established as a weed of fields, gardens, lawns, and waste ground throughout the U.S.

2. **Digitaria serotina** (Walt.) Mich. Much like No. 1; lvs densely pilose; racemes 2–6, slender, often curved, 4–8 cm; pedicels terete, glabrous; spikelets 1.5–1.7 mm, villous with minute crooked hairs; first glume lacking, the second a third to half as long as the spikelet; sterile lemma 5-nerved; fertile lemma stramineous to nearly white, or brown-tinged. Waste ground; coastal plain from Fla. and La. (and Cuba) to se. Va., and rarely adventive northward.

3. **Digitaria Ischaemum** (Schreb.) Muhl. Much like No. 1; lvs glabrous; racemes 2–5 (8), 4–10 (15) cm; spikelets elliptic or somewhat obovate, 1.7–2.1 mm, often purple; first glume lacking or minute and hyaline; second glume and sterile lemma equal and about as long as the spikelet, both ± pubescent or subtomentose with capitellate hairs, especially in stripes between the nerves; fertile lemma purple-black. Native of Eurasia, now established as a weed over much of the U.S., and throughout our range, but less abundant than No. 1. (*D. humifusa.*)

4. **Digitaria violascens** Link. Distinguished from No. 3 by the somewhat smaller (ca 1.5 mm), less pubescent spikelets, the hairs not capitellate. Pantropical, extending into our range in Ky. and s. Ind.

5. **Digitaria filiformis** (L.) Koeler. Branched from the base, 3–10 dm, erect or ascending; lower sheaths usually ± pilose, the upper sparsely so or glabrous; racemes 2–6, erect or ascending, often distinctly separated at base; rachis triquetrous, narrowly winged; spikelets in pairs or threes, well separated and scarcely overlapping; first glume lacking, the second three-fifths to four-fifths as long as the spikelet, usually pubescent and erose-ciliate with capitellate hairs; fertile lemma brown or dark purple. Fields and open ground, often a troublesome weed southward. Forms with glabrous spikelets occur in both vars. (*D. laeviglumis*).

var. filiformis. Culms 5–10 dm; upper sheaths glabrous, the lower glabrous to sparsely pilose; spikelets 1.7–2.2 mm. N.H. to Mich. and Kans., s. to Fla. and Mex.

var. villosa (Walt.) Fern. Culms 8–15 dm; upper sheaths glabrous or pilose, the lower densely pilose; racemes mostly 10–15 cm; spikelets 2–2.6 mm. Coastal plain from Va. to Fla. and Tex., and n. in the interior to Ill. (*D. villosa.*)

79. LEPTOLOMA Chase. Fall witch-grass. Spikelets fusiform, 1-fld, solitary on long slender pedicels; first glume minute or obsolete; second glume nearly as long as the spikelet, strongly 5–7-nerved; fertile lemma minutely rugulose, cartilaginous, with hyaline margins; perennial, often in large bunches, the culms ± decumbent at base; panicle very diffuse, eventually breaking away from the culm and rolling before the wind. (B&B I, 204.)

1. **Leptoloma cognatum** (Schult.) Chase. Culms tufted, 4–7 dm; lower sheaths villous to papillose-hirsute; blades 5–8 cm, narrow; panicle often a third to half the height of the plant, diffusely branched, purplish, villous in the axils; pedicels 1–4 cm, 3-angled, scabrous; spikelets acute, 2.5–3 mm, subglabrous on the second glume and sterile lemma. Dry, especially sandy soil; s. Mich. and Minn. to Va., Fla., Neb., Ariz. and n. Mex., and at scattered stations ne. to N.H.

80. ERIOCHLOA HBK. Spikelets racemose, short-pediceled in 2 rows on one side of the rachis, lance-ovoid; lower rachilla-joint thickened, forming a ring-like

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callus below the second glume.
glume and sterile lemma subec
lemma indurate, finely rugulose,
branched from the base, with te
(B&B I, 204.)

1. **Eriochloa contracta** Hitchc. C
flat, 4–7 mm wide, hairy; panicle 10–1
several, overlapping, 1–2 cm, the ra
purple-margined; spikelets lance-ovo
aristate, appressed-villous; fertile lem
and Ariz., also intr. in Mo., s. Ill. an

81. AXONOPUS Beauv. S
winged rachis, forming a slenc
equaling the sterile lemma; ferti
inrolled margins, its back turne
long, terminal (or also axillary).
other racemes below the summ

1. **Axonopus furcatus** (Fluegge)
compressed, 4–8 dm; lvs to 10 mm
below, often with another from the
the sterile lemma obscure, the oth
2.5–3 mm. Damp or wet soil of t
Md. (*Anastrophus f.*)

82. PASPALUM L. Spike
plano-convex or sc what bic
2-rowed or 4-rowed, usually sp
rachis; first glume usually no
lemma of about equal length.
smooth or minutely papillose.
nial (except *P. Boscianum*), u
soft lvs and a terminal infl c
additional racemes on axillary

Rachis of the racemes broad, foliaceous
them.
Racemes numerous, usually 20–50; sp
Racemes normally 2–5; spikelets 1.7–
Rachis of the racemes narrow or wingle
Racemes regularly 2, approximate or
Racemes 1 and terminal, or 2–several
Racemes loosely fld, the spikelets in
fl of a pair barely reaching the
Racemes spike-like, with numerous
Spikelets long-villous, especially
Racemes 3–6; spikelets 2.9–3.
Racemes 8–30; spikelets 2.2–2
Spikelets glabrous or minutely h
Fertile lemma dark brown at
Fertile lemma stramineous or
Sterile lemma 5–7-nerved, t
submarginal, or the len
Spikelets solitary. .....
Spikelets all or mostly pa
Spikelets 3.8–4.3 mm;
Spikelets 2.8–3.1 mm;
Sterile lemma 3-nerved, the
of the midnerve.
Spikelets flattened on bo
Spikelets plano-convex, a
Racemes 5–10; spikele

FERNALD ENVIRONMENTAL MANAGEMENT PROJECT

RESULTS OF SURVEYS FOR MOUNTAIN BINDWEED

PREPARED BY:

RUST Environment & Infrastructure Inc.
PROJECT NO. 72740.000

September 23, 1994

RUST ENVIRONMENT & INFRASTRUCTURE

RUST Environment & Infrastructure Inc.
11785 Highway Drive, Suite 100
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September 23, 1994

Ms. Becky Bixby
FERMCO
P.O. Box 398704
Cincinnati, Ohio 45239-8706

Regarding: Field Surveys for Mountain Bindweed at the FEMP Site
Project No. 72740.000

Dear Ms. Bixby:

RUST Environment & Infrastructure Inc. (RUST) has completed field surveys at the Fernald Environmental Management Project (FEMP) property in order to determine the presence or absence of Mountain Bindweed (*Polygonum cilinode*), a state endangered species. Under the Comprehensive Environmental Response, Compensation and Liability Act (CERCLA) regulations (Section 121), FEMP must meet the substantive requirements of the Federal Endangered Species Act of 1973, the Ohio Revised Code of 1975, the Ohio Division of Wildlife Order of 1976, and the Ohio Endangered Plant Law of 1978. The survey was conducted in accordance with our proposal number CP-3205 dated March 24, 1994.

Despite actively searching for Mountain Bindweed in its preferred habitats, this species was not observed at the FEMP property. Marginally suitable habitat exists for this species near the Inactive Flyash Pile and the pine plantations; however, historically, Mountain Bindweed has only been reported to occur in Northeastern Ohio. One species of bindweed was observed in these habitats at the FEMP property; however, this species was determined to be Climbing Buckwheat (*Polygonum convolvulus*), a common species that occurs throughout Ohio.

RUST has appreciated this opportunity to provide environmental services to FERMCO for this project. Should you have any questions or comments regarding any of the information provided in this report, please feel free to contact the undersigned.

Respectfully submitted,

RUST Environment & Infrastructure, Inc.

Karen A. Fields

Karen A. Fields
Staff Biologist

Reviewed by:

Allan M. Hale

Allan M. Hale, Ph.D.
Senior Ecologist

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Species Identification and Taxonomic Information I

1.0 INTRODUCTION

Mountain Bindweed (*Polygonum cilinode*) is a state endangered plant species. Under the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) regulations (Section 121), the Fernald Environmental Management Project (FEMP) must meet the substantive requirements of the Federal Endangered Species Act of 1973, the Ohio Revised Code of 1975, the Ohio Division of Wildlife Order of 1976, and the Ohio Endangered Plant Law of 1978. As such, RUST Environment & Infrastructure, Inc. (RUST) has completed field surveys at the FEMP property in order to determine the presence or absence of Mountain Bindweed at the property.

Mountain Bindweed blooms from late June through August with fruiting occurring from July through September. The preferred habitat of Mountain Bindweed is dry woods and thickets, rocky slopes, and the borders of woods and roadsides. All of the most recent observations of this species in Ohio have been from the northeast portion of the state. However, in a 1986 survey of the FEMP property (conducted by Miami University), this species was reported to occur in the riparian woods and pine plantations of the property. Thus, field surveys for this species were conducted in the riparian woodlands (along Paddys Run and in the northern woodlands), both pine plantations, and in the Inactive Flyash Pile, since it is more representative of the reported preferred habitat of Mountain Bindweed at the FEMP property. Surveys for Mountain Bindweed were conducted by three biologists from RUST on June 15 and 16, and August 23 and 24, 1994.

2.0 SURVEY METHODS

Prior to conducting the field sampling, each of the team members were given taxonomic descriptions of Mountain Bindweed and identifying characteristics of the species. Examples of this information are provided in Appendix I. On June 15, 1994, the northern woodland area, both pine plantations, and the western pasture areas adjacent to Paddys Run were surveyed for Mountain Bindweed (Figure 1). This survey was done in conjunction with a similar survey conducted for Running Buffalo Clover (*Trifolium stoloniferum*), a federally endangered species. A species of bindweed was observed in the eastern half of the northern woodlands and in the pine plantations; however, since the species was not in flower, a positive determination of the species could not be made at this time. These locations were marked with engineering flagging for future reference for re-evaluation during the August survey period. No species of bindweed were observed in the western pasture area.

On June 16, 1994, the Inactive Flyash Pile and the southern portion of the west pasture were surveyed for Mountain Bindweed. Once again, a species of bindweed was observed in the Inactive Flyash Pile; however, a positive determination of the species could not be made at this time since the species was not in flower. This area was noted on the field map and the populations were marked for future reference for re-evaluation during the August survey period. Mountain Bindweed was not identified in any of the other areas surveyed.

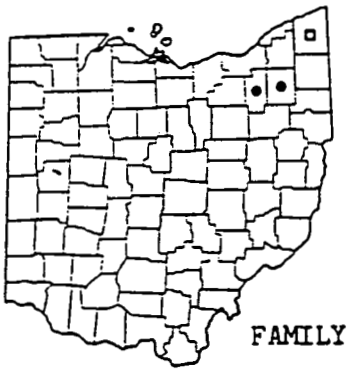
On August 23, 1994, the northern pine plantation, the northern woodland area, and the riparian areas along Paddys Run were surveyed for Mountain Bindweed. The species of bindweed previously observed during the June survey was relocated in the pine plantation and in the eastern half of the northern woodland. This population was identified as Climbing Buckwheat (*Polygonum convolvulus*) by its beardless ocreae (the basal paired appendages of a leaf) and the

nutlets were dull black in color. Climbing Buckwheat is a common species found throughout Ohio. No species of bindweed were observed along the riparian areas of Paddys Run.

On August 24, 1994, the Inactive Flyash Pile, the southern pine plantation, the riparian areas near the storm sewer outfall ditch, and the running track were surveyed for Mountain Bindweed. The species of bindweed previously noted as occurring in the Inactive Flyash Pile and the southern pine plantation was also identified as Climbing Buckwheat and not Mountain Bindweed. No species of bindweed were observed in any of the other locations surveyed.

3.0 RESULTS AND CONCLUSIONS

Several populations of bindweed were observed during the surveys conducted in June and August 1994 at the FEMP property. However, these populations were all identified as being Climbing Buckwheat, a common species occurring throughout Ohio. This identification was based on the beardless ocreae and dull black nutlets observed in these populations. Mountain Bindweed has retrorsely bearded ocreae and glossy black nutlets. Despite actively searching for Mountain Bindweed in suitable habitats at the FEMP property, this species was not observed in any of the areas surveyed.



POLYGONUM CILINODE Michx.
Mountain Bindweed

FAMILY: Polygonaceae.

HABIT: Twining, occasionally erect, herbaceous perennial, to 2 m.; flowering late June-August; fruiting July-September.

SIMILAR SPECIES: Polygonum cilinode closely resembles the common bindweeds P. scandens and P. convolvulus. In P. cilinode the bases of the sheaths (ocreae) are retrorsely barbed whereas in the other two species they are beardless. The achenes of P. cilinode are very glossy black whereas in P. scandens and P. convolvulus the achenes are dull.

TOTAL RANGE: Nfld. to Sask., s. to N.S., N.E., n. NJ, PA, WV, OH, MI, WI, and MN, and in uplands to NC and TN.

STATE RANGE: There are post-1960 records from Portage and Summit counties. A 1932 record exists from Ashtabula County.

STATE STATUS: 1980-Endangered, 1982-E, 1984-E.

HABITAT: Dry woods and thickets, rocky slopes, borders of woods, and roadsides.

HAZARDS: Roadside mowing, clearing of fencerow thickets, and opening of the forest canopy.

RECOVERY POTENTIAL: Unknown, but possibly good. Apparently tolerant of some disturbance.

INVENTORY GUIDELINES: Mature flowering and fruiting material is needed for accurate identification. Avoid overcollecting.

COMMENTS: In dense shade populations are often sterile and nearly impossible to identify.

This plant may be more common than the records indicate and should be sought throughout woodlands in northeastern Ohio.

Fernald (1914) divides this species into two varieties. Under this concept, Ohio plants are the typical variety. The var. laevigatum Fern. is restricted to mountainous areas of Virginia and West Virginia.

SELECTED REFERENCES:

Fernald, M.L. 1914. The West Virginia variety of Polygonum cilinode. Rhodora 49: 210-216.

1/84 BKA, JFB
SP JT 802

Polygonum cilinode

20. P. cilinode Michaux.* Perennial, trailing or infrequently twining. Leaves acuminate, cordate-hastate to cordate-sagittate; ocreae retrorsely bearded at base. Racemes paniculate, terminal or axillary. Calyx white, infrequently tinted with pink; sepals not wing-keeled in fruit. Nutlets lustrous, black. June-Sept. In openings and clearings at higher elevations; mts. of N.C. [Va., Ga., W.Va.] *Bilderdykia cilinodis* (Michaux) Greene—S. Flowers frequently infected with smut.

6799

FERNALD ENVIRONMENTAL
MANAGEMENT PROJECT

RESULTS OF SURVEYS FOR
MOUNTAIN BINDWEED

PREPARED BY:

RUST Environment & Infrastructure Inc.
PROJECT NO. 72740.000

September 23, 1994

000106

RUST ENVIRONMENT & INFRASTRUCTURE

RUST Environment & Infrastructure Inc.
11785 Highway Drive, Suite 100
Cincinnati, OH 45241
Tel. (513) 733-9374 • FAX (513) 733-8213

September 23, 1994

Ms. Becky Bixby
FERMCO
P.O. Box 398704
Cincinnati, Ohio 45239-8706

Regarding: Field Surveys for Mountain Bindweed at the FEMP Site
Project No. 72740.000

Dear Ms. Bixby:

RUST Environment & Infrastructure Inc. (RUST) has completed field surveys at the Fernald Environmental Management Project (FEMP) property in order to determine the presence or absence of Mountain Bindweed (*Polygonum cilinode*), a state endangered species. Under the Comprehensive Environmental Response, Compensation and Liability Act (CERCLA) regulations (Section 121), FEMP must meet the substantive requirements of the Federal Endangered Species Act of 1973, the Ohio Revised Code of 1975, the Ohio Division of Wildlife Order of 1976, and the Ohio Endangered Plant Law of 1978. The survey was conducted in accordance with our proposal number CP-3205 dated March 24, 1994.

Despite actively searching for Mountain Bindweed in its preferred habitats, this species was not observed at the FEMP property. Marginally suitable habitat exists for this species near the Inactive Flyash Pile and the pine plantations; however, historically, Mountain Bindweed has only been reported to occur in Northeastern Ohio. One species of bindweed was observed in these habitats at the FEMP property; however, this species was determined to be Climbing Buckwheat (*Polygonum convolvulus*), a common species that occurs throughout Ohio.

RUST has appreciated this opportunity to provide environmental services to FERMCO for this project. Should you have any questions or comments regarding any of the information provided in this report, please feel free to contact the undersigned.

Respectfully submitted,

RUST Environment & Infrastructure, Inc.

Karen A. Fields

Karen A. Fields
Staff Biologist

Reviewed by:

Allan M. Hale

Allan M. Hale, Ph.D.
Senior Ecologist

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Species Identification and Taxonomic Information I

1.0 INTRODUCTION

Mountain Bindweed (*Polygonum cilinode*) is a state endangered plant species. Under the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) regulations (Section 121), the Fernald Environmental Management Project (FEMP) must meet the substantive requirements of the Federal Endangered Species Act of 1973, the Ohio Revised Code of 1975, the Ohio Division of Wildlife Order of 1976, and the Ohio Endangered Plant Law of 1978. As such, RUST Environment & Infrastructure, Inc. (RUST) has completed field surveys at the FEMP property in order to determine the presence or absence of Mountain Bindweed at the property.

Mountain Bindweed blooms from late June through August with fruiting occurring from July through September. The preferred habitat of Mountain Bindweed is dry woods and thickets, rocky slopes, and the borders of woods and roadsides. All of the most recent observations of this species in Ohio have been from the northeast portion of the state. However, in a 1986 survey of the FEMP property (conducted by Miami University), this species was reported to occur in the riparian woods and pine plantations of the property. Thus, field surveys for this species were conducted in the riparian woodlands (along Paddys Run and in the northern woodlands), both pine plantations, and in the Inactive Flyash Pile, since it is more representative of the reported preferred habitat of Mountain Bindweed at the FEMP property. Surveys for Mountain Bindweed were conducted by three biologists from RUST on June 15 and 16, and August 23 and 24, 1994.

2.0 SURVEY METHODS

Prior to conducting the field sampling, each of the team members were given taxonomic descriptions of Mountain Bindweed and identifying characteristics of the species. Examples of this information are provided in Appendix I. On June 15, 1994, the northern woodland area, both pine plantations, and the western pasture areas adjacent to Paddys Run were surveyed for Mountain Bindweed (Figure 1). This survey was done in conjunction with a similar survey conducted for Running Buffalo Clover (*Trifolium stoloniferum*), a federally endangered species. A species of bindweed was observed in the eastern half of the northern woodlands and in the pine plantations; however, since the species was not in flower, a positive determination of the species could not be made at this time. These locations were marked with engineering flagging for future reference for re-evaluation during the August survey period. No species of bindweed were observed in the western pasture area.

On June 16, 1994, the Inactive Flyash Pile and the southern portion of the west pasture were surveyed for Mountain Bindweed. Once again, a species of bindweed was observed in the Inactive Flyash Pile; however, a positive determination of the species could not be made at this time since the species was not in flower. This area was noted on the field map and the populations were marked for future reference for re-evaluation during the August survey period. Mountain Bindweed was not identified in any of the other areas surveyed.

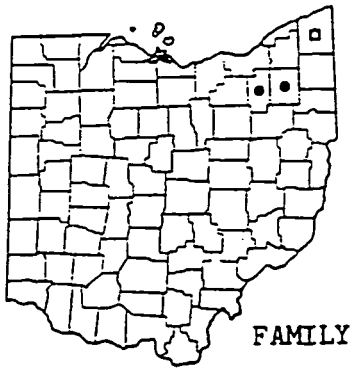
On August 23, 1994, the northern pine plantation, the northern woodland area, and the riparian areas along Paddys Run were surveyed for Mountain Bindweed. The species of bindweed previously observed during the June survey was relocated in the pine plantation and in the eastern half of the northern woodland. This population was identified as Climbing Buckwheat (*Polygonum convolvulus*) by its beardless ocreae (the basal paired appendages of a leaf) and the

nutlets were dull black in color. Climbing Buckwheat is a common species found throughout Ohio. No species of bindweed were observed along the riparian areas of Paddys Run.

On August 24, 1994, the Inactive Flyash Pile, the southern pine plantation, the riparian areas near the storm sewer outfall ditch, and the running track were surveyed for Mountain Bindweed. The species of bindweed previously noted as occurring in the Inactive Flyash Pile and the southern pine plantation was also identified as Climbing Buckwheat and not Mountain Bindweed. No species of bindweed were observed in any of the other locations surveyed.

3.0 RESULTS AND CONCLUSIONS

Several populations of bindweed were observed during the surveys conducted in June and August 1994 at the FEMP property. However, these populations were all identified as being Climbing Buckwheat, a common species occurring throughout Ohio. This identification was based on the beardless ocreae and dull black nutlets observed in these populations. Mountain Bindweed has retrorsely bearded ocreae and glossy black nutlets. Despite actively searching for Mountain Bindweed in suitable habitats at the FEMP property, this species was not observed in any of the areas surveyed.



POLYGONUM CILINODE Michx.
Mountain Bindweed

FAMILY: Polygonaceae.

HABIT: Twining, occasionally erect, herbaceous perennial, to 2 m.; flowering late June-August; fruiting July-September.

SIMILAR SPECIES: Polygonum cilinode closely resembles the common bindweeds P. scandens and P. convolvulus. In P. cilinode the bases of the sheaths (ocreae) are retrorsely barbed whereas in the other two species they are beardless. The achenes of P. cilinode are very glossy black whereas in P. scandens and P. convolvulus the achenes are dull.

TOTAL RANGE: Nfld. to Sask., s. to N.S., N.E., n. NJ, PA, WV, OH, MI, WI, and MN, and in uplands to NC and TN.

STATE RANGE: There are post-1960 records from Portage and Summit counties. A 1932 record exists from Ashtabula County.

STATE STATUS: 1980-Endangered, 1982-E, 1984-E.

HABITAT: Dry woods and thickets, rocky slopes, borders of woods, and roadsides.

HAZARDS: Roadside mowing, clearing of fencerow thickets, and opening of the forest canopy.

RECOVERY POTENTIAL: Unknown, but possibly good. Apparently tolerant of some disturbance.

INVENTORY GUIDELINES: Mature flowering and fruiting material is needed for accurate identification. Avoid overcollecting.

COMMENTS: In dense shade populations are often sterile and nearly impossible to identify.

This plant may be more common than the records indicate and should be sought throughout woodlands in northeastern Ohio.

Fernald (1914) divides this species into two varieties. Under this concept, Ohio plants are the typical variety. The var. laevigatum Fern. is restricted to mountainous areas of Virginia and West Virginia.

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Polygonum cilinode

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FERNALD ENVIRONMENTAL MANAGEMENT PROJECT

RESULTS OF SURVEYS FOR SLENDER FINGER-GRASS

Prepared by:

RUST Environment & Infrastructure Inc.
Project No. 72740.000

December 8, 1994

RUST ENVIRONMENT & INFRASTRUCTURE

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Tel. (513) 733-9374 • FAX (513) 733-8213

December 8, 1994

Ms. Becky Bixby
FERMCO
P.O. Box 398704
Cincinnati, Ohio 45239-8706

Regarding: Field Surveys for Slender Finger-grass at the FEMP Site
Project No. 72740.000

Dear Ms. Bixby:

RUST Environment & Infrastructure, Inc. (RUST) has completed field surveys at the Fernald Environmental Management Project (FEMP) property in order to determine the presence or absence of Slender Finger-grass (*Digitaria filiformis*), a state endangered species. Under the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) regulations (Section 121), FEMP must meet the substantive requirements of the Federal Endangered Species Act of 1973, the Ohio Revised Code of 1975, the Ohio Division of Wildlife Order of 1976, and the Ohio Endangered Plant Law of 1978. The survey was conducted in accordance with our proposal number CP-3205 dated March 24, 1994.

The grass family is one of the largest in number of genera and species, and, among flowering plants, is probably the largest in the number of individuals and one of the most widely distributed (Hitchcock, 1971). When identifying a group of related variable grass species, the question arises as to whether there are several closely related but distinct species, or a few distinct species, each of which shows great variation. As a result, identification of grasses depends upon the study of abundant material both in the field and in the herbarium. Brown (1979) expressed the frustration of identifying grasses by stating, "To identify grasses with

existing technical manuals requires a fair amount of botanical knowledge, an endless amount of patience, and luck."

Since grass species are among the most difficult plants to identify in the field, RUST biologists reviewed taxonomic descriptions of Slender Finger-grass from several botanical references, and carried these descriptions into the field for use as reference material. Upon completion of the field surveys, RUST initially identified what they felt was a population of Slender Finger-grass growing along the vehicle path to ground water monitoring wells located in the northern woodlands at the FEMP property.

Representative specimens of this population were subsequently sent to the Ohio Department of Natural Resources (ODNR) Division of Natural Areas and Preserves for verification as *Digitaria filiformis*. Mr. Greg Schneider, a botanist with ODNR, determined that the populations were *Digitaria ischaemum* (Smooth Crabgrass) based on the presence of a winged rachis (the main axis of the inflorescence) on the specimens. Since this contradicted the initial identification of the specimens, the specimens were also sent to Dr. John Thieret, an expert in grasses from Northern Kentucky University, for identification. Dr. Thieret confirmed ODNR's determination that the specimens were *D. ischaemum* based on the non-erect growth, presence of a winged rachis, and dark brown mature spikelets.

Several populations of crabgrass were observed during the surveys conducted in August 1994 at the FEMP property. Through verification procedures with the ODNR Division of Natural Areas and Preserves and Dr. John Thieret, a grass expert from Northern Kentucky University, these populations were determined to consist of two separate species of crabgrass, *Digitaria sanguinalis* and *Digitaria ischaemum*, both of which are common species in Ohio. Although marginally suitable habitat (full sun with sandy/sterile soils) does exist for Slender Finger-grass near the Inactive Flyash Pile, the running track and additional openings in the northern

woodlands, *Digitaria filiformis* was determined not to occur in these areas.

Should you have any questions or comments regarding any of the information provided in this report, please feel free to contact the undersigned.

Respectfully submitted,

RUST Environment & Infrastructure, Inc.

Karen A. Fields

Karen A. Fields
Staff Biologist

Reviewed by:

Allan M. Hale

Allan M. Hale, Ph.D.
Senior Ecologist

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Appendix

Species Identification and Taxonomic Information I

1.0 INTRODUCTION

Slender Finger-grass (*Digitaria filiformis*) is a state endangered species of crabgrass. Under the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) regulations (Section 121), the Fernald Environmental Management Project (FEMP) must meet the substantive requirements of the Federal Endangered Species Act of 1973, the Ohio Revised Code of 1975, the Ohio Division of Wildlife Order of 1976, and the Ohio Endangered Plant Law of 1978. As such, RUST Environment & Infrastructure, Inc. (RUST) has completed field surveys at the FEMP property in order to determine the presence or absence of Slender Finger-grass at the property.

Slender Finger-grass blooms from August through October in Ohio. The preferred habitat of Slender Finger-grass is in full sun, in sandy and/or sterile soils. In a 1986 botanical survey of the FEMP property conducted by Miami University, this species was reported to occur in the riparian habitats at the site. Thus, RUST conducted field surveys for this species in the riparian woodlands (along Paddys Run and in the northern woodlands) and in the Inactive Flyash Pile, since it represents a habitat with sterile, sandy soils. Surveys for Slender Finger-grass were conducted by three biologists from RUST on August 23 and 24, 1994.

2.0 SURVEY METHODS

Since grass species are among the most difficult plants to identify in the field and because the genus *Digitaria* in particular is composed of many distinct species all of which have highly variable identifying characteristics, each of the team members reviewed several taxonomic descriptions of Slender Finger-grass and the identifying characteristics of the species. Examples of this information are provided in Appendix I. These descriptions were carried into the field

for use as reference material in the event that any suspect populations of Slender Finger-grass were observed.

The herbaceous ground cover stratum is the area of concern for this threatened and endangered species program; therefore, qualitative "cruise" methods were used to cover the maximum area of the facility in the most effective manner. The cruise method used is equivalent to the Point-Intercept method for measuring the relative frequency/occurrence of a species (Bonham, 1989). Using this technique, Slender Finger-grass was actively searched for by biologists from RUST who walked along pre-determined transects that traversed the preferred habitats of the species.

A total of five distinct habitats were surveyed for the presence of Slender Finger-grass: the pine plantations, northern woodlands, riparian areas along Paddys Run, the Inactive Flyash Pile, and the open areas surrounding the oval running track (Figure 1). The riparian areas along Paddys Run and the northern woodlands were surveyed because Slender Finger-grass was reported to occur in these areas in the 1986 Miami University botanical survey of the FEMP property. The clearings between the rows of the pine plantations, the Inactive Flyash Pile and the areas near the running track were surveyed because these areas all have conditions that closely resemble the preferred habitat of the species based on Ohio Department of Natural Resources (ODNR) records.

Thus, on August 23, 1994, the northern pine plantation, the northern woodland area, and the riparian areas along Paddys Run were surveyed for Slender Finger-grass in conjunction with a similar survey being conducted for Mountain Bindweed (*Polygonum cilinode*), a state endangered plant species. Along Paddys Run, each bank of the creek was examined, as well as suitable habitat adjacent to the creek (i.e., openings in the canopy cover adjacent to the creek bed). RUST observed one suspected population of Slender Finger-grass growing along the vehicle path

to groundwater monitoring wells located in the northern woodland (Figure 1). This population consisted of several hundred individuals. No other suspected populations of Slender Finger-grass were observed in any of the areas surveyed on this day. A representative sample of this suspected population of Slender Finger-grass was photographed and a specimen was collected for positive taxonomic identification.

On August 24, 1994, the Inactive Flyash Pile, the southern pine plantation, the riparian areas near the storm sewer outfall ditch, and the running track were surveyed for Slender Finger-grass. Suspected populations of Slender Finger-grass were observed in one area of the Inactive Flyash Pile and near the running track (Figure 1). Representative specimens were collected from each of these populations for positive taxonomic identification. No other suspected populations of Slender Finger-grass were observed in any of the areas surveyed.

Since several specimens from the FEMP property appeared to have the distinguishing characteristics of the species, *Digitaria filiformis*, Ms. Pat Jones with the ODNR Division of Natural Areas and Preserves, was contacted by RUST on August 25, 1994 to determine the location of voucher specimens of this state endangered species. Ms. Jones indicated that the largest voucher collection for *D. filiformis* could be found in the Ohio State University Department of Biological Diversity Herbarium. On August 29, 1994, a representative from RUST visited the herbarium curated by Dr. Richard L. Stuckey (Professor Emeritus, Botany, Ohio State University), and individually viewed all available *D. filiformis* specimens for later comparison with the FEMP samples. Based on these observations, RUST identified three different species of *Digitaria* to be growing at the site including *D. serotina, D. sanguinalis,* and *D. filiformis*.

RUST's specific taxonomic identification of *Digitaria filiformis* followed the morphologic

characteristics of the species as listed in Radford et. al., 1968, which include: culms in small tufts; slender and erect growth, 10 to 60 centimeters (cm.) in height; lower sheaths pilose; upper sheaths glabrous; blades erect and 5 to 15 cm. long; racemes unequal, erect and in groups of 1 to 5; spikelets 1.5 to 1.7 millimeters (mm.) long; second glume and sterile lemma pubescent with short capitellate hairs; the glume shorter than the spikelet; and the fertile lemma dark brown. All specimens collected from the FEMP property were pressed and mounted for future reference.

Since a state endangered plant species was tentatively identified as occurring at the FEMP property, the pressed specimens collected by RUST were sent to the ODNR Division of Natural Areas and Preserves for verification. Upon review of these specimens, Mr. Greg Schneider, a botanist with ODNR, determined that the specimens labeled as *Digitaria filiformis* and *Digitaria serotina* were actually *Digitaria ischaemum*, Smooth Crabgrass. His determination was based upon the fact that each of the specimens sent to ODNR had a fascicled rachis (the main axis of the inflorescence was winged), and, since *D. filiformis* is the only species of *Digitaria* that does not have a winged rachis, Mr. Schneider determined that the specimens were *D. ischaemum*.

Since ODNR's identification did not confirm RUST's initial identification, RUST met with representatives of FERMCO and the Department of Energy at which time FERMCO and RUST suggested that the specimens be sent to a third-party for validation since many of the morphologic characteristics used to identify the specimens are highly variable within the genus, *Digitaria*. As a result, the specimens were also sent to Dr. John Thieret, a grass expert from Northern Kentucky University, for identification. Dr. Thieret confirmed ODNR's determination that the specimens were actually *D. ischaemum*. Dr. Thieret based his decision on the non-erect growth of the specimens, presence of a winged rachis, and the mature spikelets being dark

brown in color.

3.0 RESULTS AND CONCLUSIONS

Several populations of crabgrass were observed during the surveys conducted in August, 1994 at the FEMP property. Through verification procedures with the ODNR Division of Natural Areas and Preserves and Dr. John Thieret, a grass expert from Northern Kentucky University, these populations were determined to consist of two separate species of crabgrass, *Digitaria sanguinalis*, and *Digitaria ischaemum*, both of which are common species in Ohio. Although marginally suitable habitat (full sun with sandy/sterile soils) does exist for Slender Finger-grass near the Inactive Flyash Pile, the running track and in additional openings in the northern woodlands, *Digitaria filiformis* was determined not to occur in these areas.

4.0 REFERENCES

Bonham, Charles, 1989. Measurements for Terrestrial Vegetation. John Wiley & Sons, Inc. New York, New York.

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Hitchcock, A.S., 1971. Manual of the Grasses of the United States. Dover Publications, Inc., New York, New York.

Radford, Albert, et. al., 1968. Manual of the Vascular Flora of the Carolinas. University of North Carolina Press, Chapel Hill, North Carolina.

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6799

OHIO ENDANGERED AND THREATENED VASCULAR PLANTS

Abstracts of State-Listed Taxa

Edited by Robert M. McCance, Jr.
James F. Burns

Division of Natural Areas and Preserves
Department of Natural Resources
Columbus, Ohio

1984

Richard F. Celeste, Governor

Lt. Gov. Myrl H. Shoemaker, Director

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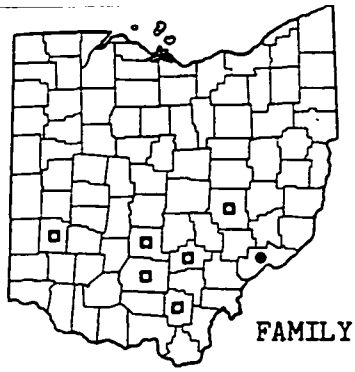

DIGITARIA FILIFORMIS (L.) Koel.
Slender Finger-grass

FAMILY: Gramineae (Poaceae).

HABIT: Herbaceous, erect, caespitose annual, 0.5-10 dm.; flowering August-October.

SIMILAR SPECIES: Three species of Digitaria occur in Ohio, two of which are very common. This species differs from the others by penduncle characters and its generally erect habit. This species superficially resembles members of Paspalum.

TOTAL RANGE: FL to TX and Mex., n. to s. NH, MA, NY, s. MI, IL, and IA.

STATE RANGE: There is a post-1960 record from Washington County. There are pre-1960 records from Hocking, Jackson, Montgomery, Muskingum, Pickaway, and Ross counties.

STATE STATUS: 1980-Endangered, 1982-E, 1984-E.

HABITAT: In full sun in sterile sandy soils.

HAZARDS: Grazing; overshading by woody species as a result of succession.

RECOVERY POTENTIAL: Unknown, but prob ly good due to its weedy nature.

INVENTORY GUIDELINES: Mature flowering material, with underground parts, is needed for identification. Note density of basal tufts.

COMMENTS: This species is likely more common than the records indicate, and intensive searching should find additional locations.

SELECTED REFERENCES:

Henrard, J.T. 1950. Monograph of the genus Digitaria. Universitare Pers Leiden, Leiden. 999 p.

Hitchcock, A.S. 1951. Manual of grasses of the United States. Ed. 2, rev. by A. Chase, U.S. Dep. Agr. Misc. Publ. 200. 1051 p.

2/84 DS
SP GH B26

6799

MANUAL OF THE GRASSES OF THE UNITED STATES

A. S. Hitchcock

Second Edition
Revised by AGNES CHASE

IN TWO VOLUMES

VOLUME TWO

DOVER PUBLICATIONS, INC.
NEW YORK

000127

2. **Trichachne califórnica** (Benth.) Chase. COTTONTOP. (Fig. 824.) Culms erect from a knotty swollen felty-pubescent base, 40 to 100 cm. tall; leaves numerous, the sheaths glabrous to sparsely pilose; blades mostly less than 12 cm. long, 3 to 5 mm. wide, from nearly glabrous to densely puberulent; panicle mostly 5 to 10 cm. long, the few racemes usually 3 to 5 cm. long, occasionally longer, erect or nearly so; spikelets approximate, excluding the hairs 3 to 4 mm. long, the white to purplish hairs much exceeding them, often spreading, the middle internerves of the sterile lemma glabrous. ♃ (*T. saccharata* Nash.)—Plains and dry open ground, Texas and Oklahoma to Colorado, Arizona, and Mexico; South America.

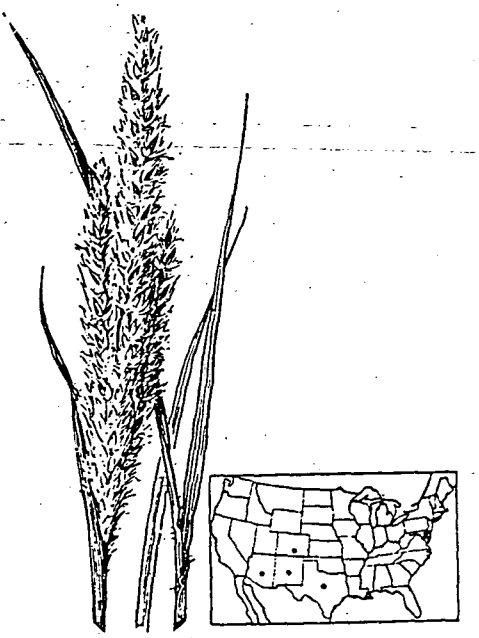

FIGURE 824.—*Trichachne californica*. × 1. (Hitchcock 13608, Tex.)

3. **Trichachne pátens** Swallen. (Fig. 825.) Culms tufted, erect, 40 to 90 cm. tall; sheaths more or less papillose-pilose, the lowermost densely felty-pubescent; blades 5 to 15 cm. long, 1 to 4 mm. wide, scabrous; panicle 10 to 18 cm. long, the racemes stiffly ascending or spreading; spikelets remote, 4 mm. long, densely silky, the hairs exceeding the spikelet; frui 3 mm. long, acute. ♃ —Dry fields, prairies, and roadsides, Texas.

4. **Trichachne hitchcóckii** (Chase) Chase. (Fig. 826.) Culms tufted and branching at base, leafy below, slender, 30 to 50 cm. tall; sheaths and blades nearly glabrous to puberulent, sometimes densely so toward base, the blades 2 to 5 cm. long, 2 to 3 mm. wide; panicle long-exserted, 6 to 10 cm. long, the few racemes 3 to 4 cm. long, mostly rather remote and erect; spikelets 2.5 to 3 mm. long, densely silky-villous, the prominent nerves not hidden, the grayish hairs not exceeding the spikelet. ♃ —Dry plains, Texas; northern Mexico.

129. DIGITÁRIA Heister. CRABGRASS

(*Syntherisma* Walt.)

Spikelets in twos or threes, rarely solitary, subsessile or short-pediceled, alternate in 2 rows on one side of a 3-angled winged or wingless rachis; spikelets lanceolate or elliptic, nearly planoconvex; first glume minute or wanting; second glume equaling the sterile lemma or shorter; fertile lemma cartilaginous, the hyaline margins pale. Annual or perennial, erect to prostrate, often weedy grasses, the slender racemes digitate or approximate on a short axis. Type species, *Digitaria sanguinalis*. Name from Latin *digitus*, finger, alluding to the digitate inflorescence of the type species.

The species are in the main good forage grasses. *Digitaria sanguinalis*, the common crabgrass, is a weed in cultivated soil. In the Southern States, where it produces an abundant growth in late summer on fields from which crops have been gathered, it is utilized for forage and is sometimes cut for hay. This species and *D. ischaemum* are common weeds in lawns. They form a fine green growth at first but start late and die in the fall.

on 602. Cuba)

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1a. Rachis winged or flat-margined, the margin as wide as the central rib; plants annual, creeping at least at base.
Rachis bearing scattered long fine hairs (these rarely wanting); spikelets narrow, acuminate, nearly glabrous ..... 2. D. HORIZONTALIS.
Rachis not bearing hairs; spikelets elliptic, acute, pubescent.
Plants perennial, stoloniferous ..... 7. D. LONGIFLORA.
Plants annual. Culms erect or decumbent spreading.
Sheaths glabrous; fertile lemma brown.
Spikelets 2 mm. long, 1 mm. wide, the hairs or most of them capitellate. 3. D. ISCHAEMUM.
Spikelets 1.5 to 1.7 mm. long, about 0.6 mm. wide, the hairs not capitellate.
Sterile lemma with 5 distinct nerves; spikelets sparingly pubescent, 1.7 mm. long; fertile lemma light brown; racemes, if more than 2, not digitate. 4. D. FLORIDANA.
Sterile lemma with 3 distinct nerves; spikelets distinctly pubescent, 1.5 mm. long, fertile lemma dark brown, racemes usually all digitate. 5. D. VIOLASCENS.
Sheaths pilose or villous; fertile lemma pale.
Spikelets 1.5 to 1.7 mm. long; pedicels terete, glabrous ..... 6. D. SEROTINA.
Spikelets 2.5 to 3.5 mm. long; pedicels angled, scabrous ..... 1. D. SANGUINALIS.
1b. Rachis wingless or with a very narrow margin (see also *D. horizontalis*), triangular; plants not creeping (except in *D. texana*), annual or perennial.
2a. Fertile lemma pale or gray.
Plants annual, decumbent and rooting at base. Spikelets 3 mm. long, glabrous or nearly so ..... 8. D. SIMPSONI.
Plants perennial.
Spikelets densely or sparsely villous; racemes 5 to 10.
Spikelets 2.8 to 3.5 mm. long, sparsely to densely villous ..... 14. D. RUNYONI.
Spikelets 2 to 2.5 mm. long, rather sparsely villous ..... 13. D. TEXANA.
Spikelets glabrous to obscurely appressed-pubescent on the internerves; racemes 2 to 5, some of them naked at base for 1 to 1.5 cm.
First glume broad, hyaline, minute but obvious; spikelets 3.2 mm. long, glabrous. 15. D. PAUCIFLORA.
First glume obsolete or nearly so; spikelets 2.5 to 2.8 mm. long, obscurely to obviously appressed-pubescent.
Racemes 2 to 4; culms ascending from a curved base; sheaths papillose-pilose. 16. D. SUBCALVA.
Racemes 5 to 10; culms erect; sheaths conspicuously villous. 17. D. ALBICOMA.
2b. Fertile lemma dark brown. Plants erect or at least not rooting at the decumbent base; annual or sometimes apparently perennial.
Second glume and sterile lemma glabrous (see also *D. laeviglumis* under *D. filiformis*). 12. D. GRACILLIMA.
Second glume and sterile lemma capitellate-pubescent.
Spikelets 2 to 2.5 mm. long ..... 10. D. VILLOSA.
Spikelets 1.5 to 1.7 mm. long.
Blades folded or involute, flexuous ..... 11. D. DOLICHOPHYLLA.
Blades flat ..... 9. D. FILIFORMIS.

1. Digitaria sanguinalis (L.) Scop.

CRABGRASS. (Fig. 827.) Plant branching and spreading, often purplish, rooting at the decumbent base, the culms sometimes as much as 1 m. long, the flowering shoots ascending; sheaths, at least the lower, papillose-pilose; blades 5 to 10 mm. wide, pubescent to scaberulous; racemes few to several, 5 to 15 cm. long, rarely longer, digitate, with usually 1 or 2 whorls a short distance below; spikelets about 3 mm. long; first glume minute but evident; second glume about half as long as the spikelet, narrow, ciliate; sterile lemma strongly nerved, the lateral internerves appressed-pubescent, the hairs sometimes spreading at maturity (*D. fimbriata* Link); fertile lemma pale. ⊙ —Fields, gardens, and waste places, a troublesome weed in lawns and cultivated ground throughout the United States at low and medium altitudes, more common in the East and South; temperate and tropical regions of the world. Native of Europe. A specimen with nearly glabrous sheaths and inflorescences of 2 racemes collected by

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FIGURE 826.—*Trichachne hitchcockii*. Plant, × 1; spikelet and floret, × 10. (Type.)

Tracy in Mississippi, said to be introduced, has been erroneously referred to *Syntherisma barbatum* (Willd.) Nash (*Digitaria barbata* Willd.).

DIGITARIA SANGUINALIS var. CILIÁRIS (Retz.) Parl. Sterile lemma, pectinate-ciliate, the stiff cilia 1.5 mm. long. Along railroad, Berks County, Pa. Waif from Asia.

2. Digitaria horizontális Willd. (Fig. 828.) Resembling *D. sanguinalis*, the culms more slender, the racemes mostly subracemose, very slender, lax, the rachis scarcely winged, bearing scattered long fine spreading hairs (these rarely wanting); spikelets narrow, about 2 mm. long; first glume minute or obsolete; second glume half as long as the spikelet. ⊙ (*Syntherisma setosum* Nash; *S. digitatum* Hitchc.)—Waste places, southern and central Florida; ballast, Mobile, Ala.; tropical regions of North America and South America.

3. Digitaria ischaémum (Schreb.) Schreb. ex Muhl. SMOOTH CRABGRASS. (Fig. 829.) Erect or usually soon decumbent-spreading, resembling *D. sanguinalis* but not so coarse or tall; foliage glabrous, bluish or purplish; racemes mostly 2 to 6, 4 to 10 cm. long, the rachis with thin wings wider than the midrib; spikelets about 2 mm. long; first glume hyaline, obscure; second glume and sterile lemma as long as the dark fertile lemma, pubescent with capitellate hairs. ⊙ (*Syntherisma humifusum* Rydb.)—Waste places, often a troublesome weed in lawns. Quebec to Georgia, west to Washington and California; introduced from Eurasia. The first glume is so thin as to be apparently wanting. DIGITARIA ISCHAEMUM var. MISSISSIPPIÉNSIS (Gattinger) Fernald. Taller, the racemes mostly 5 to 7, often 10 or even 15 cm. long; first glume often more easily seen. ⊙ —Maryland, Indiana, Illinois, Virginia, Tennessee, South Carolina, and Georgia.

4. Digitaria floridána Hitchc. (Fig. 830.) Culms tufted, decumbent at base, 20 to 30 cm. tall; foliage glabrous except for a few long hairs around the mouth of the sheath; blades 4 to 7 cm. long, 3 to 6 mm. wide; racemes 3 or 4, rather distant on the axis, 3 to 6 cm. long, the rachis wings wider than the midrib; spikelets 1.5 to 1.7 mm. long, rather sparingly pubescent; first glume wanting; second glume and sterile lemma about as long as the light-brown fertile lemma. ⊙ —Sandy pine woods, Florida (Hernando County). The inflorescence resembles that of *D. filiformis*, but the rachis is winged; the spikelets are smaller than those of *D. ischaemum*.

5. Digitaria violáscens Link. (Fig. 831.) Annual or apparently perennial; culms numerous in a tuft, spreading at base, slender, 10 to 40 cm. tall; leaves mostly clustered near the base, the sheaths glabrous; blades flat, mostly less than 5 cm. long, 3 to 6 mm. wide, the upper culm blade distant, reduced; racemes slender, 2 to 5, usually 2 or 3, digitate or some-

FIGURE 827.—*Digitaria sanguinalis*. Plant, views of spikelet, and floret, × 10. (Kans.)

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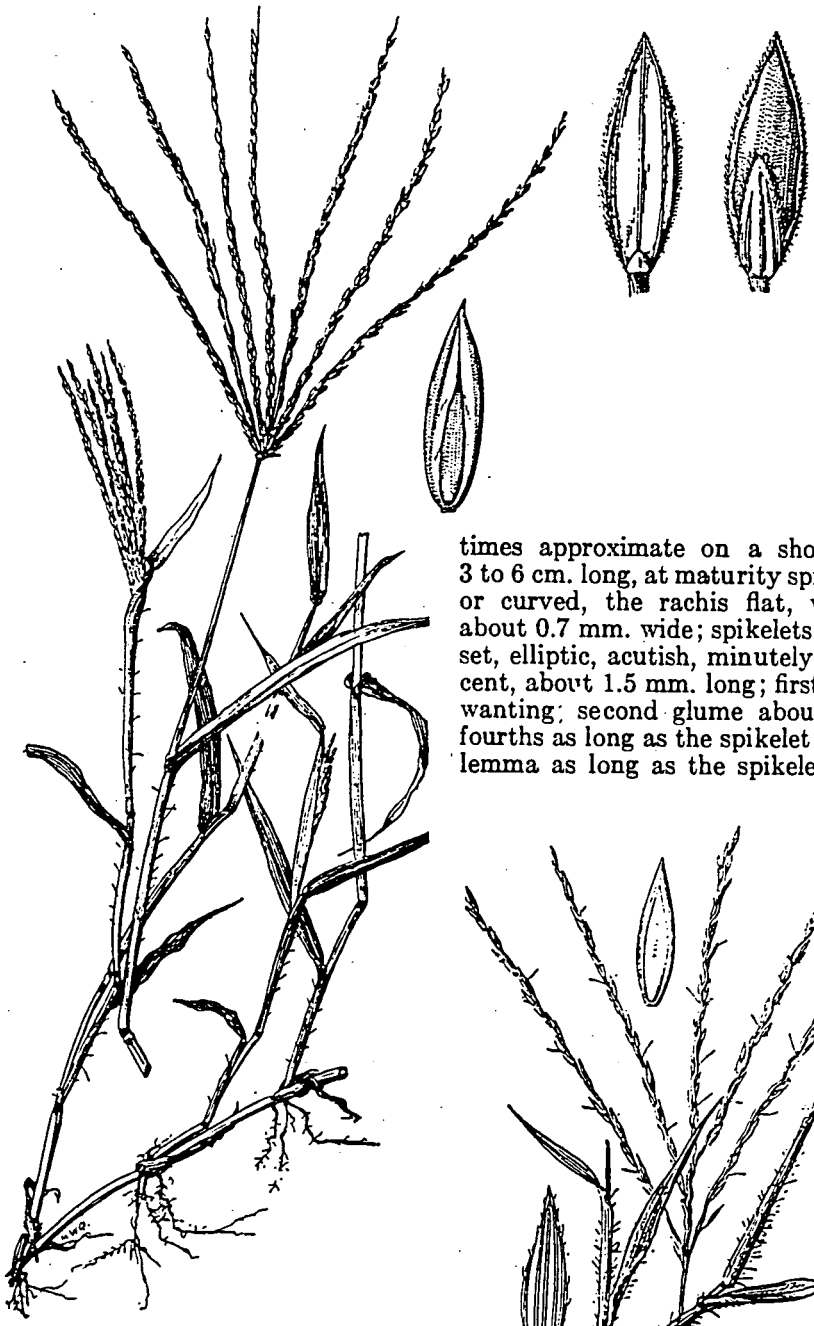

FIGURE 827.—*Digitaria sanguinalis*. Plant. × ½; two views of spikelet, and floret. × 10. (Norton 566, Kans.)

times approximate on a short axis 3 to 6 cm. long, at maturity spreading or curved, the rachis flat, winged, about 0.7 mm. wide; spikelets closely set, elliptic, acutish, minutely pubescent, about 1.5 mm. long; first glume wanting; second glume about three fourths as long as the spikelet; sterile lemma as long as the spikelet, with

FIGURE 828.—*Digitaria horizontalis*. Plant. × 1; spikelet and floret. × 10. (Nash 996, Fla.)

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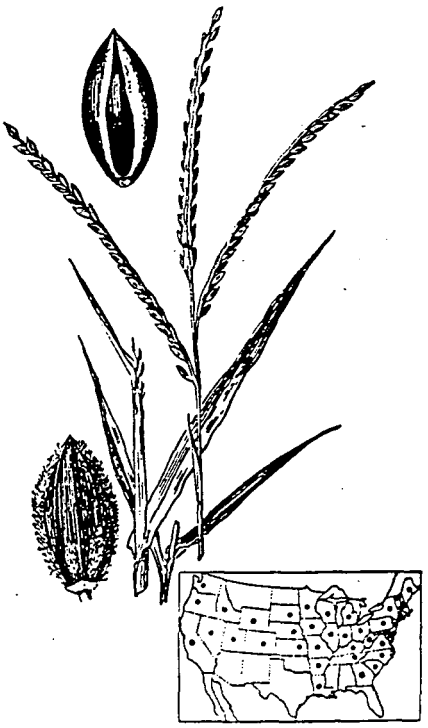

FIGURE 829.—*Digitaria ischaemum*. Plant, × 1; spikelet and floret, × 10. (Jones 1761, Vt.)

FIGURE 830.—*Digitaria floridana*. Plant, × 1; spikelet and fertile floret, × 10. (Type.)

FIGURE 831.—*Digitaria violascens*. Pa views of spikelet, and floret, × 10. Ala.)

three distinct nerves and 1 or 2 obscure pairs; fertile lemma acute, dark brown at maturity. ⊙ ♃ —Open pineland in sandy soil, Indiana and Kentucky; Georgia and Florida to Arkansas and Texas; tropical America; tropical Asia.

6. Digitaria serótina (Walt.) Michx. (Fig. 832.) Creeping, sometimes forming extensive mats; flowering culms ascending or erect, 10 to 30 cm. tall; leaves crowded on the creeping culms, the blades short; sheaths villous; blades 2 to 8 cm. long, 3 to 7 mm. wide; racemes usually 3 to 5, slender, often arcuate, 3 to 10 cm. long, the rachis with thin wings wider than the midrib; spikelets pale, about 1.7 mm. long; first glume wanting; second glume about one-third as long as the sterile lemma, both finely pubescent; fertile lemma pale. ⊙ —Pastures and waste places, Coastal Plain, Pennsylvania to Florida and Louisiana; Philadelphia (ballast); Cuba.

7. Digitaria longiflóra (Retz.) Pers. (Fig. 833.) Stoloniferous; culms ascending, 20 to 40 cm. tall, glabrous; sheaths glabrous; ligule membranaceous, 1 mm. long; blades 1 to 4 cm. long, 3 to 5 mm. wide, flat, glabrous; racemes 2 to 4, 3 to 8 cm. long, usually curved, the rachis flat, 0.5 to 0.8 mm. wide; spikelets 1.5 mm. long, elliptic, minutely pubescent. ♃ —Ditches and sandy ground, southern Florida; tropical regions of the Old World; introduced in the American Tropics.

8. Digitaria simpsóni (Vasey) Fernald. (Fig. 834.) Resembling *D. sanguinalis* in habit; sheaths papillose-pilose, those of the innovations compressed-keeled; blades not more than 6 mm. wide, softly pilose; racemes 4 to 8, ascending, pale, 8 to 12 cm. long, the triangular rachis narrowly margined; spikelets about 3 mm. long; first glume hyaline, obsolete or nearly so; second glume and sterile lemma finely 7- to 9-nerved, glabrous or very obscurely pubesce exceeding the pale, slightl fertile lemma. ⊙ —Sa Florida, rare; Isla de Pi

9. Digitaria filifórmis (Fig. 835, *A*.) Culms in s slender, usually erect, 10 tall, rarely taller, those of unequal; lower sheaths upper mostly glabrous; bl usually 5 to 15 cm. long more robust plants), 1 wide; racemes mostly 1 to erect or ascending, mostl 10 cm. long, somewhat c fascicled; spikelets 1.5 t long; first glume wanti glume and sterile lemma with short capitellate h times nearly glabrous, shorter than the spikelet; ma dark brown, slightly ⊙ —Sandy fields and s ground, New Hampshir and Oklahoma, south Texas, and Mexico. A

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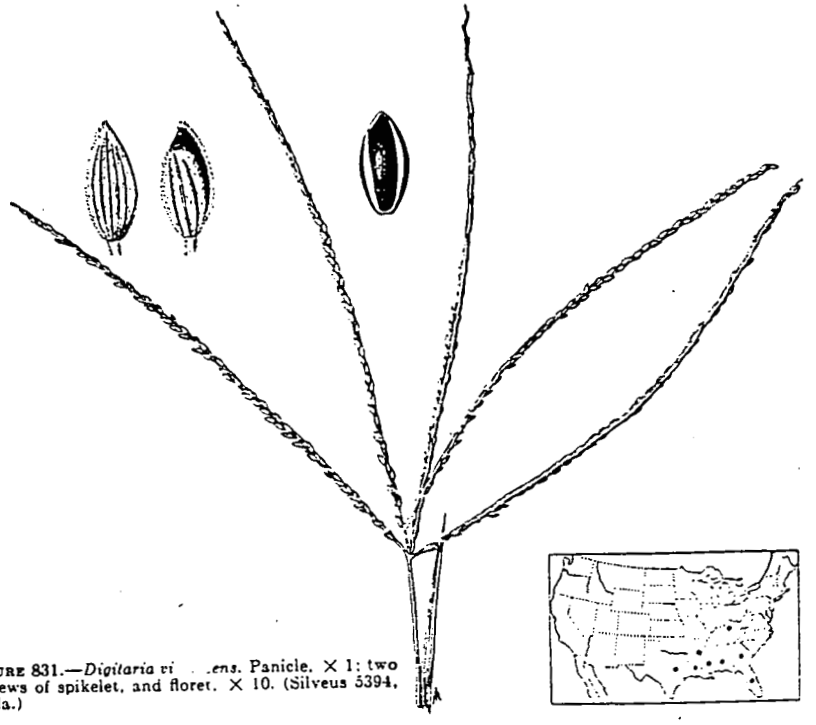

FIGURE 831.—*Digitaria vi* .*ens*. Panicle. × 1; two views of spikelet, and floret. × 10. (Silveus 5394, Ala.)

nt. × 1; spike- Type.)

(Retz.) Pers. culms as- , glabrous; membrana- ades 1 to 4 de, flat, gla- 3 to 8 cm. rachis flat, spikelets 1.5 tely pubes- nd sandy a; tropical d; introduced

Vasey) Fer- mbling *D.* aths papillose- ations com- more than ; racemes 4 8 to 12 cm. is narrowly ut 3 mm. obsolete or ne and sterile ed, glabrous

or very obscurely pubescent, barely exceeding the pale slightly apiculate fertile lemma. ⊙ —Sandy fields, Florida, rare; Isla de Pinos, Cuba.

9. Digitaria filifórmis (L.) Koel. (Fig. 835, *A*.) Culms in small tufts, slender, usually erect, 10 to 60 cm. tall, rarely taller, those of a tuft very unequal; lower sheaths pilose, the upper mostly glabrous; blades erect, usually 5 to 15 cm. long (longer in more robust plants), 1 to 4 mm. wide; racemes mostly 1 to 5, unequal, erect or ascending, mostly less than 10 cm. long, somewhat distant, not fascicled; spikelets 1.5 to 1.7 mm. long; first glume wanting; second glume and sterile lemma pubescent with short capitellate hairs, sometimes nearly glabrous, the glume shorter than the spikelet; fertile lemma dark brown, slightly apiculate. ⊙ —Sandy fields and sterile open ground, New Hampshire to Iowa and Oklahoma, south to Florida, Texas, and Mexico. A form with

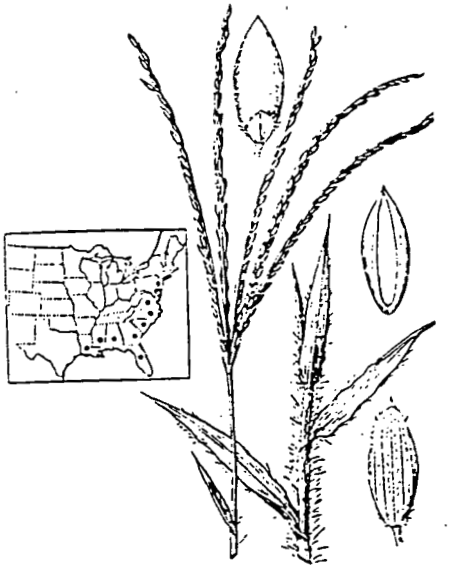

FIGURE 832.—*Digitaria serotina*. Plant. × 1; two views of spikelet, and floret. × 10. (Tracy 4653, Miss.)

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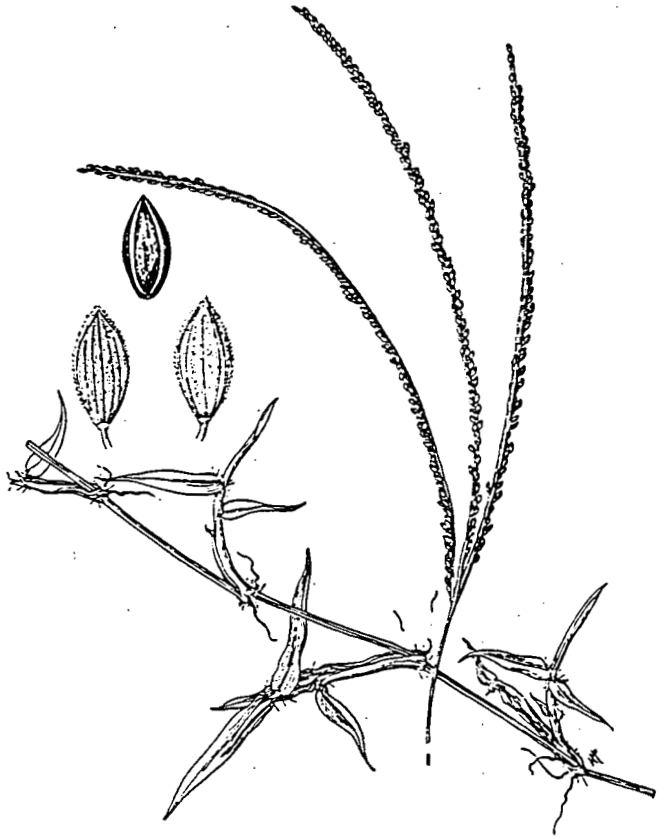

FIGURE 833.—*Digitaria longiflora*. Plant, × ½. Stolon and panicle, × 1; spikelet and floret, × 10. (Silveus 4405, Fla.)

glabrous spikelets from Manchester, N. H., has been described as *D. laeviglumis* Fernald (835, *B.*).

10. Digitaria villósa (Walt.) Pers. (Fig. 836.) Perennial at least in the Southern States, in large tufts, purplish at base; culms 0.75 to 1.5 m. tall, rarely branching; sheaths, at least the lower, grayish villous, sometimes sparsely so; blades elongate, 3 to 6 mm. wide, often flexuous, from softly pilose to nearly glabrous; racemes 2 to 7, narrowly ascending, rarely somewhat spreading, very slender, usually 15 to 25 cm. long, rather distant, often naked at base, sometimes interrupted; spikelets 2 to 2.5 mm. long, usually densely pubescent with soft capitellate hairs, the hairs longer than in *D. filiformis*, and sometimes only obscurely capitellate, the spikelets otherwise very like those of *D. filiformis*. ♃ —Sandy fields and woods, Maryland to Missouri, south to Florida and Texas; Cuba, Mexico. This species and *D. filiformis* seem to intergrade to some extent. Plants from peninsular Florida with less strongly pubescent sheaths, 2 to 4 elongate racemes, and spikelets with longer hairs have been distinguished as *D. leucocoma* (Nash) Urban.

11. Digitaria dolichophýlla Henr. (Fig. 837.) Slender wiry perennial, 50 to 115 cm. tall; blades elongate, folded or involute, flexuous, about 1 mm. wide; racemes mostly 1 to 3, erect, 5 to 20 cm. long, usually 10 to 20 cm., very slender, loosely flowered; spikelets about 1.5 mm.

long, the capitellate hairs rath stiff and appressed; fruit dark brow ♃ (Has been confused with . *panicea* (Swartz) Urban.)—Moist pi barrens and open ground, southe Florida; Cuba, Puerto Rico.

12. Digitaria gracíllima (Scribı Fernald. (Fig. 838.) Perennial dense tufts; culms 60 to 100 cm. ta erect; lower sheaths appressed-villou blades elongate, 1 to 2 mm. wic

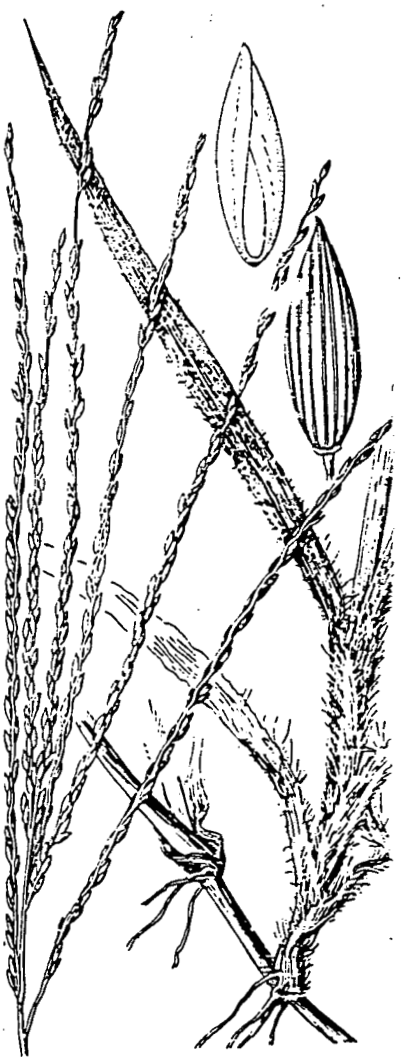

FIGURE 834.—*Digitaria simpsoni*. Plant, × 1; let and floret, × 10. (Curtiss 6422, Fla.)

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long, the capitellate hairs rather stiff and appressed; fruit dark brown. ♃ (Has been confused with *D. panicea* (Swartz) Urban.)—Moist pine barrens and open ground, southern Florida; Cuba, Puerto Rico.

12. Digitaria gracíllima (Scribn.) Fernald. (Fig. 838.) Perennial in dense tufts; culms 60 to 100 cm. tall, erect; lower sheaths appressed-villous; blades elongate, 1 to 2 mm. wide, often involute, more or less flexuous; racemes mostly 2 or 3, distant (rarely as many as 5 and fairly approximate), very slender; spikelets rather remote, relatively long pediceled, about 2.3 mm. long, glabrous; first glume ob-

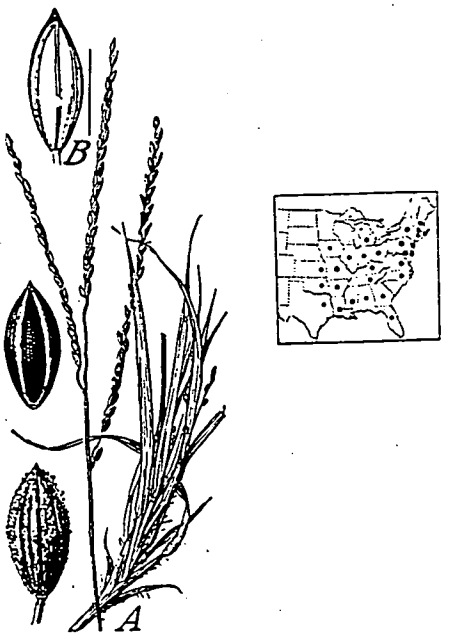

FIGURE 835.—*A, Digitaria filiformis.* Plant, × 1; spikelet and floret, × 10. (Bissell, Conn.) *B, D. laevigatum.* Spikelet, × 10. (Type coll.)

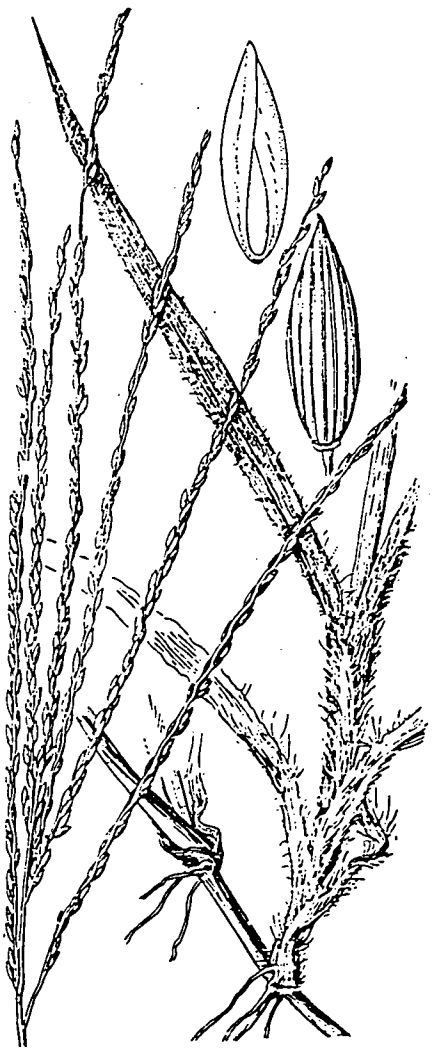

FIGURE 834.—*Digitaria simpsoni.* Plant, × 1; spikelet and floret, × 10. (Curtiss 6422, Fla.)

FIGURE 836.—*Digitaria villosa.* Plant, × 1; spikelet and floret, × 10. (Curtiss 5300, Fla.)

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MANUAL OF THE VASCULAR FLORA OF THE CAROLINAS

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THE UNIVERSITY OF NORTH CAROLINA PRESS
CHAPEL HILL

000136

long, sterile lemma 1-3 nerved, glaucous, obtuse, 3-4 mm long; fertile lemma and palea nerveless or faintly nerved, papillose, obtuse, 3-4 mm long. Grain dark red, broadly ellipsoid, 2.8 mm long. (n = 60, 80) Aug.-Oct. Low woods, roadsides and fields; pied. and cp. [Va., Ga., Fla., Ala., Miss., Tenn., Ky.] Includes *P. difforme* Le Conte—S; *P. floridanum* var. *glabratum* Engelm.

75. DIGITARIA Heister Crab Grass

Annuals; internodes glabrous. Leaves cauline; blade margins cartilaginous, scaberulous; sheath margins usually scarious; ligules membranous. Racemes racemose, ascending; rachis usually winged, scaberulous. Spikelets plano-convex, ellipsoid, acute. First glume usually absent, 2nd glume villous on nerves and margins, acute, sterile lemma 5-7 nerved, acute; fertile lemma and palea nerveless, cartilaginous, glabrous, acute; fertile lemma margins flat, hyaline. Grain whitish to brownish, ellipsoid. These plants are our worst field and garden weeds.

Rachis trigonous, not distinctly winged	1. *D. filiformis.*
Rachis not trigonous, distinctly winged.	
Sheath glabrous	2. *D. ischaemum.*
Sheath pubescent.	
Spikelets 2.8-3.2 mm long	3. *D. sanguinalis.*
Spikelets 1.5-1.8 mm long	4. *D. serotina.*

1. **D. filiformis** (L.) Koeler. Cespitose annual; culms 3-12 dm tall, nodes glabrous. Blades to 15 cm long, 2-4 mm wide, papillose-hirsute and scaberulous above, glabrous or occasionally pilose to hirsute beneath; sheaths papillose-hirsute; ligules erose to lacerate, 0.5-1 mm long. Racemes 2-7, ascending, 3-12 cm long; rachis trigonous, wingless, scaberulous. Spikelets 1.8-2.5 mm long; pedicels scaberulous, 0.5-3 mm lo Second glume 5-nerved, 1.2-1.5 mm long, sterile lemma margir ciliate, 1.8-2 mm long; fe e lemma and palea purple, papillose lined, 1.8-2 mm long. Grain 1-1.2 mm long. (n = 18) Sept.-Oct. Sandy fields, roadsides.

1a. var. **filiformis.*** Spikelets 1.8-2 mm long; plant 3-7.5 dm tall. Scattered throughout. [Va., Ga., Fla., Ala., Miss., Tenn., Ky.] *Syntherisma filiforme* (L.) Nash—S.

1b. var. **villosa** (Walter) Fernald. Spikelets 2-2.5 mm long; plant frequently more than 1 m tall. Pied. and cp. [Va., Ga., Fla., Ala., Miss., Tenn.] *Syntherisma villosum* Walter—S.

2. **D. ischaemum** (Schreber) Schreber ex Muhl. Cespitose to decumbent annual; culms 1.5-6 dm tall, nodes glabrous. Blades to 14 cm long, 2-7 mm wide, glabrous on both surfaces or sparsely pilose; sheaths glabrous; ligules 1-2.5 mm long. Racemes 2-6, ascending, 2-9 cm long; rachis wing scaberulous, 1 mm wide. Spikelets 1.5-2.2 mm long, in groups of 2 or 3; pedicels minutely scaberulous angled, 0.5-2 mm long. Second glume usually 3-nerved, 1.8-2.2 mm long; sterile lemma slightly villous, 1.8-2.2 mm long; fertile lemma and palea purple, papillose lined, 1.8-2.2 mm long. Grain 1.2-1.4 mm long. (n = 18).

2a. var. **ischaemum**. Spikelets 1.8-2.2 mm long. July-Oct. Fields and lawns; throughout. [Va., Ga., Ala., Miss., Tenn., Ky., W.Va.] *Syntherisma ischaemum* (Schreber) Nash—S.

2b. var. **violascens** (Link) Radford. Spikleets ca. 1.5 mm long. Sept.-Oct. Sandy woods and roadsides; cp. [Ga., Fla., Ala., Miss., Ky.] *D. violascens* Link—G.

3. **D. sanguinalis** (L.) Scopoli.* Cespitose, mat-forming annual freely rooting at the lower nodes; culms 2-7 dm tall, lower nodes pilose, upper glabrous. Blades to 16 cm long, 1-16 mm wide, pubescent or puberulent above, scaberulous beneath, occasionally papillose-hirsute basally; sheaths papillose-hirsute; ligules erose, 2-3 mm long. Racemes 3-9, ascending, 2-16 cm long; rachis wing 0.8-1 mm wide, scaberulous. Spikelets 2.8-3.2 mm long, in 2 or 4 rows; pedicels scaberulous angled, 0.5-2 mm long. First glume triangular, glabrous, acute, 0.5 mm long, 2nd glume 5-nerved, 2.8-3.2 mm long; sterile lemma margins villous, 2.8-3.2 mm long; fertile lemma and palea purplish, papillose lined, 2.8-3.2 mm long. Grain 2-2.2 mm long. (n = 18, 24, 27) July-Oct. Fields, roadsides and waste places; throughout. [Va., Ga., Fla., Ala., Miss., Ky., W.Va.] *Syntherisma sanguinale* (L.) Dulac.—S.

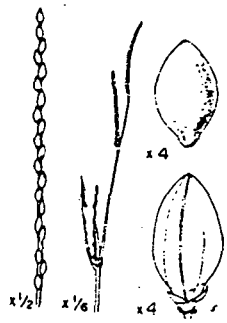
4. **D. serotina** (Walter) A
tall, nodes appressed pubescent. Bl
sheaths villous; ligules 1-2.5 mm
scaberulous, 0.8 mm wide. Spikelet
mm long. Second glume absent or a
villous, 1.5-1.8 mm long; fertile ler
long. Oct. Sandy woodlands, rare;
Miss.] *Syntherisma serotinum* Walt

76. BR

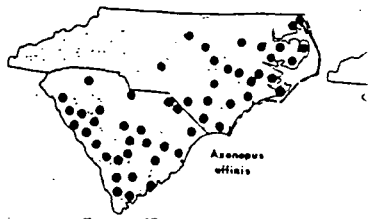
1. **B. platyphylla** (Griseba
nodes; culms 3-6 dm tall, nodes and
5-14 mm wide, glabrous on both su
papillose-pilose, margins ciliate; lig
ascending, 4-8 cm long; rachis win
spikelet. Spikelets ovoid, not plano
setose. 0.5-1 mm long. First glume fa
2nd glume and sterile lemma 7-ne
sterile palea scarious; fertile lemma
long. Grain yellowish, broadly ellip
Co., N.C., Beaufort, Dillon, Richla

77. AXON

Rhizomatous perennials usua
low cauline; blades glabrou n both
glabrous, margins glabrous; ligules
jugate; rachis trigonous, wingless, s



Brachiaria platyphylla



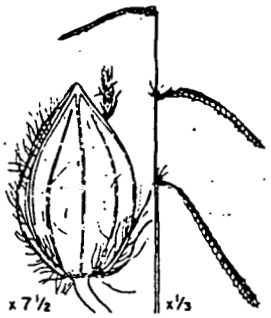
long; rachis wing scaberulous, 1 mm wide. Spikelets orbicular, 2.5-3 mm broad, in 2 rows; pedicels scaberulous, 1-1.5 mm long. Second glume 3-nerved, glabrous, 2.5-3 mm long, sterile lemma 5-nerved, glabrous, 2.5-3 mm long; fertile lemma and palea nerveless, slightly papillose, 2.5-3 mm long. Grain yellowish, suborbicular, 2 mm broad. (n = 20) June-Aug. Fields, meadows and roadsides; throughout. [SE.] Includes *P. longipilum* Nash, *P. circulare* Nash—S; *P. laeve* var. *circulare* (Nash) Fernald—F.

14. P. praecox Walter. Erect perennial from short rhizomes; culms 6-9 dm tall, nodes and internodes glabrous. Blades to 20 cm long, 1.5-4 mm wide, glabrous or villous on both surfaces, occasionally pilose basally above; sheaths glabrous, villous or sparsely papillose above, margins smooth; ligules 2-2.5 mm long. Racemes 3-5, racemose, ascending, 2-6 cm long; rachis wing scaberulous, 1-1.2 mm wide. Spikelets broadly obovoid to suborbicular, flattish, 2.2-3.2 mm long, in 4 rows, 2 rows rudimentary; pedicels scaberulous angled, 0.1-1 mm long. Second glume and sterile lemma 3-nerved, yellowish green, margins scarious, obtuse, 2.2-3.2 mm long; fertile lemma and palea nerveless, papillose, obtuse, 2.2-3.2 mm long. Grain brownish, broadly ellipsoid, flat, 2 mm long. (n = 10, 20) Savannahs and low pinelands; cp.

14a. var. **praecox.** Sheaths and blades glabrous or sparsely papillose. May-July. [Va., Ga., Fla., Ala., Miss.].

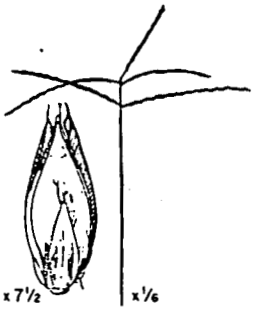
14b. var. **curtisianum** (Steudel) Vasey. Sheaths and blades villous or hirsute. June-Oct. Savannahs and low pinelands; cp. [Va., Ga., Fla., Ala., Miss., Tenn., Ky.] *P. lentiferum* Lam.—S.

15. P. floridanum Michaux. Coarse perennial from stout rhizome; culms 5-15 dm tall, nodes and internodes glabrous. Blades to 40 cm long, 1-15 mm wide, glabrous on both surfaces; sheaths glabrous, occasionally pubescent apically, margins glabrous; ligules membranous, 1-2 mm long. Racemes 2-7, racemose, ascending, [illegible] 3 cm long; rachis scaberulous, 1-2 mm wide. Spikelets suborbicular or broadly ellipsoid, 3-4 mm long, in 4 rows or by abortion 3 or 2; pedicels scaberulous, 1-2 mm long. Second glume 5-7 nerved, glaucous, obtuse, 3-4 mm

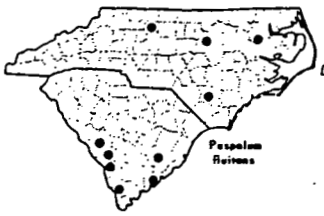


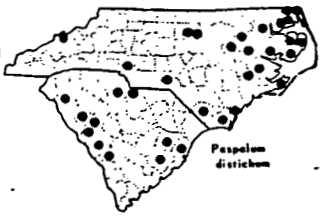
Paspalum dilatatum

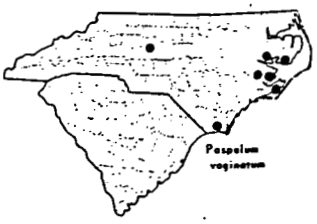
Digitaria filiformis

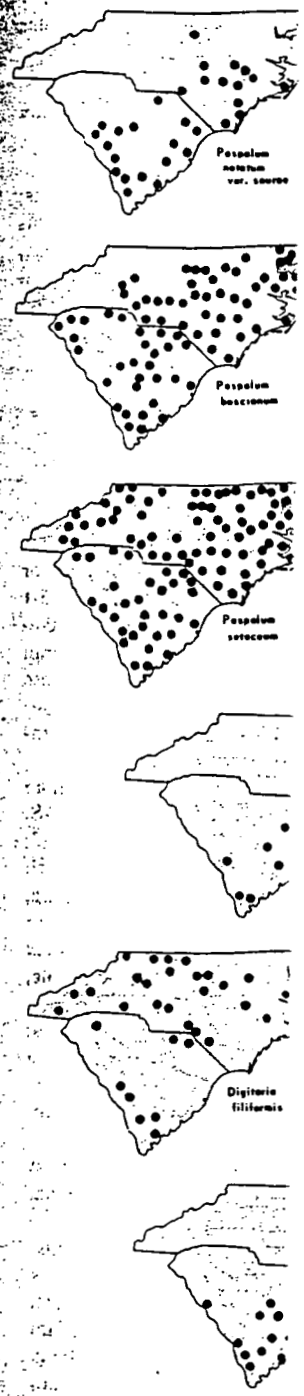


Digitaria sanguinalis









BULLETIN OF THE OHIO BIOLOGICAL SURVEY
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Volume 7 Number 1

A DESCRIPTIVE KEY TO THE GRASSES OF OHIO BASED ON VEGETATIVE CHARACTERS

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5. Culms submersed or floating or prostrate on wet soil and rooting at nodes, short or as much as 1 m long; ligule and auricles 1-3 (5) mm long; sheaths of floating branches inflated, glabrous or hairy; blades usually not more than 1 cm wide and 10 cm long but sometimes considerably wider and longer; annual. ***Paspalum fluitans*** (Ell.) Kunth

   Four counties along the Ohio River; panicle 1-1.5 dm long, of many bladelike branches that are wider than the 2 rows of attached spikelets; spikelets about 1.8 mm long, minutely hairy; first glume absent, the second as long as the spikelet; August-October.

5. Growing in dry or moist open places, not in water or very wet soil; culms ascending or rarely erect, or ascending from a decumbent base, sometimes prostrate, sometimes rooting at lower nodes.

   6. Perennial, not weedy; culms short to moderately tall, much branched, leafy, ascending from a knotty decumbent base, the base often with feltlike pubescence; internodes short, the lower often 2-3 cm long, the upper somewhat longer; whole plant often a rather large bunch; lower sheaths often pubescent; blades 2-6 mm wide, mostly less than 1 dm long, the bases often asymmetric; ligule and vertical auricles 1-1.5 mm long, usually higher on one side than on the other and extending horizontally farther on one side than on the other. ***Leptoloma cognatum*** (Schult.) Chase, fall witchgrass.

      Open sandy soil, dry fields; 8 northern and 6 south-central counties; panicle diffuse, one-third the height of the plant or more, at maturity breaking away as a tumbleweed; spikelets 2.5-3 mm long, narrow, solitary at ends of capillary branchlets, each with 1 perfect floret and an additional lemma; sterile lemma and second glume minutely hairy, the first glume absent or very small; hyaline margins of lemma of perfect floret enclosing the palea; July-October.

   6. Annual, weedy; culms spreading or ascending from a decumbent base, sometimes, especially when crowded, erect or nearly so, sometimes prostrate, usually rooting at lower nodes; internodes several to many, usually short; foliage often tinged with blue or purple; sheaths loose or inflated, mostly shorter than internodes, with pale longitudinal lines (visible when sheath is removed and held to light); blades 2-8 (10) mm wide, often with pale or purple edge; ligule 1-3 mm long. Species of ***Digitaria***, crabgrass.

      Waste places, lawns, cultivated fields, and gardens; general and abundant; inflorescence a panicle of spikelike racemes clustered at or near summit of peduncle, sometimes all or most of them in one or two whorls; spikelets 2-3 mm long, each with 1 perfect floret and an additional lemma; first glume minute or sometimes absent.

      7. Nodes, sheaths, and blades more or less hairy, the hairs, at least some of them, papilla-based; blades 4-8 (10) mm wide, 4-15 cm long; culms sometimes to 1 m long, especially when prostrate, but often much shorter. ***Digitaria sanguinalis*** (L.) Scop., crabgrass.

         Second glume half as long as the pale or green lemma; first glume minute; June-frost.

      7. Plants glabrous or with a few straggling hairs, the hairs not papilla-based; blades 2-4 (6) mm wide, 2-10 cm long; culms usually short. ***Digitaria ischaemum*** (L.) Scop., smooth crabgrass.

         Second glume as long as the dark lemma; first glume sometimes absent or vestigial; July-frost.

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7. Blades 1-4 mm wide, sometimes pubescent near base; ligule 1-1.5 mm long, minutely toothed; sheaths, at least the lower, with papilla-based hairs that are sometimes prominent; culms slender to very slender, short to moderately tall, in small tufts, sometimes branched at base or lower nodes, usually erect, those of a tuft unequal in length; foliage and panicle not red; annual. ***Digitaria filiformis*** (L.) Koel.

   Sandy or sterile open ground; 9 counties, mostly southern; inflorescence of 1 to several spikelike racemes attached along a rachis, not fascicled; spikelets 1.5-2 mm long, with 1 perfect floret plus an additional lemma, often in 3's on the axis of the raceme; first glume absent; second glume and slightly longer sterile lemma short-pubescent; fertile lemma and palea dark, elliptic; hyaline margins of lemma overlapping the palea; August-October.

7. Blades 3-10 mm wide; ligule 1-3 mm long, either laciniate-toothed, the teeth ending in hairs, **OR** entire and often brown.

   8. Blades acuminate to aristate at tip; ligule 1-2 mm long, laciniate-toothed, the teeth ending in hairs; sheaths papillose-pubescent, often sparsely so, the hairs slender and sometimes deciduous, the small papillae remaining; culms short to tall, erect or sometimes bent and branched below; foliage and panicle usually red or purple; annual. ***Leptochloa filiformis*** (Lam.) Beauv., red sprangletop.

      Open or shaded areas, sometimes a weed in states farther south; Adams and Gallia counties; apparently rare in Ohio; panicle half the height of the plant, lance-ovoid, of many spikelike branches attached along the rachis; spikelets small, few flowered; lemma 1-1.5 mm long, pubescent on nerves; July-October.

   8. Blades acuminate; ligule 1-3 mm long, entire, often brown; sheaths keeled, the uppermost sometimes inflated; sheaths and blades glabrous to pubescent on surface and margin, the hairs sometimes papilla-based; foliage green; perennial. ***Panicum palum laeve*** Michx. (Incl. ***P. longipilum*** Nash and ***P. circulare*** Nash) (See p. 62).

4. Culms without cormlike bases; plants glabrous or more or less pubescent but without velvety or papillose pubescence.

   5. Blades prow-shaped at tip, the tip often so slender that its shape may not be noticeable without magnification; blades 1-3 (4) mm wide; perennial.

      6. Basal tufts present; culms usually slender, short to moderately tall, pubescent or puberulent, sometimes only below the nodes and below the panicle; sheaths, at least the lower ones, pubescent or puberulent; blades pubescent, puberulent or glabrous, sometimes folded or rolled in drying; ligule 0.5-2 mm long, truncate. ***Koeleria cristata*** (L.) Pers., junegrass.

         Koelaria cristata is an illegitimate name. Names used by authors in recent years have included ***K. macrantha*** (Ledeb.) Schultes, ***K. nitida*** Nutt., and ***K. pyramidata*** (Lam.) Beauv.

         Dry prairies, open woods, sandy soil; 3 counties along western Lake Erie and Greene County; panicle shining, narrow and spikelike, silvery green, the rachis pubescent; spikelets 4-5 mm long; June-August.

      6. Culms in small tufts, mostly short and slender, erect or bent at base; plants glabrous; blades sometimes rolled, the tips slender;

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Manual of Vascular Plants of Northeastern United States and Adjacent Canada

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78. DIGITARIA Heist. Crab grass. Spikelets 1-fld, single or in clusters of 2 or 3 on unequal pedicels on one side of an elongate rachis; first glume minute or lacking; second glume a third to fully as long as the spikelet, conspicuously 5–7-nerved; fertile lemma cartilaginous with hyaline margins, acute, often shining, usually faintly marked with longitudinal rows of minute pits; ours annual, branched from the base, with few–several terminal, digitate or approximate, spike-like, one-sided racemes. (*Syntherisma.*) (B&B I, 203.)

Culms rooting at the lower nodes; rachis 0.5–1 mm wide, broadly winged, the wings as wide as or wider than the central rib.
  Second glume a third to half as long as the white to stramineous or pale brown fertile lemma.
    Spikelets 2.4–3 mm; pedicels triquetrous, scabrous. ..... 1. *D. sanguinalis.*
    Spikelets 1.5–1.7 mm; pedicels terete, glabrous. ..... 2. *D. serotina.*
  Second glume three-fourths to fully as long as the dark brown or purple-black fertile lemma.
    Second glume as long as the spikelet; hairs of the spikelet capitellate. ..... 3. *D. Ischaemum.*
    Second glume three-fourths as long as the spikelet; hairs not capitellate. ..... 4. *D. violascens.*
Culms erect or ascending; rachis slender, triquetrous, very narrowly winged. ..... 5. *D. filiformis*

1. **Digitaria sanguinalis** (L.) Scop. Decumbent or prostrate, much branched, rooting at the nodes, usually 3–6 dm; blades 4–10 cm × 5–10 mm, pilose; racemes 3–6 in each of 1–3 whorls, 5–15 cm; rachis 1 mm wide, broadly winged, scabrous on the margins; pedicels triquetrous, scabrous; spikelets 2.4–3 mm; first glume minute, often deciduous, the second half as long as the spikelet; sterile lemma usually scabrous on the 5 strong nerves; fertile lemma greenish-brown. Native of Europe, now cosmopolitan and established as a weed of fields, gardens, lawns, and waste ground throughout the U.S.

2. **Digitaria serotina** (Walt.) Mich. Much like No. 1; lvs densely pilose; racemes 2–6, slender, often curved, 4–8 cm; pedicels terete, glabrous; spikelets 1.5–1.7 mm, villous with minute crooked hairs; first glume lacking, the second a third to half as long as the spikelet; sterile lemma 5-nerved; fertile lemma stramineous to nearly white, or brown-tinged. Waste ground; coastal plain from Fla. and La. (and Cuba) to se. Va., and rarely adventive northward.

3. **Digitaria Ischaemum** (Schreb.) Muhl. Much like No. 1; lvs glabrous; racemes 2–5 (8), 4–10 (15) cm; spikelets elliptic or somewhat obovate, 1.7–2.1 mm, often purple; first glume lacking or minute and hyaline; second glume and sterile lemma equal and about as long as the spikelet, both ± pubescent or subtomentose with capitellate hairs, especially in stripes between the nerves; fertile lemma purple-black. Native of Eurasia, now established as a weed over much of the U.S., and throughout our range, but less abundant than No. 1. (*D. humifusa.*)

4. **Digitaria violascens** Link. Distinguished from No. 3 by the somewhat smaller (ca 1.5 mm), less pubescent spikelets, the hairs not capitellate. Pantropical, extending into our range in Ky. and s. Ind.

5. **Digitaria filiformis** (L.) Koeler. Branched from the base, 3–10 dm, erect or ascending; lower sheaths usually ± pilose, the upper sparsely so or glabrous; racemes 2–6, erect or ascending, often distinctly separated at base; rachis triquetrous, narrowly winged; spikelets in pairs or threes, well separated and scarcely overlapping; first glume lacking, the second three-fifths to four-fifths as long as the spikelet, usually pubescent and erose-ciliate with capitellate hairs; fertile lemma brown or dark purple. Fields and open ground, often a troublesome weed southward. Forms with glabrous spikelets occur in both vars. (*D. laeviglumis*).

var. filiformis. Culms 5–10 dm; upper sheaths glabrous, the lower glabrous to sparsely pilose; spikelets 1.7–2.2 mm. N.H. to Mich. and Kans., s. to Fla. and Mex.

var. villosa (Walt.) Fern. Culms 8–15 dm; upper sheaths glabrous or pilose, the lower densely pilose; racemes mostly 10–15 cm; spikelets 2–2.6 mm. Coastal plain from Va. to Fla. and Tex., and n. in the interior to Ill. (*D. villosa.*)

79. LEPTOLOMA Chase. Fall witch-grass. Spikelets fusiform, 1-fld, solitary on long slender pedicels; first glume minute or obsolete; second glume nearly as long as the spikelet, strongly 5–7-nerved; fertile lemma minutely rugulose, cartilaginous, with hyaline margins; perennial, often in large bunches, the culms ± decumbent at base; panicle very diffuse, eventually breaking away from the culm and rolling before the wind. (B&B I, 204.)

1. **Leptoloma cognatum** (Schult.) Chase. Culms tufted, 4–7 dm; lower sheaths villous to papillose-hirsute; blades 5–8 cm, narrow; panicle often a third to half the height of the plant, diffusely branched, purplish, villous in the axils; pedicels 1–4 cm, 3-angled, scabrous; spikelets acute, 2.5–3 mm, subglabrous on the second glume and sterile lemma. Dry, especially sandy soil; s. Mich. and Minn. to Va., Fla., Neb., Ariz. and n. Mex., and at scattered stations ne. to N.H.

80. ERIOCHLOA HBK. Spikelets racemose, short-pediceled in 2 rows on one side of the rachis, lance-ovoid; lower rachilla-joint thickened, forming a ring-like

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callus below the second glume, th
glume and sterile lemma subequ
lemma indurate, finely rugulose, w
branched from the base, with terr
(B&B I, 204.)

1. **Eriochloa contracta** Hitchc. Cu
flat, 4–7 mm wide, hairy; panicle 10–15
several, overlapping, 1–2 cm, the rac
purple-margined; spikelets lance-ovoid.
aristate, appressed-villous; fertile lemm
and Ariz., also intr. in Mo., s. Ill. and

81. AXONOPUS Beauv. Sp
winged rachis, forming a slende
equaling the sterile lemma; fertile
inrolled margins, its back turned
long, terminal (or also axillary), t
other racemes below the summit

1. **Axonopus furcatus** (Fluegge) H
compressed, 4–8 dm; lvs to 10 mm
below, often with another from the u
the sterile lemma obscure, the othe
2.5–3 mm. Damp or wet soil of th
Md. (*Anastrophus f.*)

82. PASPALUM L. Spikel
plano-convex or so what bic
2-rowed or 4-rowed, usually spi
rachis; first glume usually non
lemma of about equal length,
smooth or minutely papillose, i
nial (except *P. Boscianum*), us
soft lvs and a terminal infl of
additional racemes on axillary

Rachis of the racemes broad, foliaceous
them.
Racemes numerous, usually 20–50; spi
Racemes normally 2–5; spikelets 1.7–2
Rachis of the racemes narrow or wingles
Racemes regularly 2, approximate or l
Racemes 1 and terminal, or 2–several
Racemes loosely fld, the spikelets in
fl of a pair barely reaching the
Racemes spike-like, with numerous,
Spikelets long-villous, especially a
Racemes 3–6; spikelets 2.9–3.8
Racemes 8–30; spikelets 2.2–2.
Spikelets glabrous or minutely ha
Fertile lemma dark brown at n
Fertile lemma stramineous or
Sterile lemma 5–7-nerved, th
submarginal, or the lem
Spikelets solitary.
Spikelets all or mostly pai
Spikelets 3.8–4.3 mm; r
Spikelets 2.8–3.1 mm; r
Sterile lemma 3-nerved, the
of the midnerve.
Spikelets flattened on bot
Spikelets plano-convex, a
Racemes 5–10; spikelet