THE DISTRIBUTION AND BREEDING HABITAT OF THE BARKING TREEFROG, HYLA GRATIOSA LECONTE, IN SOUTH-CENTRAL KENTUCKY AND NORTH-CENTRAL TENNESSEE

DANIEL EARL VANNORMAN

THE DISTRIBUTION AND BREEDING HABITAT OF THE BARKING TREEFROG, HYLA GRATIOSA LECONTE, IN SOUTH-CENTRAL KENTUCKY AND NORTH-CENTRAL TENNESSEE

An Abstract

Presented to the

Graduate and Research Council of

Austin Peay State University

In Partial Fulfillment

of the Requirements for the Degree

Master of Science

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by

Daniel Earl VanNorman

March 1985

Abstract

The distribution and the breeding habitat of a disjunct population of the barking treefrog (Hyla gratiosa) were studied in the Pennyroyal Plain region of Kentucky and Tennessee from May through August, 1983 and 1984. Twenty breeding sites and 16 road collections were recorded from six Kentucky and two Tennessee counties. Most breeding took place in flooded sinks of grain fields. Other vertebrates observed utilizing these sites included 11 species of amphibians, two species of reptiles, and one species of fish. Of these, anurans were most abundant. Averages for air temperature, water temperature, dissolved oxygen, and pH recorded at the various breeding sites while males were calling were 24.2°C, 27.0°C, 8 ppm, and 7.3, respectively. During 1983, the species was first observed on 20 May and last seen on 26 July; during 1984, 18 May and 28 August were the earliest and latest dates activity was recorded. Calling was first heard on 8 June in 1983 and on 18 May in 1984; it was last recorded on 26 July in 1983 and on 15 July in 1984. Juvenile individuals were encountered on roads near breeding sites from 25 June to 28 August in 1984. An average of 3.3 males were heard calling at each site. They were routinely observed in an inflated condition at the surface of shallow water (2-120 cm deep), usually among grain stubble within 5.2 m of water's edge. Only one female was encountered at a

breeding site during this study; three were encountered on roads. The averages for snout-vent length and tibia length of all specimens examined (34) were 47.6 mm and 21.2 mm, respectively.

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Tables

To the Graduate and Research Council:

I am submitting herewith a Thesis written by Daniel Earl VanNorman entitled "The Distribution and Breeding Habitat of the Barking Treefrog, Hyla gratiosa LeConte, in South-Central Kentucky and North-Central Tennessee." I have examined the final copy of this paper for form and content, and I recommend that it be accepted in partial fulfillment of the requirements for the degree of Master of Science, with a major in Biology.

A. Floyd Scott
Major Professor

We have read this thesis and
recommend its acceptance.

Edward Chester
Second Committee Member

Charles N. Boehms
Third Committee Member

Accepted for the
Graduate Council:

William N. Eldin
Dean of the Graduate School

Acknowledgements

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Table of Contents

Figures

Figure Page

CHAPTER 1

Introduction

The barking treefrog, Hyla gratiosa LeConte, occurs on the Atlantic and Gulf coastal plains from southeastern Louisiana to southern Florida and north to southeastern Virginia. It is also found locally in northern Alabama, eastern Georgia, Tennessee and Kentucky (Conant 1975). An introduced population once persisted in New Jersey, but may now be extinct (Caldwell 1982).

In south-central Kentucky and north-central Tennessee, Hyla gratiosa is represented by a disjunct, apparently relict population (Monroe and Giannini 1977). The first reports of the species from this region were from Montgomery County, Tennessee (Scott and Harker 1968). Subsequently, additional records were obtained from other sites in Montgomery County (Henderson 1978, Scott, Chester and Snyder 1980) and from the following Kentucky counties: Todd (Monroe and Taylor 1972), Caldwell (Monroe and Giannini 1977, Giannini 1983), Lyon and Trigg (Giannini 1983).

In Kentucky, Hyla gratiosa is considered an endangered species by the Endangered Species Committee of the Kentucky Academy of Science and by the Kentucky Nature Preserves Commission (Branson et al. 1981). In Tennessee, the Tennessee Wildlife Resources Agency designates this species' protection status as "deemed in need of management" and the

Tennessee Heritage Program considers it an animal of "special concern" (Eagar and Hatcher 1980).

Most of the existing information on the life history of Hyla gratiosa is based on studies conducted in the Okefenokee Swamp of Georgia (Wright 1932, Wright and Wright 1949). However, bits of additional information have been presented on breeding habitat (Allen 1932, Black and Gosner 1958, Blem and Miller 1980, Brandt 1933, Cahn 1939, Henderson 1978, Funderburg 1953 and 1955, Goin 1938, Jobson 1940, Martof 1954, McKeever 1977, Monroe and Giannini 1977, Neill 1952 and 1958, Oldham and Gerhardt 1975), spacial positioning of breeding pond occupants (Bartlett 1981, Deckert 1915, Henderson 1978, Gerhardt 1974, Goin 1938, Monroe and Giannini 1977, Neill 1952, Oldham and Gerhardt 1975), and duration of breeding season (Blem and Miller 1980, Brandt 1936, Deckert 1915, Henderson 1978, Giannini 1983, Oldham and Gerhardt 1975, Travis 1980).

Except for the limited information presented by Henderson (1978) on four small breeding populations in Montgomery County, Tennessee, and Giannini (1983) on breeding populations in Caldwell County, Kentucky, little is known about the disjunct Kentucky-Tennessee population. The main purpose of this study was to determine the limits of the distribution of this little-known population and to characterize the breeding habitats it utilizes. The number of individuals at each breeding site, spacial positioning of

breeding pond occupants, duration of the daily calling period, and duration of the breeding season were also investigated.

CHAPTER 2

Description of Study Area

Physiography and Geography

The study was conducted in the Pennyroyal Plain Subsection, Highland Rim Section, Interior Low Plateaus Physiographic Province as defined by Quarterman and Powell (1978). This area includes much of the karst terrain of south-central Kentucky and north-central Tennessee and makes up the southern portion of what has been called the "Cavernous Limestone Plateau" or the "Mississippian Plateaus" (Jillson 1927, Quarterman and Powell 1978, Saur 1927).

According to Quarterman and Powell (1978), the Pennyroyal Plain is bound on the west and southwest by the Western Highland Rim Subsection, on the south by the crest or drainage divide at the top of the Highland Rim Escarpment, on the east by the Greensburg Upland Subsection, and on the north by the Shawnee Hills Section as marked by the Dripping Springs Escarpment. In Kentucky, the Pennyroyal region occupies approximately 3,300 square miles (University of Kentucky 1970), and includes portions of Barren, Caldwell, Christian, Green, Hart, Logan, Lyon, Metcalfe, Simpson, Todd, Trigg, and Warren counties. In Tennessee, portions of Cheatham, Montgomery, Robertson, Stewart, and Sumner counties are included (figure 1).

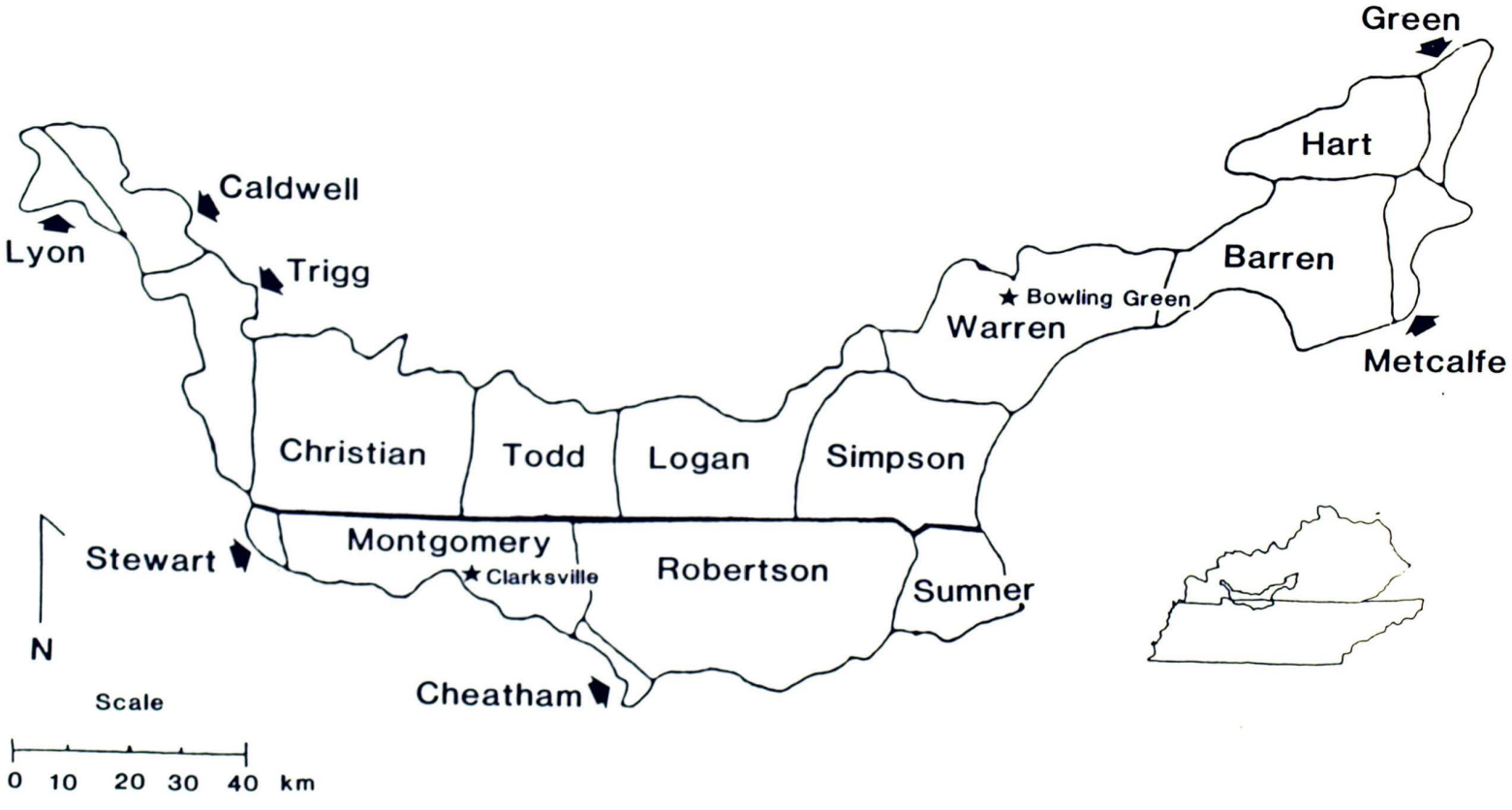

Figure 1. Pennyroyal Plain region of Kentucky and Tennessee showing location relative to state boundaries (inset) and portions of counties involved.

Geology

Altitudes on the upland portions of the Pennyroyal Plain range from about 900 feet above sea level (asl) in the southeast to around 650 feet asl adjacent to the Dripping Springs Escarpment. Along the major streams, elevations drop as low as 500 feet asl (Quarterman and Powell 1978).

The Ste. Genevieve, St. Louis, and Warsaw Limestones, all of Mississippian Age, underlie the Pennyroyal Plain (Quarterman and Powell 1978, McFarlan 1943). Much of the outcrop area of the Ste. Genevieve Limestone is characterized by sinkholes and sinkhole plains. The St. Louis Limestone outcrop area includes numerous sinkholes but is more notably a zone of sinking streams. The Warsaw Limestone and the updip margin of the St. Louis Limestone is generally characterized by surface drainage (Quarterman and Powell 1978).

Although sinking streams are numerous, several large streams arise in or flow through the Pennyroyal Plain (Quarterman and Powell 1978). The Green River crosses the northeast portion and the Barren River flows northwestward from the Greensburg Upland Subsection to Bowling Green, Kentucky. The Red River and its tributaries drain the southern portion and flow into the Cumberland River at Clarksville, Tennessee and the Little River and its tributaries drain the western portion. Much of the water diverted underground through sinking streams and sinkholes

enters the streams of the Pennyroyal Plain via the many springs in the area (Quarterman and Powell 1978).

Soils

The principal soil series for the Kentucky portion of the Pennyroyal Plain are Pembroke, Cumberland, and Crider (University of Kentucky 1970). Pembroke soils are deep, well-drained soils that occupy gently sloping and sloping upland areas. They have a red to reddish brown subsoil and a thin layer of loess on the surface. Cumberland soils developed from stream-deposited materials, are well-drained, and have a dark red subsoil. Crider soils are well-drained, occur in close association with Pembroke soils, but have thicker loess mantles and a less red subsoil.

The principal soil series for the Tennessee portion of the Pennyroyal Plain are Pembroke-Crider, Baxter-Bewleyville-Pembroke, and Dickson-Mountview-Guthrie (Springer and Elder 1980). Pembroke-Crider soils occupy undulating and rolling areas, and are red and brown, well-drained, silty soils from thin loess, alluvium, and limestone. Baxter-Bewleyville-Pembroke soils also occupy rolling and undulating areas, and are red and brown, well-drained, cherty, clayey and silty soils also from limestone, thin loess, and alluvium. Dickson-Mountview-Guthrie soils occupy undulating areas, and are well-drained to poorly drained, silty soils from thin loess and limestone.

Vegetation

The forests of the Pennyroyal Plain are part of the Eastern Deciduous Forest Formation and lie within the Mississippian Plateau Section of the Western Mesophytic Region (Braun 1950).

The uplands support oak-hickory on drier sites and mixed hardwoods with a high beech component on more mesic sites. Sinks originally supported oak swamps but most have been lumbered and/or drained (Quarterman and Powell 1978). Included in the Pennyroyal Plain are most of the areas once called the "Big Barrens" (Braun 1950, Dicken 1935, McInteer 1942, Saur 1927). These were treeless areas that supported extensive stands of prairie grasses and herbs (Quarterman and Powell 1978), and, where appropriate outcrops occur, small cedar glades (Baskin and Baskin 1977). Except in the cedar barrens of slopes, these prairie communities have been almost completely destroyed (Braun 1950). Pastures and cornfields cover most of the barrens, but scrubby oak thickets, dominated by post oak and blackjack oak, and black oak woods with an understory of dogwood are also present (Braun 1950).

About 75 percent of the Pennyroyal Plain in Kentucky is now in cropland, 15 percent is in pasture, and 10 percent is in woodland (Bladen and Bailey 1977, University of Kentucky 1970).

Climate

Most of the Pennyroyal Plain region is located in Kentucky; therefore, it was felt that Kendall's (1933) report on the climatic conditions of western Kentucky would be an appropriate source on which to base this region's climate.

The mean annual temperature is 59°F (15°C). Average monthly temperatures during summer range from 72°F (22°C) to 80°F (27°C), whereas during the winter months they vary between 33°F (0.5°C) and 39°F (4°C) (Kendall 1933). The warmest month in the Pennyroyal region is July, averaging 77.4°F (25.2°C) (Saur 1927) and the coldest month is January, averaging 33°F (0.5°C) (Kendall 1933).

The Pennyroyal Plain region of Kentucky and Tennessee has a humid, mesothermal climate with little or no water deficiency throughout the year (Thornthwaite 1948).

The average annual precipitation for southwestern Kentucky is 48 inches (122 cm) (Kendall 1933), with the Pennyroyal region averaging 47.9 inches (121.7 cm) each year (Saur 1927). Generally the amount of rainfall is greater in the winter months than in the summer months. The driest month is October with an average of 2.6 inches (6.7 cm) of rainfall. March is the wettest month with an average of 5.1 inches (12.9 cm) (Saur 1927). The average number of days per year with appreciable precipitation is 104 (5 to 8 days per month for September to November and 8 to 12 days per month for the rest of the year). Occasionally there is an

overabundance of rain, especially in the spring months, and periods of drought sometime occur during the fall (Kendall 1933).

CHAPTER 3

Materials and Methods

Distribution data were obtained from surveys of the literature and various museum collections (Austin Peay State University Museum of Zoology and University of Louisville Museum), and extensive personal field work aimed predominately at locating new breeding sites. Searches for new breeding sites were conducted at night from May to August, 1983 and 1984, when males could be heard calling and all individuals were more apt to be moving. Roads traversing promising terrain (as determined from scanning USGS 7.5 minute topographic maps) were driven, especially following periods of rainfall. Overall, 117 night trips (61 in 1983; 56 in 1984), averaging 3.5 hours each, were logged. Total mileage driven was approximately 10,400.

Attempts were made to collect at least one adult male and one adult female from each breeding site; juveniles were also collected when encountered. Sex was determined by whether the individual was calling or not, by the presence or absence of vocal sacs, and by the presence (males) or absence (females) of a green throat band. Snout-vent length (SVL) and tibia length was taken on all individuals captured. Measurements were taken to the nearest millimeter using vernier calipers.

The origin (natural or man-made), current human usage, and hydroperiod of breeding sites were determined either by personal observation or by owner interviews.

Hydrogen ion (pH) and dissolved oxygen (DO) concentrations of water at breeding sites were determined just off shore while males were calling. Instruments used included a Fisher Accumet Mini pH Meter, Model 640, and a Chemetrics, Inc. dissolved oxygen test kit, Model 0-12. Air and water temperatures were recorded only when males were heard calling; a mercury thermometer was used.

Other vertebrates utilizing breeding sites were determined by hand collecting, seining, and identification of breeding calls (in the case of other anurans). At least one specimen of each species was collected whenever possible. Dominant aquatic and emergent vegetation was usually identified in the field, but collections for laboratory identification were made when necessary.

The number of individuals at each breeding site was determined by the direct count method. Spot-lighting was employed to locate members of both sexes; males were also detected by listening for their calls.

Spacial positioning of breeding pond occupants was characterized by their distance from shore and height above water or ground (if not in water). Measurements were taken with a standard meter stick and a telescoping fishing pole

marked in centimeters. Distances were determined to the nearest 0.5 m and depth to the nearest 0.5 cm.

Conant's (1975) field guide was employed to identify adult amphibians and reptiles. Tadpoles and larval salamanders were identified using the keys of Altig (1970), Brandon (1961), and Monroe (1973). Fishes were identified using the keys of Smith-Vaniz (1968) and Clay (1975). Nomenclature of the herpetofauna follows Collins et al. (1982). Fish nomenclature follows Robins et al. (1980).

All specimens collected were processed using standard museum procedures and deposited in the Austin Peay State University Museum of Zoology (Nos. 3592 to 3642).

CHAPTER 4

Results

Twenty-five museum specimens and 16 literature records of Hyla gratiosa were located from Caldwell, Logan, Lyon, Todd, and Trigg counties in Kentucky, and from Montgomery County, Tennessee. Detailed accounts including data accompanying these specimens and records appear in appendixes A and B. Twenty breeding sites and 16 road collections were recorded from Caldwell, Christian, Logan, Lyon, Todd, and Trigg counties in Kentucky and from Montgomery and Robertson counties in Tennessee (figure 2). Seven breeding sites were permanent ponds (mostly used by cattle) and 13 were temporary or semi-permanent flooded sinks in barley, corn, or wheat fields.

The temporary sinks generally had mud bottoms and, when visited, most had grain stubble floating on and emerging from shallow water and present around the shoreline. The permanent ponds also had mud bottoms with fescue growing along the shore. From about mid-summer until fall herbaceous vegetation was observed along the shores of these sites. More detailed descriptions of all sites can be found in appendix D.

Generally, aquatic and emergent vegetation was sparse at breeding sites. However, of that observed, green algae (Chlorophyta) appeared to be the most abundant aquatic plant,

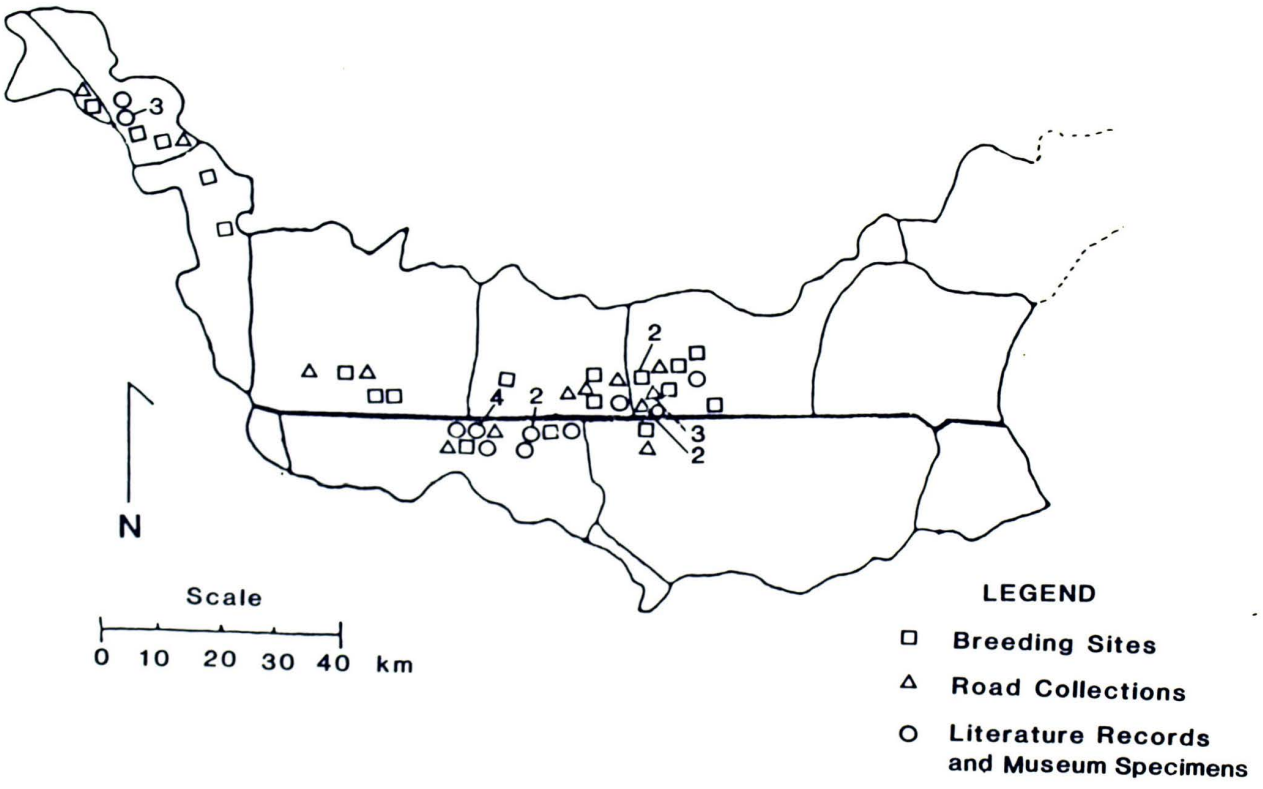

Figure 2. Localities in the Pennyroyal Plain where Hyla gratiosa has been documented. Numerals indicate multiple localities that are too close together to be resolved at this scale. (See appendixes A-F for more information on these sites.

usually growing along the bottom. Black willow (Salix nigra) appeared to be the most abundant emergent plant, being found mainly in the permanent and semi-permanent ponds.

Other vertebrates observed utilizing breeding sites were Acris crepitans, Ambystoma tigrinum, Bufo woodhousei fowleri, Chelydra serpentina, Gastrophyrne carolinensis, Hyla crucifer, H. versicolor complex, Ictalurus melas, Notophthalmus viridescens, Pseudacris triseriata, Pseudemys scripta elegans, Rana catesbeiana, R. clamitans, and R. sphenocephala. An account of the sites from which each of these was taken appears in appendix E.

Averages for air temperature, water temperature, dissolved oxygen, and pH recorded at all breeding sites are given in table 1. Individual readings of these physical parameters for each site are presented in appendix F.

During 1983, Hyla gratiosa was first observed on 20 May and last seen on 26 July; during 1984, 18 May and 28 August were the earliest and latest dates in which activity was recorded (figure 3). Calling was first heard on 8 June in 1983 and on 18 May in 1984 and was last recorded on 26 July in 1983 and 15 July in 1984. Juvenile individuals (27 mm to 41 mm SVL) were encountered on roads near breeding sites from 25 June to 28 August in 1984 (appendix C). With few exceptions, calling was limited to the period between 2100 and 2400 CDT.

Table 1. Means, standard deviations, and ranges of air temperature, water temperature, dissolved oxygen, and pH values recorded at Hyla gratiosa breeding sites in the Pennyroyal Plain between 8 June and 26 July of 1983 and 18 May and 15 July of 1984.

	N*	Mean	Standard deviation	Range
Air temperature	26	24.2°C	3.3	17-32°C
Water temperature	23	27.0°C	1.5	24-29°C
Dissolved oxygen	15	8 ppm	2.5	2.5-12.0 ppm
pH	11	7.3	1.3	5.0-9.2

*Number of readings

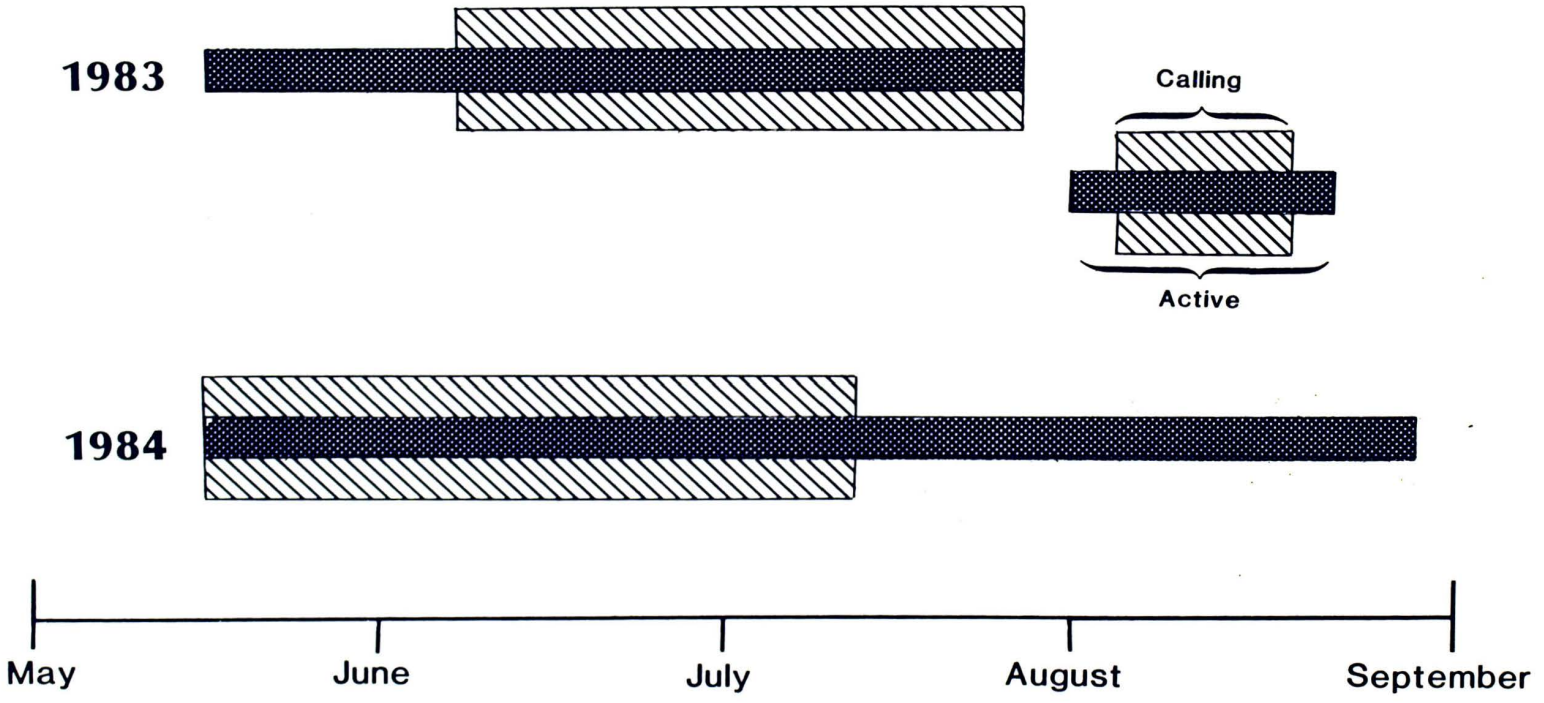

Figure 3. Durations of calling and activity periods observed for Hyla gratiosa in the Pennyroyal Plain during 1983 and 1984.

From one to eight males (mean 3.3 ± 2.00 SD) were heard calling at each site (appendix F). They were routinely observed in an inflated condition at the surface of shallow water, two to 120 cm deep (mean 28.0 cm ± 23.40 SD), usually among grain stubble within 5.2 m (± 5.90 SD, range 0-20 m) of the water's edge.

Only one female was encountered at a breeding site. This occurred on 19 June 1983 in Christian County, Kentucky at a flooded sink in a wheatfield on the south side of Featrace Lane, 1.0 km west of its junction with Kentucky 345. She was observed in axillary amplexus floating at the surface of shallow water (20 cm deep) among floating wheat stubble, 5 m from the water's edge. Three additional females were encountered on roads. These were found on 24 May 1983, 17 June 1983, and 19 August 1984. Data accompanying each of these collections can be found in appendix C.

The snout-vent lengths and tibia lengths of all individuals combined averaged 47.6 mm (± 13.15 SD, range 27.0-75.0 mm) and 21.2 mm (± 4.80 SD, range 13.0-27.0 mm), respectively. For males these values were 56.2 mm (± 6.38 SD, range 45.0-61.0 mm) and 24.3 mm (± 2.10 SD, range 20.0-27.0 mm) and the females measured 57.5 mm (± 0.71 SD, range 57.0-58.0 mm) and 25.3 mm (± 0.35 SD, range 25.0-25.5 mm). Juveniles had average snout-vent lengths of 31.7 mm (± 4.35 SD, range 27.0-41.0 mm) and average tibia lengths of 15.3 mm (± 2.20 SD, range 13.0-19.0 mm).

CHAPTER 5

Discussion

Breeding Sites

Breeding sites tended to be clustered in the central Pennyroyal in southeastern Todd County and southwestern Logan County, Kentucky and in northeastern Montgomery County and northwestern Robertson County, Tennessee. From there they were found scattered along a line running through the western Pennyroyal from south-central Christian County, Kentucky to southeastern Lyon County, Kentucky. Extensive searching eastward through Simpson County, Kentucky and Robertson County, Tennessee failed to reveal any breeding sites, despite the presence of what appeared to be favorable habitat. Additional work in these areas may yet reveal the species' presence.

In the part of Hyla gratiosa's range outside the Pennyroyal Plain, breeding has been observed in a wide variety of habitats. Wright (1932), and Wright and Wright (1949) found them breeding in temporary, semi-permanent, or permanent, open ponds located within pine barrens, cypress woods, and flooded cornfields. They were also found in cypress woods by Allen (1932), Neill (1952), and Oldham and Gerhardt (1975) and in flooded cornfields by Jobson (1940). Black and Gosner (1958) found breeding activity in a permanent pond encircled by deciduous woods. Other breeding

individuals have been found in a swamp, a small grassy pond, a flooded sand pit (Funderburg 1953, 1955), a semi-permanent pond with dense undergrowth (Cahn 1939), a small permanent woodland pond (Goin 1938), a natural pond in a live-oak hammock (Neill 1958), and other types of ponds, swamps, and streams (Blem and Miller 1980, Brandt 1933, Martof 1954, McKeever 1977).

In the Pennyroyal Plain, however, breeding sites seem to be more uniform in character. Monroe and Giannini (1977) described the Caldwell County, Kentucky sites as a flooded slough containing several permanent wet areas with considerable submergent grass and weedy growth. Henderson's (1978) Montgomery County, Tennessee sites were generally permanent sinkholes and man-made ponds surrounded by pasture. The breeding sites in this study were generally open ponds with very little, if any, woody vegetation. The majority of them were temporary and semi-permanent flooded sinks found in grain fields, with the rest being permanent sink ponds, most of which were used by cattle.

Associated Species

Very little information exists on the other vertebrates that utilize the breeding habitat of *Hyla gratiosa*. However, Wright (1932) reported many vertebrates, predominately anurans, utilizing *Hyla gratiosa* breeding sites in the Okefenokee Swamp, Georgia. Cahn (1939) reported observing *Acris crepitans*, *A. gryllus*, *Bufo woodhousei fowleri*, *Hyla*

crucifer, H. versicolor, Rana catesbeiana, and R. sphenocephala at a breeding site in northern Alabama, and Black and Gosner (1958) reported observing Acris crepitans, Hyla versicolor, and Rana clamitans from a site in New Jersey. Except for A. gryllus, these same species were encountered sharing breeding sites with Hyla gratiosa in the Pennyroyal Plain. The observation of more frog species present than other vertebrates is probably due to the temporary nature of the breeding sites and to the fact that sites were usually visited in the evening during early to mid-summer when the frogs were breeding.

Fish were found at only one breeding site (appendix E). Several juvenile black bullheads, Ictalurus melas, were taken on 15 August 1983 from a nearly dry temporal pond where Hyla gratiosa had been heard calling earlier in the year. Mount (1975) suggested that permanent bodies of water containing fish are probably unsuitable breeding sites for Hyla gratiosa.

Environmental Variables

In Wright's (1932) study, the average minimum air temperature at which Hyla gratiosa began calling was 70°F (21°C), provided adequate rainfall had occurred, and the average maximum temperature at which they were heard calling was 91°F (32°C). Giannini (1983) found that rainfall and temperature were critical for breeding activity. He noted that if air temperature dropped below 18.9°C, calling

activity ceased, but if it was above 18.9°C calling resumed, with the most activity occurring when the temperature was at least 21.1°C. During this study calling activity was observed at an average temperature of 24.2°C, always following periods of rainfall.

Nothing has been published on the dissolved oxygen content, pH, or temperature of the water at Hyla gratiosa breeding sites.

Activity and Breeding Periods

Throughout its range, breeding activity of Hyla gratiosa has been recorded from early spring to late summer. Conant (1975), Oldham and Gerhardt (1975), and Wright and Wright (1949) reported breeding activity to occur from March to August. Deckert (1915) reported the breeding season to extend from March to June. Travis (1980) reported that breeding activity normally starts in early May and rarely continues after mid-June. Blem and Miller (1980) reported that the first warm rains of February or March will bring them to their breeding sites and that they breed throughout the summer. Brandt (1936) reported spring appearances as early as March and observed individuals remaining at the breeding sites as late as September.

For the Pennyroyal Plain, breeding activity has been reported to occur from late spring to mid-summer. Henderson (1978) heard calling in Mongtomery County, Tennessee during the month of July. Giannini (1983) observed activity in

Caldwell County, Kentucky from as early as 7 May in one year to as late as 29 July in another year. In the same study, calling was heard as early as 12 May in one year and as late as 20 June in another year. Giannini and MacGregor (personal communication) collected non-calling individuals in Caldwell County Kentucky on the 2nd and 3rd of August, 1983 (appendix A).

Based upon published data cited above and the results of this study, it appears that activity of adult Hyla gratiosa in the Pennyroyal Plain begins in early May and continues until at least the end of August. Breeding activity begins in mid-May and continues until the end of July. The activity of one- to two-year-old individuals appears to begin near the end of June and to continue until the end of August.

Henderson (1978) reported that the average hourly call duration for Hyla gratiosa during 1976 was 106.6 minutes and that for 1977 it was 31 minutes. He also reported calling from as early as 1930 to as late as 2330 CDT. Although this study did not record hourly call durations for any one site, calling was generally heard during the period of 2100 to 2400 CDT.

Number and Positioning of Breeding Individuals

Wright and Wright (1949) stated that breeding choruses including more than 20 to 25 males are not often seen. However, anywhere from one to 130 males have been reported at a single breeding site (Black and Gosner 1958, Blem and

Miller 1980, Cahn 1939, Funderburg 1953, Goin 1938, Henderson 1978, Monroe and Giannini 1977, Oldham and Gerhardt 1975). This study found from one to eight males calling at a single site.

Most male Hyla gratiosa have been reported calling in an inflated condition at the surface of shallow water, usually among aquatic vegetation (Bartlett 1981, Deckert 1915, Gerhardt 1974, Henderson 1978, Oldham and Gerhardt 1975). Goin (1938) found most of the breeding individuals near the water's edge, with few in open water. Neill (1952) reported finding them in ponds, and a few on bushes and tree trunks near the water, but never more than five feet off the ground. Black and Gosner (1958) observed calling males sitting on the leaves of the white water lily. Monroe and Giannini (1977) found calling males sitting on floating vegetation in water less than one meter deep, and Henderson (1978) reported that calling males were floating on the water (15.2 to 55.8 cm deep) among aquatic vegetation, anywhere from 0.5 to 2.1 m from the water's edge. This study revealed that males call while inflated at the surface of shallow water usually among floating grain stubble and that they may be anywhere from water's edge to 20 m out from shore.

Henderson (1978) in determining total population size of Hyla gratiosa at a breeding site assumed equal sex ratio. Goin (1938) collected 170 individuals from one breeding site; 40 were females and 130 were males. Only one female was

encountered at a breeding site during this study. This apparent shortage of females was likely an artifact resulting from the greater difficulty of locating nonvocal individuals.

Size of Individuals

Henderson (1978) reported that the average SVL of the *Hyla gratiosa* he studied was 57.7 mm (± 7.59 SD, range 49.2-74.6 mm). A somewhat lower average SVL of 47.6 mm (± 13.15 SD, range 27.0-75.0 mm) was observed in this study. The difference can be accounted for by the fact that several juveniles (27.0-41.0 mm SVL) were included in this study, thus lowering the overall average SVL of the sample. When these individuals are not included, the mean SVL for the males calculates to 56.2 mm and for the females, 57.5 mm, values that closely approximates that of Henderson's (1978).

CHAPTER 6

Conclusions

Based upon the information gathered during this study, the following conclusions can be drawn about the distribution and breeding habitat of the disjunct population of Hyla gratiosa occurring in south-central Kentucky and north-central Tennessee:

1. The distribution appears to be limited to the western half of the Pennyroyal Plain with breeding colonies most concentrated at the eastern end of the occupied area.

2. The typical breeding habitat for this population is a temporary or semi-permanent flooded sink in a grain field, usually with grain stubble as the only vegetation.

3. Other species of anurans are the primary cohabitants of breeding sites.

4. Given adequate rainfall, males call at air temperatures ranging from 17°C to 32°C with a mean of 24.2°C.

5. Depending on local weather, activity of adults begins sometime in early May and continues until around the end of July. Terrestrial activity of juveniles begins near the end of June and continues until the end of August.

6. Calling occurs in the late evening and lasts approximately three hours.

7. The number of calling males at any one site usually amounts to fewer than 10 individuals.

8. Males call in an inflated condition floating on the surface of shallow water among some sort of vegetation, very often grain stubble.

9. Although females appear to be considerably less numerous than males, they are probably present in numbers approximating that of the males, but are simply overlooked because they do not call and are well camouflaged.

CHAPTER 7

Summary

The distribution and the breeding habitat of a disjunct population of the barking treefrog (Hyla gratiosa) were studied in the Pennyroyal Plain region of Kentucky and Tennessee during the period of May through August, 1983 and 1984. A total of 20 breeding sites and 16 road collections was recorded from six Kentucky and two Tennessee counties. Most breeding took place in flooded sinks of corn, barley, and wheat fields. These sites typically had mud bottoms and grain stubble along the edge of the water and shoreline. Generally, the aquatic and emergent vegetation was sparse or absent.

Other vertebrates observed utilizing Hyla gratiosa breeding sites included 11 species of amphibians, two species of reptiles and one species of fish. Among these, anurans were by far the most abundant.

Averages for air temperature, water temperature, dissolved oxygen, and pH recorded at the various breeding sites while males were calling were 24.2°C, 27.0°C, 8 ppm, and 7.3, respectively.

During 1983, the species was first observed on 20 May and last seen on 26 July; during 1984, 18 May and 28 August were the earliest and latest dates activity was recorded. Calling was first heard on 8 June in 1983 and on 18 May in 1984; it

was last recorded on 26 July in 1983 and on 15 July in 1984. Juvenile individuals were encountered on roads near breeding sites from 25 June to 28 August in 1984. Calling was generally heard between 2100 and 2400 CDT.

An average of 3.3 (range 1-8) males were heard calling at each site. They were routinely observed in an inflated condition at the surface of shallow water (2-120 cm deep), usually among grain stubble and within 5.2 m of the water's edge.

Only one female was encountered at a breeding site during this study, but three were encountered on roads.

The average SVL and tibia length of the 34 individuals examined were 47.6 mm and 21.2 mm, respectively.

Information obtained in this study should help locate new breeding sites, serve as the basis for additional research on the Pennyroyal population, and aid in determining its status and needs for continued survival.

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APPENDIXES

Appendix A. Collection data pertaining to specimens of Hyla gratiosa examined. Sources included Austin Peay State University Museum of Zoology (APMZ), University of Louisville Museum (ULM), and John MacGregor's personal collection.

KENTUCKY

CALDWELL CO.

12 km SW Princeton, Kentucky (370027N 875312W); 2 specimens, ULM 6780-6781, 5 July 1976, Raymond W. Giannini.

Raymond Giannini's house (in basement) on Schoolhouse Rd. (KY 514), 1.1 mi W of KY 139; 1 juvenile, John MacGregor's personal collection, 2 August 1983, Raymond W. Giannini.

On mud in mowed wheat field, 0.5 mi off W side of KY 514, 1.5 mi W of KY 139; 1 specimen, John MacGregor's personal collection, 3 August 1983, John MacGregor, Raymond Giannini, and Marc Evans.

LOGAN CO.

1.6 mi N Keysburg at jct. of Prentiss-Lawrence and Prentiss-Keysburg Rd., on road at night after rain (364026N 870020W); 2 specimens, APMZ 2919, 20 May 1979, Floyd Scott.

0.6 mi E of Todd-Logan Co. line on KY Hwy 848, 11 air mi W of Adairville, on road in rain (363925N 870258W); 1 specimen, APMZ 2920, 20 May 1979, Floyd Scott, Mike Northington, Ronnie Harrison.

TODD CO.

5 mi S of Allensville, Kentucky; 3 specimens, ULM 4346-4348, 3 June 1971, Burt Monroe, Jr., Ralph Taylor; 1 specimen, ULM 4798, 18 May 1972, Burt Monroe, Jr.; 1 specimen, APMZ 3177, 12 June 1971, D. Harker, M. Silvey.

TENNESSEE

MONTGOMERY CO.

Rossview Rd., 4.2 mi W of its jct. with Port Royal Rd. (363347N 871328W); 1 specimen, APMZ 2922, 30 May 1979, Floyd Scott.

Dunbar Cave Rd., near Swan Lake spillway (363259N 871810W); 1 specimen, APMZ 1390, 16 May 1966, Floyd Scott, D. F. Harker; 1 specimen, APMZ 1392, 26 May 1967, D. F. Harker.

Port Royal Rd., 1.2 mi N of its jct. with Rossview Rd. (363540N 870934W); 1 specimen, APMZ 1391, 17 May 1966, Floyd Scott, D. F. Harker.

Appendix A (cont.)

L. C. Connell farm near St. Bethlehem (0.7 air mi S of Rossview; 363300N 871410W); 1 specimen, APMZ 3175, 8 June 1971, F. Scott, D. Harker, M. Silvey; 1 specimen, APMZ 3176, 7 June 1971, F. Scott, D. Harker, M. Silvey; 7 specimens, APMZ 3178, 11 June 1971, F. Scott, D. Harker, M. Silvey.

Appendix B. Literature records of Hyla gratiosa from the Pennyroyal Plain region of Kentucky and Tennessee.

KENTUCKY

CALDWELL CO.

12 km south of Princeton, Kentucky (370027N 875312W); (in barn), 1 specimen, ULM 6779, 3 July 1976; (in flooded slough 75 m from barn), 2 specimens, ULM 6780-6781, 5 July 1976 (Giannini 1983, Monroe and Giannini 1977).

Along Dry Creek approximately 50 m east of Highway 139S (370125N 875225W), two crossing Hwy 139S, one calling from creek, 29 July 1977 (Giannini 1983).

LYON CO.

Approximately 1-3 km from the first Caldwell Co. site (Giannini 1983).

TODD CO.

Breeding pond located five miles south of Allensville, Todd County, Kentucky; 3 specimens, UL 4346-4348, 3 June 1971 (Monroe and Taylor 1972).

TRIGG CO.

Approximately 1-3 km from the first Caldwell Co. site (Giannini 1983).

TENNESSEE

MONTGOMERY CO.

Mongtomery Co., TN; APMZ 1390-1392 (Scott and Harker 1968, Scott and Snyder 1968, Scott, Chester, and Snyder 1980).

Hammacksville Quadrangle, Peacher's Mill Road, 0.5 miles south of intersection with road to Clarksville Speedway (Needmore Road) (363733N 872227W); 7 May 1973 (Scott, Chester, and Snyder 1980).

Clarksville Quadrangle, Tennessee Highway 48 near junction with Hazelwood Road (363651N 871911W); 7 May 1973 (Scott, Chester, and Snyder 1980).

Sango Quadrangle, Rossview Road, 4.2 road miles west of junction with Port Royal Road (363347N 871328W); 1 adult male, (APMZ 2922), 30 May 1979, Floyd Scott (Scott, Chester, and Snyder 1980).

Appendix B (cont.)

Pond A, 3.1 km S of the Christian-Todd county border in Kentucky (363650N 872015W); (Henderson 1978).

Pond B, 2.1 km S of the Christian-Todd county border in Kentucky, 0.9 km northwest of Pond A (363720N 872015W); (Henderson 1978).

Pond C, 3.1 km S of the Christian-Todd county border in Kentucky, 27.4 m south of Pond A (363650N 872015W); (Henderson 1978).

Pond D, 0.8 km S of the Christian-Todd county border in Kentucky, 1.22 km northeast of Pond A and 0.55 km east of Pond B (based upon the map in Henderson's thesis the location should be 2 km S of the state line; 1.5 km NE of Pond A and 1.0 km east of Pond B; 363725N 871935W); (Henderson 1978).

Appendix C. Collection data pertaining to Hyla gratiosa specimens collected from the Pennyroyal Plain region of Kentucky and Tennessee during this study (see appendix D for breeding site localities).

KENTUCKY

CALDWELL CO.

SW side of KY 139, approx. 250 m from road, 3.2 km NW of its jct. with Hopson Rd. (breeding site #5; 370051N 875216W), flooded portion of corn field; 1 specimen (male; 56 mm SVL, 25 mm tibia length), APMZ 3611, 12 July 1984, D. E. VanNorman.

KY 126-128, at its jct. with KY 514 (365946N 874756W), alive on dry asphalt; 1 specimen (juvenile; 33 mm SVL, 16 mm tibia length), APMZ 3619, 21 August 1984, D. E. VanNorman.

CHRISTIAN CO.

KY 345, 2.3 km N of its jct. with KY 117 (364345N 873146W), dead on asphalt; 1 specimen (female), APMZ 3596, 17 June 1983, D. E. VanNorman.

S side of Featrace Ln., 1.0 km W of its jct. with KY 345 (breeding site #6; 364348N 873233W), temporary pond in wheat field; 2 specimens (male; 58 mm SVL, 26 mm tibia length; female; 57 mm SVL, 25.5 mm tibia length), APMZ 3597, 19 June 1983, D. E. VanNorman.

S side of KY 117, 1.0 km W of its jct. with US 41A (breeding site #7; 364143N 872750W), flooded corn field; 1 specimen (male; 59 mm SVL, 26 mm tibia length), APMZ 3602, 29 June 1983, D. E. VanNorman.

S side of KY 117, 0.3 km W of its jct. with US 41A (breeding site #8; 364145N 872725W), flooded corn field; 1 specimen (male; 55 SVL, 24.5 mm tibia length), APMZ 3603, 19 July 1983, D. E. VanNorman.

Zion Hope-Herndon Rd., 5.0 km W of its jct. with KY 107 (364420N 873710W), alive on asphalt; 1 specimen (juvenile; 36 mm SVL, 19 mm tibia length), APMZ 3615, 6 August 1984, D. E. VanNorman.

LOGAN CO.

Pond on S side of Smith Rd., at its jct. with the Dot-Tenn. State Line Rd.; 0.8 air km N of the KY-TN state line (breeding site #9; 363911N 865611W), cattle pond; 1 specimen (male; 58 mm SVL, 26 mm tibia length), APMZ 3599, 22 June 1983, D. E. VanNorman, A. F. Scott, G. Hale.

Appendix C (cont.)

James Rose Rd., 0.2 km E of KY 102 (364200N 870215W), alive on asphalt; 1 specimen (male; 50 mm SVL, 24 mm tibia length), APMZ 3604, 15 June 1984, D. E. VanNorman, A. F. Scott.

KY 848, 0.5 km E of the Todd-Logan county line (363921N 870316W), alive on asphalt; 1 specimen (male; 53 mm SVL, 23 mm tibia length), APMZ 3605, 15 June 1984, D. E. VanNorman, A. F. Scott.

S side of James Rose Rd., 1.6 km E of KY 102 jct. (breeding site #11; 364150N 870120W), flooded wheat field; 1 specimen (male; 51 mm SVL, 25 mm tibia length), APMZ 3606, 17 June 1984, D. E. VanNorman.

W side of KY 102, 0.2 km S of James Rose Rd. (breeding site #12; 364156N 870225W), permanent pond approx. 100 m from road; 1 specimen (male; 45 mm SVL, 20 mm tibia length), APMZ 3607, 18 June 1984, D. E. VanNorman.

SE side of KY 102, 0.9 air km S of the jct. of KY 102 and James Rose Rd. (breeding site #13; 364134N 870231W), flooded portion of wheat field; 1 specimen (male; 52 mm SVL, 24 mm tibia length), APMZ 3608, 25 June 1984, D. E. VanNorman.

In flooded sink, 0.3 km off N side of James Rose Rd., 3.2 km E of jct. with KY 102 (breeding site #14; 364206N 870025W), in barley field; 1 specimen (male; 49 mm SVL, 22 mm tibia length), APMZ 3609, 25 June 1984, D. E. VanNorman.

KY 102, 1.1 km S of James Rose Rd. (next to breeding site #10; 364133N 870156W), on road next to flooded portion of barley field; 3 specimens (juveniles; 27 mm SVL, 14 mm tibia length; 28 mm SVL, 13 mm tibia length; 28 mm SVL, 13 mm tibia length), APMZ 3610, 25 June 1984, D. E. VanNorman.

KY 102, 2.3 km S of its jct. with James Rose Rd. (364104N 870130W), alive on asphalt; 1 specimen (juvenile; 33 mm SVL, 16 mm tibia length), APMZ 3613, 31 July 1984, D. E. VanNorman; 1 specimen (juvenile; 41 mm SVL, 19 mm tibia length), APMZ 3616, 14 August 1984, D. E. VanNorman.

KY 102, 4.2 km S of James Rose Rd. (364005N 870129W), alive on asphalt; 1 specimen (juvenile; 28 mm SVL, 14 mm tibia length), APMZ 3617, 14 August 1984, D. E. VanNorman.

Appendix C (cont.)

LYON CO.

KY 730, 0.8 km W of KY 903 (370035N 875649W), alive on asphalt; 2 specimens (juveniles; 28 mm SVL, 13 mm tibia length; 29 mm SVL, 14 mm tibia length), APMZ 3612, 12 July 1984, D. E. VanNorman.

TODD CO.

KY 848, 0.8 km E of the US 79-KY 848 jct. (364027N 870830W), alive on N side of wet road; 1 specimen, John MacGregor's personal collection, 20 May 1983, John MacGregor, D. E. VanNorman.

KY 848, 1.0 km E of jct. of Allison Rd. and KY 848 (363936N 870650W), middle of road on wet asphalt; 1 specimen (male; 57 mm SVL, 26 mm tibia length), APMZ 3592, 20 May 1983, D. E. VanNorman, John MacGregor.

KY 848, 2.4 km E of its jct. with L and N RR (Hadensville) (363933N 870638W), dead on wet pavement; 1 specimen, APMZ 3593, 20 May 1983, D. E. VanNorman, John MacGregor.

E corner of the jct. of Snaden Mill Rd. and US Hwy 79 (breeding site #17; 364147N 870717W), flooded wheat field; 1 specimen (male; 61 mm SVL, 27 mm tibia length), APMZ 3598, 21 June 1983, D. E. VanNorman.

E side of Co. Rd. 1802, 0.2 km N of its jct. with Jack Gray Rd.; 4.0 air km S of Trenton, KY (breeding site #18; 364113N 871539W), flooded corn field; 1 specimen (male; 60 mm SVL, 25 mm tibia length), APMZ 3601, 28 June 1983, D. E. VanNorman.

Allensville-Tenn. State Line Rd., 2.4 km S of its jct. with KY 102 (Allensville) (364145N 870405W), alive on wet asphalt; 1 specimen (juvenile; 35 mm SVL, 17 mm tibia length), APMZ 3614, 26 July 1984, D. E. VanNorman.

TRIGG CO.

Pond on W side of Hwy 1507, 0.2 km N of its jct. with KY 958; 6.4 air km S of the jct. of KY 126 and 124 (Cerulean) (breeding site #19; 365403N 874241W), located in wheat field; 1 specimen (male; 49 mm SVL, 21 mm tibia length), APMZ 3595, 15 June 1983, D. E. VanNorman, A. F. Scott, J. Koons, K. Souza.

Appendix C (cont.)

TENNESSEE

MONTGOMERY CO.

Hazelwood Rd., 1.6 km W of its jct. with TN 48 (363645N 872013W), dead on asphalt; 1 specimen (female), APMZ 3594, 24 May 1983, D. E. VanNorman.

Guthrie Ln. (Co. Rd. 6317), 1.8 km SW of the TN-KY state line (Jim Johnson Rd.) (363821N 871602W), alive on dry asphalt; 1 specimen (female; 58 mm SVL, 25 mm tibia length), 19 August 1984, D. E. VanNorman.

ROBERTSON CO.

W side of Keysburg Rd., 3.5 road km SW of the KY-TN state line; 6.0 air km NNE of Adams P.O. (breeding site #3; 363748N 870220W), flooded barley field; 1 specimen (male; 60 mm SVL, 25 mm tibia length), APMZ 3600, 26 June 1983, D. E. VanNorman.

Keysburg Rd., 4.8 road km S of the TN-KY state line (363721N 870255W), alive on asphalt; 1 specimen (juvenile; 34 mm SVL, 16 m tibia length), APMZ 3620, 28 August 1984, D. E. VanNorman.

Appendix D. Location and description of Hyla gratiosa breeding sites examined during this study in the Pennyroyal plain region of Kentucky and Tennessee (dates visited follow descriptions).

Site No. 1 Montgomery Co., TN; large cattle pond on S side of Rossview Rd. (370 m from road), 5.3 km W of its jct. with Port Royal Rd. (363350N 871234W); mud bottom, shoreline muddy with scattered fescue; surrounding area in pasture; pond spring fed from cave on N side (spring surrounded by trees); 8 and 9 June 1983.

Site No. 2 Montgomery Co., TN; flooded portion of corn field on S side of Hazelwood Rd., 1.6 km E of Needmore Rd. (363644N 872010W); mud bottom, shoreline muddy with corn and other terrestrial herbaceous vegetation; two islands with terrestrial vegetation near the middle; woods on E side; 23 and 24 June 1984.

Site No. 3 Robertson Co., TN; flooded portion of barley field on the W side of Keysburg Rd., 3.5 road km SW of the KY-TN state line; 6.0 air km NNE of the Adams P.O. (363748N 870220W); bottom and shoreline littered with barley stubble, trees growing near middle of pond; 25 and 26 June 1983.

Site No. 4 Caldwell Co., KY; large cattle pond on NW side of KY 514, 1.3 km SW of KY 126-128 (365918N 874815W); mud bottom, shoreline muddy with scattered fescue; surrounding area in pasture; 10 July 1984.

Site No. 5 Caldwell Co., KY; flooded portion of corn field on SW side of KY 139 (approximately 250 m from road), 3.2 km NW of its jct. with Hopson Rd. (370051N 875216W); mud bottom, with shoreline and surrounding area in corn; 10 and 12 July 1984.

Site No. 6 Christian Co., KY; temporary pond in wheat field on the S side of Featrace Ln., 1.0 km W of its jct. with KY 345 (364348N 873233W); bottom and shoreline littered with wheat stubble; green algae (Chlorophyta) growing on bottom; corn and tobacco fields, and another sink nearby; 19 June 1983.

Site No. 7 Christian Co., KY; flooded portion of corn field on the S side of KY 117, 1.0 km W of its jct. with US 41A (364143N 872750W); bottom and shoreline littered with previous year's corn

stubble; green algae (Chlorophyta) growing along bottom; 29 June 1983, 19 July 1983.

Site No. 8 Christian Co., KY; flooded portion of grain field on the S side of KY 117, 0.3 km W of its jct. with US 41A (364145N 872725W); bottom and shoreline littered with previous year's corn stubble and surrounding area in pasture; Heteranthera limosa growing along the shore and water's edge, and green algae (Chlorophyta) growing on bottom; 18 and 19 July 1983.

Site No. 9 Logan Co., KY; cattle pond on the S side of Smith Rd. at its jct. with the Dot-Tenn. State Line Rd.; 0,8 air km N of the KY-TN state line (363911N 865611W); mud bottom, with two-thirds of the shoreline bordered by trees, and the rest made up of mud and grass; island located in the middle with two or three trees and some black willow (Salix nigra) growing on it; duckweed (Lemaceae) growing on surface of the water; 22 June 1983.

Site No. 10 Logan Co., KY; flooded portion of barley field just off E side of KY 102, 1.1 km S of its jct. with James Rose Rd. (364133N 870156W); bottom and shoreline muddy except for area along roadside which supported terrestrial herbaceous vegetation; surrounding area with barley stubble and other flooded sinks; green algae (Chlorophyta) growing along the bottom; 17, 18 and 25 June 1984.

Site No. 11 Logan Co., KY; flooded portion of wheat field on the S side of James Rose Rd., 1.6 km E of its jct. with KY 102 (364150N 870120W); shoreline muddy with some wheat stubble; surrounding area in wheat; 17 June 1984.

Site No. 12 Logan Co., KY; permanent pond on W side of KY 102 (approximately 100 m from the road in a hay field), 0.2 km S of its jct. with James Rose Rd. (364156N 870225W); sloping shoreline with pin oak (Quercus palustris), cottonwood (Populus deltoides), black locust (Robinia pseudoacacia), and black willow (Salix nigra); green algae (Chlorophyta) growing on bottom; 17 and 18 June 1984.

Appendix D (cont.)

Site No. 13 Logan Co., KY; flooded portion of wheat field on SE side of KY 102, 0.9 air km S of the jct. of KY 102 and James Rose Rd. (364134N 870231W); wheat stubble along the edge of water and the shoreline; surrounding area in wheat and corn; 25 June 1984.

Site No. 14 Logan Co., KY; flooded sink in barley field, 0.3 km off N side of James Rose Rd., 3.2 km E of jct. with KY 102 (364206N 870025W); terrestrial herbaceous vegetation around the water's edge and shore; surrounding area in barley with other flooded sinks nearby; 25 June 1984.

Site No. 15 Lyon Co., KY; permanent pond, approximately 190 m from the S side of KY 730, 0.8 km W of KY 903 (370027N 875649W); most of the shore made up of terrestrial herbaceous vegetation with black willow (Salix nigra) growing along the south shore; buttonbush (Celphalanthus occidentalis) growing five to 10 m from shore and aquatic vegetation growing on bottom; 12 and 13 July 1984.

Site No. 16 Todd Co., KY; semi-permanent pond on S side of KY 848 (430 m from road), 1.3 km E of its jct. with Allison Rd. (363923N 870615W); 20 and 21 June 1983.

Site No. 17 Todd Co., KY; flooded wheat field on E corner of the jct. of Snaden Mill Rd. and US Hwy 79 (364147N 870717W); bottom and shoreline covered with wheat stubble; fenceline along NE side of highway along NW and SW side, and drainage ditch along NE side; 21 June 1983.

Site No. 18 Todd Co., KY; flooded field on Co. Rd. 1802, 0.2 km N of its jct. with Jack Gray Rd.; 4.0 air km S of Trenton, KY (364113N 871539W); corn stubble floating on surface of water; steep sloping shore (1 m wide) between east side of road and water's edge covered with trumpet creeper (Campsis radicans), elm saplings (Ulmus) and sawgrass; 8 June 1983, 18 July 1983.

Site No. 19 Trigg Co., KY; permanent pond on W side of Hwy 1507, 0.2 km N of its jct. with KY 958; 6.4 air km S of the jct. of KY 126 and KY 124 at Cerulean (365403N 874241W); shoreline and surrounding area a wheat field bordered by

Appendix D (cont.)

terrestrial herbaceous vegetation; green algae (Chlorophyta) growing on bottom and at surface; 15 June 1983.

Site No. 20 Trigg Co., Ky; permanent pond on the W side of Montgomery Rd., 1.1 km S of its jct. with Montgomery-H. Thomas Rd.; 4.7 air km NW of Caledonia, KY (365122N 874327W); mud bottom, with shoreline surrounded predominately by terrestrial herbaceous vegetation with large black willows (Salix nigra) bordering south end; corn also growing around the pond; green algae (Chlorophyta) growing in water; 9 July 1984.

Appendix E. Other vertebrates observed utilizing *Hyla gratiosa* breeding sites during the study period. Site numbers are indicated in parentheses (see appendix D for site locations and descriptions).

Osteichthyes

Cypriniformes

Ictaluridae

Ictalurus melas (6)

Amphibia

Caudata

Ambystomatidae

Ambystoma tigrinum (19)

Salamandridae

Notophthalmus viridescens (19)

Anura

Ranidae

Rana catesbeiana (1), (2), (3), (7), (9), (13), (14), (15), (17), (18), (19), (20)

Rana clamitans (8)

Rana sphenocephala (1), (6), (8), (12), (18), (19)

Bufonidae

Bufo woodhousei fowleri (1), (2), (3), (6), (7), (8), (11), (13), (14), (17), (18), (19), (20)

Hylidae

Acris crepitans (1), (2), (3), (4), (5), (6), (7), (9), (10), (11), (12), (13), (14), (15), (16), (17), (18), (19), (20)

Hyla crucifer (1)

Hyla versicolor (complex) (1), (2), (3), (6), (7), (10), (11), (12), (13), (14), (16), (18), (20)

Appendix E. (cont.)

Pseudacris triseriata (1)

Microhylidae

Gastrophyrne carolinensis (2), (3), (5), (6), (17), (18)

Reptilia

Testudinata

Chelydridae

Chelydra serpentina (12)

Emydidae

Pseudemys scripta elegans (12), (18)

Appendix F. Air temperature, water temperature, dissolved oxygen, pH, and number of males observed calling each time a breeding site was visited (see appendix D for locations and descriptions of sites).

Site no.	Date(s) visited	Air temperature (°C)	Water temperature (°C)	Dissolved oxygen (ppm)	pH	Number of calling males
1.	8 June 1983	17.0	ND*	ND	ND	ND
	9 June 1983	20.0	ND	ND	ND	ND
2.	23 June 1984	24.0	24.0	7.0	ND	2
	24 June 1984	21.0	25.0	7.0	ND	2
3.	26 June 1983	27.0	29.0	ND	ND	5
4.	10 July 1984	27.0	27.0	7.0	8.0	1
5.	10 July 1984	25.0	26.0	7.0	ND	4
	12 July 1984	22.0	26.0	ND	ND	3
6.	19 June 1983	22.0	25.0	ND	ND	5
7.	29 June 1983	26.0	28.0	ND	ND	8
	19 July 1983	25.0	28.0	2.5	7.2	6

Appendix F. (cont.)

Site no.	Date(s) visited	Air temperature (°C)	Water temperature (°C)	Dissolved oxygen (ppm)	pH	Number of calling males
8.	18 July 1983	24.0	27.0	12.0	7.3	1
	19 July 1983	29.0	29.0	12.0	7.0	3
9.	22 June 1983	23.0	27.0	ND	ND	2
10.	18 June 1984	28.0	28.0	6.0	9.0	1
11.	17 June 1984	28.0	26.0	8.0	6.9	5
12.	18 June 1984	25.0	29.0	7.0	ND	3
13.	25 June 1984	23.0	26.0	9.0	9.2	2
14.	25 June 1984	21.0	26.0	7.0	5.5	2
15.	13 July 1984	22.0	29.0	7.0	5.0	2
16.	20 June 1983	22.0	ND	ND	ND	ND
17.	21 June 1983	23.0	27.0	ND	ND	2
18.	28 June 1983	32.0	27.0	ND	ND	6
	18 July 1983	27.0	29.0	9.0	7.8	6

Appendix F. (cont.)

Site no.	Date(s) visited	Air temperature (°C)	Water temperature (°C)	Dissolved oxygen (ppm)	pH	Number of calling males
19.	15 June 1983	21.0	25.0	ND	ND	2
20.	9 July 1984	25.0	29.0	12.0	8.0	2
Mean (N)**		24.2 (26)	27.0 (23)	8.0(15)	7.3 (11)	3.3 (23)
Standard deviation		3.3	1.5	2.5	1.3	2.0

*Not Determined
**(N)=Number of samples