

young hatch as miniature froglets (Lazell, 1989; Bartlett and Bartlett, 1999a). Development may be accelerated by warmer temperatures, with hatching occurring as early as 13 d post-deposition (Lazell, 1989). Lazell (1989) notes that hatching appears to be most successful with 100% humidity.

i. Brood sites. Eggs are laid on the ground under moist cover (Lazell, 1989), but females are not known to brood (Goin, 1947a).

ii. Parental care. None (Goin, 1947a).

D. Juvenile Habitat. Humid areas that provide cover, such as leaf mold, flower beds, and moist litter (Goin, 1947a; Carr and Goin, 1955).

E. Adult Habitat. Same as juveniles; adults are found in humid habitats that provide cover (Carr, 1940a). Greenhouse frogs are particularly common in gardens, greenhouses, nurseries, and other moist substrates (Goin, 1944; Bartlett and Bartlett, 1999a). These frogs will hide beneath leaf litter, mulch, boards, or stepping stones (Carr, 1940a; Bartlett and Bartlett, 1999a). Greenhouse frogs are also found outside of human influence in suitable natural habitats (Butterfield et al., 1997). They are secretive and nocturnal except on warm, overcast, or rainy days (Carr, 1940a; Bartlett and Bartlett, 1999a).

F. Home Range Size. Unknown.

G. Territories. Unknown.

H. Aestivation/Avoiding Desiccation. Unknown.

I. Seasonal Migrations. None.

J. Torpor (Hibernation). In late March in the southern Everglades of Florida, greenhouse frogs have been found hibernating underneath the loose bark of wild tamarind (*Lysiloma* sp.), a small tree common in the hammocks (Harper, 1935).

K. Interspecific Associations/Exclusions. Greenhouse frogs are found under the same cover objects as eastern narrow-mouthed toads (*Gastrophryne carolinensis*; Carr, 1940a; personal observations) and in the same habitats as many small fossorial and semi-fossorial amphibians and reptiles (Dalrymple, 1988; Conant and Collins, 1998; Meshaka et al., 2000; Meshaka and Layne, 2002, 2005), with which they may or may not compete.

L. Age/Size at Reproductive Maturity. Sexually mature male greenhouse frogs range in size from 15.0–17.5 mm SVL; females range from 19.5–25.0 mm SVL (Bartlett and Bartlett, 1999a). Lazell (1989) records a large adult measuring 32 mm. Sexual maturity is reached in 1 yr (Goin, 1947a; Duellman and Schwartz, 1958).

M. Longevity. Unknown.

N. Feeding Behavior. In order of occurrence, greenhouse frogs eat ants, beetles, and roaches, but include other types of small invertebrates (Goin, 1947a; Duellman and Schwartz, 1958; Lazell, 1989). In Jamaica, diet did not include roaches, but

animals ate numerous ants, mites, spiders, and longlegs (Stewart, 1979).

O. Predators. In the Everglades, greenhouse frogs are eaten by Cuban treefrogs (*Osteopilus septentrionalis*) and ring-necked snakes (*Diadophis punctatus*; Wilson and Porras, 1983; Meshaka, 1994, 2001; Meshaka et al., 2004).

P. Anti-Predator Mechanisms. Unknown.

Q. Diseases. Unknown.

R. Parasites. None reported in the United States.

4. Conservation.

Greenhouse frog populations appear to be stable across much of their native range. They have been rapidly expanding their distribution up peninsular Florida and along the Gulf Coast and have been introduced in Hawaii on Hawaii Island and Oahu, where they are considered an invasive species (Bartlett and Bartlett, 1999a; Kraus et al., 1999; Meshaka et al., 2004; M. Stewart, personal communication). Greenhouse frogs are locally abundant and occur across a wide range of habitats and regions in Florida (Carr, 1940a; Dalrymple, 1988; Lips, 1991; Meshaka et al., 2000). In this connection, greenhouse frogs have the potential to compete for food with lizards such as reef geckos (*Sphaerodactylus notatus*) and mole skinks (*Eumeces egregius*), which are already threatened because they are habitat specialists and their habitat is rapidly disappearing.

Leptodactylus fragilis Brocchi, 1877

WHITE-LIPPED FROG

W. Ronald Heyer

Author's note: *Leptodactylus fragilis* has been cited historically as either *L. albilabris* (e.g., Metcalf, 1923, in part) or *L. labialis* (e.g., Mulaik, 1937; Maslin, 1963a,b; Dixon and Heyer, 1968; Heyer, 1971;

Villa, 1972; Meyer and Foster, 1996; Levell, 1997; McCranie and Wilson, 2002).

1. Historical versus Current Distribution.

White-lipped frogs (*Leptodactylus fragilis*) are known throughout lowland Middle America to the north coast of South America as far as Venezuela (Heyer, 1978, 2002). In the United States, these frogs marginally occur in southernmost Texas, specifically in the extreme southern edge of the Lower Rio Grande Valley (Garrett and Barker, 1987). They are known historically from one locality in Cameron County, two localities in Hidalgo County, and one locality from Starr County (Heyer, 1978). Dixon (1987, 1996) reported no new localities.

2. Historical versus Current Abundance.

Dixon (1987, p. 66) commented: "This frog may be extirpated from Texas through the continuous dispersal of organophosphate chemicals in the Rio Grande Valley."

3. Life History Features.

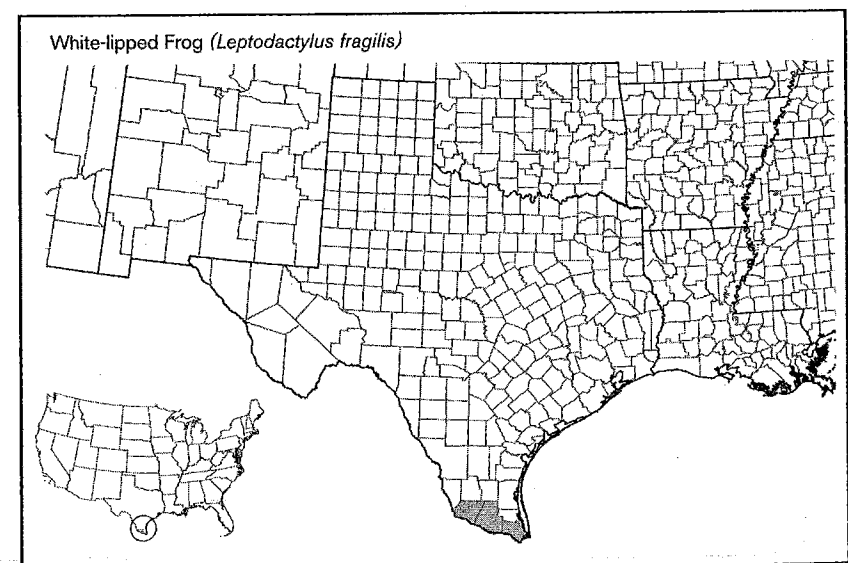
A. Breeding.

i. Breeding migrations. Males have been found calling under clumps of grass, dirt clods, and from small depressions (Garrett and Barker, 1987).

ii. Breeding habitat. Brooding chambers, excavated by males, are found under rocks, logs, or debris in clay soil (Dixon and Heyer, 1968). Dixon and Heyer (1968) note that these chambers may contain calling males or foam nests.

B. Eggs.

i. Egg deposition sites. Eggs are laid in foam nests, created by body secretions, in small brooding chambers excavated by adults (Maslin, 1963a,b; Garrett and Barker, 1987). The foam aids in preventing desiccation of the eggs during development (Garrett and Barker, 1987).



ii. Clutch size. A foam nest from Texas contained 86 yellow eggs (Mulaik, 1937). Villa (1972, p. 122) reported 25–250 eggs/nest.

C. Larvae/Metamorphosis. Early development takes place in the foam nests within the brooding chamber; larvae are released to ponds during heavy rains (Dixon and Heyer, 1968).

i. Length of larval stage. Mulaik (1937) reported a larval duration of 30–35 d in a Texas population. Meyer and Foster (1996) state that in Belize the tadpoles usually metamorphose in <2 wk.

ii. Larval requirements. Unknown.

iii. Larval polymorphisms. None.

iv. Features of metamorphosis. See "Length of larval stage" above.

v. Post-metamorphic migrations. Unknown.

D. Juvenile Habitat. Likely the same as adults.

E. Adult Habitat. Adult white-lipped frogs have been found in a variety of habitats where moisture is sufficient (Garrett and Barker, 1987). These frogs can be found in semi-permanent water bodies such as prairie potholes, oxbow lakes, and resacas (Edwards et al., 1989). Garrett and Barker (1987) note that white-lipped frogs may be encountered in irrigated agricultural fields, irrigation ditches, low grasslands, and runoff areas. These frogs are nocturnally active and may hide in burrows during the day (Garrett and Barker, 1987).

F. Home Range Size. Unknown.

G. Territories. Males call in association with incubating chambers (Dixon and Heyer, 1968) and would be expected to defend these sites from other males, although this has yet to be documented.

H. Aestivation/Avoiding Desiccation. Unknown.

I. Seasonal Migrations. Unknown.

J. Torpor (Hibernation). Unknown and unlikely.

K. Interspecific Associations/Exclusions. Unknown.

L. Age/Size at Reproductive Maturity. Males reach a maximum length of 36 mm SVL, females 40 mm SVL (Heyer, 1971).

M. Longevity. Unknown.

N. Feeding Behavior. White-lipped frogs forage nocturnally in open areas (Garrett and Barker, 1987).

O. Predators. Unknown.

P. Anti-Predator Mechanisms. Unknown.

Q. Diseases. Unknown.

R. Parasites. Metcalf (1923) reported the ciliate opalinid *Zelleriella leptodactyli* from specimens from Tehuantepec, Mexico.

4. Conservation.

Listed as Threatened, and therefore protected, by the State of Texas (Levell, 1997; www.tpwd.state.tx.us). Historically, white-lipped frogs are known from one locality in Cameron County, two localities in Hidalgo County, and one locality from Starr

County (Heyer, 1978; see above). Dixon (1987, 1996) reported no new localities and comments (1987, p. 66) "This frog may be extirpated from Texas through the continuous dispersal of organophosphate chemicals in the Rio Grande Valley."

McCranie and Wilson (2002, p. 533) state that white-lipped frogs are of low vulnerability in at least parts of their distribution.

Family Microhylidae

Gastrophryne carolinensis (Holbrook, 1836)
EASTERN NARROW-MOUTHED TOAD

Joseph C. Mitchell, Michael J. Lannoo

1. Historical versus Current Distribution.

Eastern narrow-mouthed toads (*Gastrophryne carolinensis*) occur in the southeastern and lower midwestern United States, from Maryland south to the Florida Keys, west to central Texas, and north to Kentucky, southern Illinois, southern Missouri, and extreme southeastern Nebraska (Carr, 1940a; Wright and Wright, 1949; Duellman and Schwartz, 1958; Nelson, 1972c; Harris, 1975; Martof et al., 1980; Ashton and Ashton, 1988; Dundee and Rossman, 1989; Conant and Collins, 1991; Redmond and Scott, 1996; Bartlett and Bartlett, 1999a; Mitchell and Reay, 1999; Phillips et al., 1999; Dixon, 2000; Johnson, 2000). Minton (2001) speculated that this anuran may occur in Indiana. They reach elevations to 549 m in the Smoky Mountains National Park (Huheey and Stupka, 1967), although they are absent from most of the Blue Ridge Mountains and the Appalachian region north of Tennessee (Redmond and Scott, 1996). Nelson (1972c) noted that they occur as high as 732 m in Oklahoma. Eastern narrow-mouthed toads also occur on numerous barrier islands in the Gulf Coast and off the southeastern Atlantic Coast (En-

gles, 1952; Blaney, 1971; Gibbons and Coker, 1978; Braswell, 1988; Learn et al., 1999). The disjunct population in southeastern Iowa may be extirpated (Klimstra, 1950; Nelson, 1972c).

2. Historical versus Current Abundance.

Eastern narrow-mouthed toads are solitary, secretive, and common throughout Alabama (Mount, 1975), Florida (Carr, 1940a), and Louisiana (Penn, 1943; Anderson, 1954), and locally common in Illinois (Phillips et al., 2000) and Virginia (Hoffman and Mitchell, 1996). Eastern narrow-mouthed toads are commonly captured in drift fences with pitfall traps (Gibbons and Bennett, 1974; Buhlmann et al., 1994; Enge, 1997). Some studies have revealed large numbers in local populations (e.g., Bennett et al., 1980; Gibbons and Semlitsch, 1981; Dodd, 1992, 1995b), although annual variation in numbers encountered varies among sites and years (Dodd, 1995b; Semlitsch et al., 1996; Enge, 1997).

Abundance estimates or counts are highly dependent on the sampling technique used. Funnel traps along drift fences revealed few individuals in a study in northern Florida (Vickers et al., 1985). Lamb et al. (1998) reported only 19 eastern narrow-mouthed toads among 1,070 frogs encountered under coverboards in a North Carolina floodplain. Coverboards in South Carolina produced few captures, whereas drift fences with pitfall traps yielded thousands of captures over the same time period (Grant et al., 1992). However, Grant et al. (1994) recorded high numbers of narrow-mouthed toads under coverboards in different aged pine stands. Other studies reporting high numbers of captures using drift fences with pitfall traps include Bennett et al. (1980), Gibbons and Semlitsch (1981), Dodd (1992), Enge (1997), and Hanlin et al.

