

Catalogue of American Amphibians and Reptiles.

NELSON, CRAIG E. 1972. *Gastrophryne carolinensis*.*Gastrophryne carolinensis* (Holbrook)
Eastern narrow-mouthed toad*Engystoma carolinense* Holbrook, 1836:83, pl. 10 (11th in position; not pl. 2). Type-locality, "Charleston," South Carolina. Syntypes by museum records, Acad. Nat. Sci. Philadelphia 14455-57, 3 males (examined by author).*Stenocephalus carolinensis*: Tschudi, 1838:86.*Engystoma rugosum* Duméril and Bibron, 1841:744. Type-locality, "parties meridionales de l'America du Nord" [southern part of North America], restricted to "vicinity of Charleston," South Carolina, by Schmidt (1953). Type by museum records, Mus. Natl. Hist. Natur., Paris, 5032, sex not stated, collected by Barabino (not examined by author).*Gastrophryne rugosum*: Fitzinger, 1843:33.*Gastrophryne carolinensis*: Stejneger, 1910:166.*Gastrophryne carolinense*: Strecker, 1915:46.*Engystoma carolinensis*: Nieden, 1926:64.*Microhyla carolinensis*: Parker, 1934:126, 146-147.*Microhyla carolinensis carolinensis*: Hecht and Matalas, 1946:5-7.*Gastrophryne carolinensis carolinensis*: Carvalho, 1954:13.

- CONTENT. The species is monotypic.

- DEFINITION AND DIAGNOSIS. *Gastrophryne carolinensis* differs from *G. olivacea* in coloration and from other species in foot structure and coloration. The venter is mottled and the dorsum is brown or tan and usually bears a dark median wedge. There is a single metatarsal tubercle. The toe tips are round and tapered. The toes are not webbed.

- DESCRIPTIONS. The more complete descriptions of adults include Nieden (1926), Wright (1932), Parker (1934), Wright and Wright (1949), H. M. Smith (1956), and P. W. Smith (1961). Wright and Wright (1923, 1924, 1949), Wright (1929, 1932), Orton (1946), Bragg (1950a, b; 1957) and Altig (1970) describe the tadpole. Supposed distinctions between tadpoles of *G. carolinensis* and *G. olivacea* (e.g., Altig, 1970) may not separate all individuals (Bragg 1950a, 1957; Orton, 1952; Stebbins, 1954). P. W. Smith's (1961) mention of a tadpole sucking disk is misleading. Ryder (1891), Wright (1923, 1929), Wright and Wright (1924, 1949), Orton (1946), Bragg (1950b) and Livezey and Wright (1947), describe the eggs. The jelly envelope is truncate. Wright and Wright (1949), Bragg (1950f), W. F. Blair (1955b), Awbrey (1965) and Nelson (ms.) describe the call quantitatively; Wright and Wright (1949) cite non-quantitative descriptions.

- ILLUSTRATIONS. Wright (1932) provides the best series of illustrations (adults, eggs, tadpoles, calling males, amplexus, habitat). Photographs of adults appear in: Dickerson (1906),

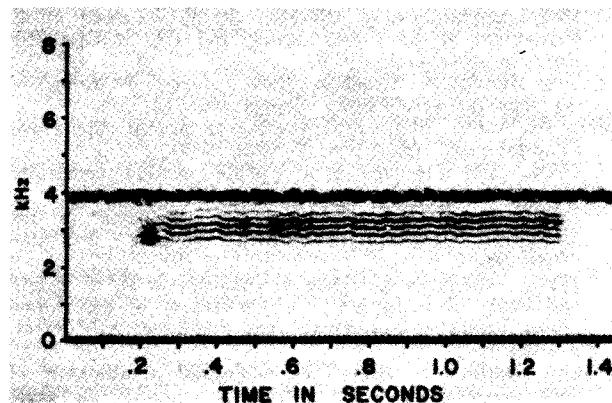


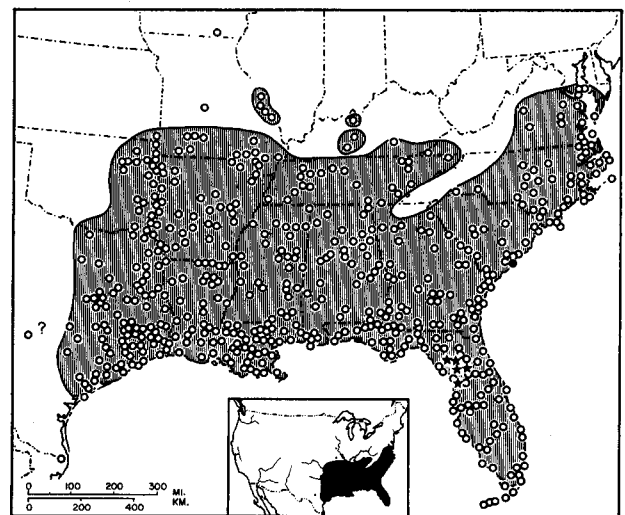
FIGURE. Audiospectrogram (narrow band, 45 Hz) of mating call of *Gastrophryne carolinensis*: Moratico, Lancaster County, Virginia, 11 July 1957 (Amer. Mus. Nat. Hist. Dept. Herpetology tape library).

Wright and Wright (1949), H. M. Smith (1956), Oliver (1955), Carr and Goin (1955), Klingelhöffer (1956), Conant (1958b, color), Bogert (1958), Cochran (1961), P. W. Smith (1961), A. P. Blair (1968), Cochran and Goin (1970, color) and others. Drawings and photographs of adults are given by Hecht and Matalas (1946); drawings by Noble (1931) and others. Photographs of tadpoles are presented by Wright (1929, 1932) and Wright and Wright (1949) and drawings by Wright (1929), Noble (1931), Orton (1946, 1952) and others. Wright (1929, 1932) and Wright and Wright (1949) include figures of the eggs. Noble (1929) and Orton (1946) illustrate developmental stages. W. F. Blair (1955b) provides an audiospectrogram. Anatomical features illustrated are: cranial anatomy (Roux, 1944), skull (W. K. Parker, 1881), hyoid and laryngeal region (W. K. Parker, 1881; Cope, 1889; Trewavas, 1933), ilium (Holman, 1963), choroid plexus (Hilton, 1954), skin histology (Elias and Shapiro, 1957; Conaway and Metter, 1967; Metter and Conaway, 1969), intestinal metaphase cells (Morescalchi, Gargiulo and Olmo, 1970), and sublingual tonsil (Myers, 1928).

- DISTRIBUTION. *G. carolinensis* is restricted to the southeastern United States. It is known from the east shore of Chesapeake Bay southward along coast and piedmont to Key West, Florida, and westward to eastern Texas, Oklahoma and Kansas. The northernmost records are disjuncts in Maryland, southwestern Virginia, Kentucky, Illinois, Iowa and Missouri. The species occurs as far west in Oklahoma as Tulsa and as far southwest in Texas as Kerr County and Brownsville. Nelson (ms.) reviews the distribution. Earlier citations are available for most marginal areas: Maryland (Conant, 1958a; Harris, 1969), Virginia (Fowler and Hoffman, 1951; Werler and McCallion, 1951), Florida Keys (Duellman and Schwartz, 1958), Tennessee (Endsley, 1954; Gentry, 1955), Kentucky (Hirschfield and Collins, 1963), Illinois (P. W. Smith, 1956), Missouri (Hurter, 1893), Kansas (H. M. Smith, 1956), Iowa (Klimstra, 1950), Oklahoma (Bragg, 1950d; A. P. Blair and Laughlin, 1955), and Texas (Brown, 1950; Smith and Sanders, 1952; W. F. Blair, 1955b). The range extends in piedmont valleys to elevations of 800 feet (Carter, 1934) and 1500 feet (Bailey, 1936) and reaches 2400 feet in Oklahoma (Nelson, ms.).

- FOSSIL RECORD. A lower Miocene ilium from Florida (Auffenberg, 1956; Holman, 1961) is indistinguishable from this species. It is also known from Florida Pleistocene deposits ("Illinoian or Kansan," Holman, 1959a, 1959b, 1962; Gut and Ray, 1963; Lynch, 1965; and Wisconsin, Holman, 1958). All records are based on ilia only.

- PERTINENT LITERATURE. The major reviews are Wright (1932), Wright and Wright (1949), and Anderson (1954). Wright (1932) describes habitat and behavior and summarizes the early literature. Anderson (1954) discusses habitat, cover,



MAP. The solid circle marks the type-locality; open circles indicate other localities, and stars indicate fossil localities.

diel activity, movement, food, predators, gonadal cycles, secondary sexual characters, reproductive behavior, sequencing of mating calls, amplexus, oviposition, number of eggs, development, growth, homing to a disturbed breeding site, and more recent literature. Bragg (1950a, d, e) summarizes habits and habitat in Oklahoma. Neill (1959) indicates salt water tolerance. Engels (1954) documents dispersal over sea water. Strübing (1954) discusses temperature preference (may have been *G. olivacea*). Brattstrom (1963) records the thermal environment of a calling male. Concentration on ants for food and mechanisms for protection from ants are described by Wood (1948), Anderson (1954), Holman and Campbell (1958), and Nelson (ms.). Jenni (1969) reports that cattle egrets feed on *G. carolinensis*. Wright (1932) reports *Thamnophis* as a predator. Anderson (1954) notes that trapped specimens are subject to predation by ants (*Iridomyrmex humilis*). Wright and Wright (1949) report use as food for captive snakes. Lee (1959) reports association with palmettos. Liner (1955) and Tinkle (1960) discuss Louisiana habitats. Breeding behavior is best described by Anderson (1954); Carr (1940), Wright and Wright (1949), Bogert (1958, 1960), and Awbrey (1965) supply important supplementary information. Jameson (1955) notes calls during amplexus. Anderson (1954) and Bogert (1960) note alarm chirps in both sexes. Burt (1938) describes a "soft murmur" call. Calling season extends from late March or early April to September or early October in Florida (Carr, 1940; Einem and Ober, 1956), North Carolina (Funderburg, 1955), and Oklahoma (Bragg, 1950c, d) but may be more restricted elsewhere (Brandt, 1953; Anderson, 1954; Martof, 1955). Goin, Goin, and Bachmann (1968) discuss larval period length. Studies on development are: Ryder (1891, repeated in Wright, 1932), Deckert (1914, but see Goin, Goin, and Bachmann, 1968), Noble (1929), Orton (1946), and Wright (1932). Conaway and Metter (1967) and Metter and Conaway (1969) describe a nuptial adhesive gland in males. Volpe (1956) reports reciprocal natural mispairing with *Hyla squirella*. Conant and Hudson (1949) cite a 6 year captive lifespan. Rekam (1960) comments on care in captivity. Hensley (1959) summarizes the reports of albinism (all from Louisiana). Hardy (1953), Fowler and Stine (1953), W. F. Blair (1955b, 1965), P. W. Smith (1957), Raun (1960) and Nelson (ms.) discuss range disjunctions. Blair (1955b) and Nelson (ms.) discuss geographic variation in body size and call. Hecht and Matalas (1946) and Duellman and Schwartz (1958) note "olivacea-like morphs" from Key West, Florida. McKeown (1970) notes bidirectional y-axis orientation.

Other features described include: osteology of the skull and larynx (W. K. Parker, 1881), cranial osteology (Pentz, 1943; Roux, 1944), laryngeal region (Trewavas, 1933), lingual region (Meyers, 1928), choroid plexus (Hilton, 1954), skin histology (Elias and Shapiro, 1957; Conaway and Metter, 1967; Metter and Conaway, 1969), yolk platelets (Karasaki, 1963), somatic chromosomes (2N = 22; Morescalchi, Garguilo, and Ulmo, 1970), amount of nuclear DNA (Goin, Goin, and Bachmann, 1968), blood protein electrophoresis (Dessaur, Fox, and Hartweg, 1962; Dessaur and Fox, 1964; Nelson, ms.); response to hormones (Knepton, 1952; Metter and Conaway, 1969), mucopolysaccharides as defense against desiccation (Elkan, 1968), and gas exchange (Hutchison, Whitford, and Kohl, 1968).

• **NOMENCLATURE HISTORY.** The combination *Stenocephalus carolinensis* has hitherto been overlooked. The only synonymized form is *Engystoma rugosum* Dumeril and Bibron. In the type description *E. rugosum* is distinguished from *G. carolinensis* by having a truncate snout and rugose skin, but is explicitly noted as having "a peu pris le meme" (almost the same) coloration as *G. carolinensis* and as resembling it in having a single metatarsal tubercle. Boulenger (1891) states "I have examined the type specimen of *Engystoma rugosum* . . . and refer it to *E. carolinense*." The combination of coloration and a single metatarsal tubercle exclude all other North American microhylids.

• **ETYMOLOGY.** The specific name refers to the Carolinas, the region in which the type was collected.

COMMENT

G. olivacea and *G. carolinensis* were usually regarded as distinct prior to Hecht and Matalas' review (1946). These authors discuss intermediates from three localities and conclude that the forms intergrade and are subspecies. Other intermediates are cited by Bragg (1950a, b, d, e; 1951)

and W. F. Blair (1955b). A. P. Blair (1950) and W. F. Blair (1955b) report viable laboratory hybrids; hybrid fertility was not tested. Some wild hybrid males do call (W. F. Blair, 1955b). Several lines of evidence indicate that these forms are distinct species which sometimes hybridize but do not form intergrading populations. Sympatric or nearly sympatric populations occur without breakdown of differences in coloration in a zone as much as 125 miles in width (Strecker, 1908; Bragg, 1946, 1950a, d, 1951, 1955; H. M. Smith, 1956; A. P. Blair, 1950, 1952; Brown, 1950a; Peterson, 1950; W. F. Blair, 1951, 1955a, b; Smith and Sanders, 1952; Lindsay, 1954; A. P. Blair and Laughlin, 1955; Raun, 1960; Awbrey, 1965; and Nelson, ms.). In the overlap zone the species differ in coloration, call (Bragg, 1950a; W. F. Blair, 1955b; Awbrey, 1965), average size (A. P. Blair, 1950; W. F. Blair, 1955a; Nelson, ms.), calling season (Bragg, 1950; Brown, 1950; W. F. Blair, 1955b), habitat (Bragg, 1950a; A. P. Blair, 1950; W. F. Blair, 1955b), and dependence on rain to initiate calling (Bragg, 1950a; W. F. Blair, 1955b). Moreover, female *G. olivacea* preferentially respond to conspecific calls (Awbrey, 1965). These forms thus remain biologically distinct in sympatry and must consequently be regarded as distinct species despite occasional hybridization. W. F. Blair (1955a, b) suggests that differences in call and size are greatest in the zone of overlap, thus providing an example of reinforcement of isolating mechanisms. Moore (1957), Volpe (1958), and Bogert (1958) discuss this hypothesis. Nelson (ms.) attributes the differences in call length discussed by Bogert (1958) to differences in chorusing conditions. Reinforcement in call is confirmed by Awbrey (1965). Geographic variation in body size and call (Nelson, ms.) is complex and precludes attribution of the differences in the sympatric populations to simple clinal variation as suggested by Volpe (1958). Bogert (1958) mentions that the sympatric differences in call frequencies might possibly be related to differences in size; since the body size of these two species shows considerable overlap, but the fundamental and dominant frequencies in the call are nearly discrete in sympatric populations (Awbrey, 1965), such an explanation is now excluded. Selective reinforcement of isolating mechanisms remains the most probable explanation of the increased differences in mating calls in the zone of sympatry.

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