Catalogue of American Amphibians and Reptiles.

MARTOF, BERNARD S. 1972. *Pseudobranchus, P. striatus.*

Pseudobranchus Gray
Dwarf siren

Pseudobranchus Gray, 1825:216. Type-species, *Siren striata* Le Conte, 1824, by monotypy.

• CONTENT. *Pseudobranchus striatus* is the only extant species. Two species, *P. robustus* and *P. vetustus*, are known as Cenozoic fossils from Florida.

• DEFINITION. *Pseudobranchus* contains the smallest living sirenids and is among the most paedomorphic of all amphibians. All individuals are aquatic, permanent larvae. The body is slender, greatly elongated, and nearly circular in cross-section; no constriction is present in the neck region. The maximum total length is 250 mm. The 29 to 37 costal grooves are distinct. The tail is about 40 per cent of the total length, ovoid in cross-section at the base but becomes compressed and is flat at the tip. A narrow fin lines the distal two-thirds of its dorsal surface and one-third of its ventral surface. The hind legs are absent whereas the anterior legs are slender and minute. The three fingers are short and stout, 2-1-3 in order of decreasing length, are not webbed, but are tipped with minute, horny caps. Metacarpal tubercles are lacking. In addition to lungs, there are three pairs of compact, external gills but only one pair of gill slits. The sides of the elongated head are nearly straight but taper anteriorly to near the eyes. The snout is rounded to nearly truncate. The skull form is distinctive in that the angular is fused with the prearticular and, as in the hynobiids, the premaxillary spines are small and the nasals meet. The prevomers do not articulate with the pterygoids; the maxillae are absent. The eyes are small, lidless, and covered by a thin membrane. The nostril is a small ventrolateral slit, not visible from above. The small, ventral mouth bears a pendulous upper lip which extends beyond the lower lip. Each jaw has a horny sheath but the lower one also has scattered, slender, pointed teeth. The prevomerine teeth occur in two elongated patches. The anterior half of the small tongue is free and pointed. The internal nares are longitudinal slits, apparently capable of tight closure. Jacobson's organ is present. The vent is a small longitudinal slit; cloacal glands and spermatothecae are lacking. Sexual dimorphism is slight. Females attain larger size but examination of gonads is often the only way to ascertain the sex of a specimen.

• DIAGNOSIS. The only genus that might be confused with *Pseudobranchus* is *Siren*. The two genera comprise the modern sirenids and are readily distinguished from all other amphibians (adults as well as larvae) in possessing only the pectoral appendages. *Pseudobranchus* has a much more limited geographic range than *Siren* and is much smaller in size. Sympatric *Siren intermedia* attain a maximum length of about 380 mm and *S. lacertina*, 915 mm. *Pseudobranchus* has a brown or light gray ground color and is striped with yellow, but may have buff or light gray. In contrast *S. lacertina* is uniformly olive to light gray with inconspicuous greenish-yellow dots on the sides and flecks on the venter; *S. intermedia* is uniformly dark brown to bluish black and may have scattered black dots. Juvenile *S. lacertina* have a prominent light stripe on the side of the body and juvenile *S. intermedia* have a red band across the snout and along the side of the head; these markings disappear as the animals reach sexual maturity. *Pseudobranchus* tends to burrow more readily than *Siren*, accordingly the body is slimmer, the head is much more pointed, and only the second branchial cleft remains open. *Siren* has 3 gill slits. *Pseudobranchus* has three toes per appendage, whereas *Siren* has four. Unlike in *Siren*, the skin of *Pseudobranchus* does not undergo metamorphosis.

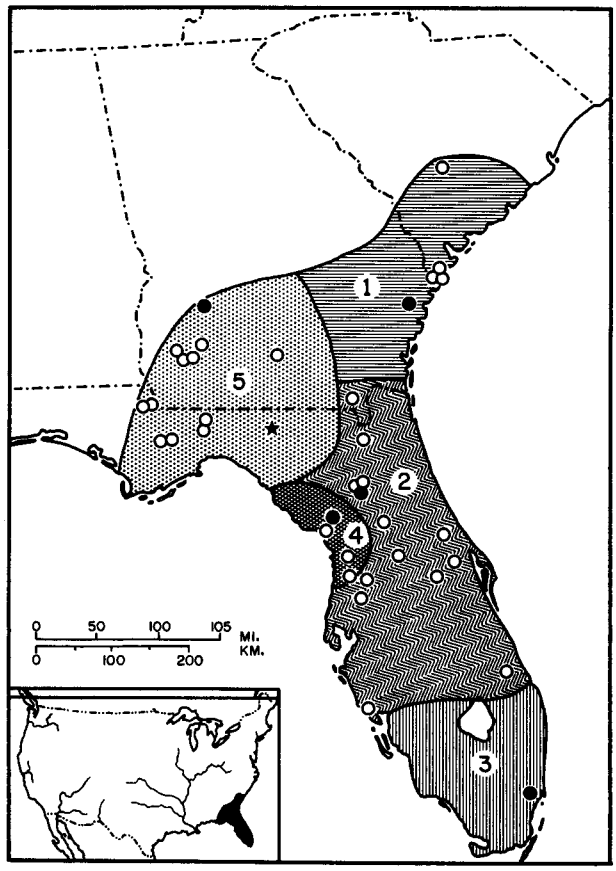
Fossil material (vertebrae) has been identified by the following method (Goin and Auffenberg, 1955:498). The lower margin of the centrum of the vertebra of *Pseudobranchus* is distinctly concave whereas that of *Siren* is nearly straight. In *Pseudobranchus* the zygapophyseal ridge curves downward and fuses with the transverse process at a point posterior to the base of the prezygapophysis, but in *Siren* the ridge is nearly straight and meets the transverse process at the base of the prezygapophysis. Furthermore, at its junction with the transverse process the zygapophyseal ridge tends to flare more in *Pseudobranchus* than in *Siren*.

• DESCRIPTIONS AND DISTRIBUTION. See account of *Pseudobranchus striatus*.

• ILLUSTRATIONS. Drawings of lateral and dorsal views of the thoracic vertebrae of *P. s. axanthus*, *P. robustus*, and *P. vetustus*, lateral and dorsal views of thoracic vertebrae of *P. s. striatus*, and a comparison with the vertebrae of *Siren* are given by Goin and Auffenberg (1955). See account of *P. striatus*.

• FOSSIL RECORD. All fossils of *Pseudobranchus* are from Cenozoic deposits of Florida; however, sirenids have been taken in the lower Cretaceous of Texas. On the basis of thoracic vertebrae collected in Alachua County, Florida, Goin and Auffenberg (1955) described two species. *P. vetustus* of the Pliocene shows strong affinities to *Siren*. *P. robustus* taken in Pleistocene deposits was considered unique because of the large, massive facets on its zygapophyses. Holman (1962) suggested that the massive condition of the zygapophyseal facets was ontogenetic and Lynch (1965) supported his interpretation. The angle between the aliform processes of the older specimens of *P. robustus* measured 79–85 degrees and averaged 81.0 (Goin and Auffenberg, 1955; Holman, 1962), but additional specimens measured 63–78 degrees and averaged 71.0 (Lynch, 1965). The latter measurements overlap those of *P. striatus* (58–82, average 72.6). Holman (1962) postulated that "*P. robustus* is the temporal equivalent of *P. striatus*" and that the transition occurred between Kansan and Recent times. Lynch (1965) concluded that the status of *P. robustus* needs further study.

For comments on the early evolutionary history of the Sirenidae see Goin and Auffenberg (1958) and Estes (1969).



MAP. Solid symbols mark type-localities, open symbols indicate other records; areas of intergradation not shown. Star marks locality for fossil species *P. robustus* and *P. vetustus* as well as a Recent locality for *P. striatus*.

• ETYMOLOGY. The name *Pseudobranchus*, of masculine gender, is derived from the Greek *pseudes* meaning "false or deceptive" and from *branchia* meaning "gills". Many naturalists of the early part of the nineteenth century, including Le Conte and Gray, thought that the lateral fleshy prolongations were not true gills but were nonrespiratory covers of the spiracles.

Pseudobranchus striatus Le Conte
Dwarf siren

Siren striata Le Conte, 1824:53. Type locality, not given, but by inference was one of the Le Conte plantations in Floyd or Liberty County, Georgia (Stejneger and Barbour, 1917:24) restricted to the vicinity of Riceborough, Liberty County, Georgia by Harper, 1935:380. No type specimen indicated.

Pseudobranchus striatus: Gray, 1825:216.

• CONTENT. Five subspecies have been described: *striatus*, *axanthus*, *belli*, *lustricolus* and *spheniscus*. See COMMENT.

• DEFINITION AND DIAGNOSIS. See generic account.

• DESCRIPTIONS. The general external morphology and coloration were described by Bishop (1943), Cochran and Goin (1970), Carr and Goin (1955), Conant (1958), Freytag (1965), and Holbrook (1842). Austin and Baker (1964) described the spermatozoa. Eggs were described by Noble (1930) and Noble and Richards (1932); hatchlings by Noble (1927), Netting and Goin (1942), and Goin and Goin (1962).

• ILLUSTRATIONS. Drawings of the lateral view of body and head were provided by Bishop (1943) and Martof (1956); dorsal view of head and gills by Noble (1931); dorsal and lateral views of head of *P. s. lustricolus* by Neill (1951). For a comparison of *P. s. striatus* and *P. s. axanthus*, lateral view of body and dorsal view of head, see Netting and Goin (1942). A comparison of midbody patterns is provided for all subspecies by Conant (1958), for *striatus*, *axanthus*, *spheniscus* and *belli* by Schwartz (1952), and for *lustricolus* by Neill (1951).

The following drawings are available: egg and comparison with that of *Siren lacertina* (Noble and Richards, 1932); hatchlings and comparison with those of *Siren lacertina* (Noble, 1927, Goin, 1947); urogenital system of male *P. s. axanthus* (Willett, 1965); spermatozoon (Austin and Baker, 1964).

Several color photographs are available: dorsolateral view of *P. s. striatus* (Cochran 1961; Klots 1966) and dorsal views of *P. s. spheniscus* and *P. s. axanthus* (Conant 1958).

Black-white photographs include: lateral view (Harper, 1935); dorsal and ventral views (Klingelhoffer, 1956); lateral and ventrolateral views of *P. s. striatus* and *P. s. axanthus* (Bishop, 1943); dorsal view of *P. s. axanthus* (Carr and Goin, 1955; Cochran and Goin, 1970).

• DISTRIBUTION. This aquatic salamander is restricted to the Coastal Plain of South Carolina (Folkerts, in press), Georgia and all of Florida except the western part of the panhandle. It possibly occurs in southeastern Alabama (Chermock, 1952). It finds food and shelter in the mud and amid the floating vegetation of a wide variety of shallow, freshwater habitats: cypress swamps, marshes, lime-sink ponds, ditches, and other small bodies of water, especially those choked with vegetation. It has prospered with the introduction of the water hyacinth. Specimens may be found by seining up and examining detritus from the bottoms of ponds. An effective collecting technique is to roll up masses of vegetation on a sloping shore and catch the animals as they wriggle toward the water, or slide a large box-like sieve of fine mesh wire under a patch of vegetation and carry it ashore for careful sorting.

• FOSSIL RECORD. See generic account.

• PERTINENT LITERATURE. Important general references include: Bishop (1943), Carr and Goin (1955), Conant (1958), and Noble (1931); anatomy, Auffenberg (1962), Hilton (1948, 1952, 1953, 1956), and Willett (1965); respiratory mechanisms, Freeman (1964); thermal requirements, Brattstrom (1963); serum proteins, Seal (1964); nature of lactic dehydrogenase in comparison with other amphibians, Salthe (1965); immunology and rate of evolution, Salthe and Kaplan (1966); respiration and habitat selection, Ultsch (1971).

• REMARKS. *Pseudobranchus striatus* is generally cryptic, spending much time in bottom vegetation and mud. Accordingly information on its life history and ecology is difficult to obtain. Nothing is known of its courtship and mating habits. Because both sexes lack cloacal glands, Noble (1931) reasoned that fertilization was external. Pituitary transplants induce egg-laying (Noble and Richards, 1932:14). In Florida, spawning occurs throughout the spring months; the eggs adhere to the roots of water plants and are laid singly (Carr, 1940). The eggs average 2.5 mm in diameter and each has three membranes, the outermost being about 7.5 mm in diameter. The upper half of the egg is heavily pigmented with brown. Goin and Goin (1962) observed that each ripe female contained over a hundred fully developed eggs and that the eggs were difficult to find in the field because they were spaced a few meters apart. They concluded, "It was difficult to see how such eggs could be fertilized after they are laid." On the other hand, the spermatozoon of *Pseudobranchus* is comparatively large and unusual. It has a greatly elongated nucleus and two axial filaments each with an undulating membrane bordered by an independently active flagellum (Austin and Baker, 1964). Possibly these adaptations facilitate external fertilization but more data are needed.

Goin and Goin (1962) observed that eggs collected in the neural groove stage hatched 17 days later indicating that the egg stage lasts several weeks. Hatchlings average about 15 mm in total length, lack balancers, but have well-developed toes and a long dorsal fin extending from the base of the head to the tip of the tail. *Pseudobranchus* undergoes less metamorphosis than any other perennibranch.

Pseudobranchus eats only living or freshly killed organisms. The main food items of this predator are chironomid larvae, amphipods (Harper, 1935), aquatic oligochaetes (Duellman and Schwartz, 1958) and ostracods (Freeman, 1967). The swimming ability of organisms often determines their availability to *Pseudobranchus* (Freeman, 1967). For example, amphipods can elude capture in open water but not amid vegetation. In contrast, rapid moving organisms, such as mosquito larvae, elude capture even amid dense vegetation. The small mouth of *Pseudobranchus* does not greatly limit the size of food objects. Freeman (1967) observed that earthworms up to about ⅓ the body weight of *Pseudobranchus* were readily subdued and eaten.

Congruent with its sluggish habits, *Pseudobranchus* has a low rate of oxygen consumption; however, its respiratory means are diverse and variable according to environmental conditions (Freeman, 1964). During prolonged drought *Pseudobranchus*, like *Siren* (Viosca, 1925; Martof, 1969), become encased in dried mud as much as 12″ below the former pond bottom. Experiments by Freeman (1958) showed that sirenids can survive such dry conditions for over 2.7 months. Meanwhile, an animal loses its slimy touch and its gills atrophy greatly. After the animal is liberated from the dried mud by the return of adequate water, its gills usually return to normal size within a week. Deep mud is also the site for hibernation (Carr, 1940).

The voice of this species is proportionally as well developed as that of *Siren lacertina*; disturbed individuals often yelp faintly (Carr, 1940).

Data on population size, structure, and turnover are especially needed.

Our knowledge of *Pseudobranchus* stands as a tribute to Coleman J. Goin. Most of the available information has resulted from his efforts and those of his associates.

1. *Pseudobranchus striatus striatus* Le Conte

Pseudobranchus striatus striatus Netting and Goin, 1942:183. Subspecific status proposed.

• DEFINITION AND DIAGNOSIS. The body is short and stocky; maximum total length is 150 mm. This is the most strikingly patterned of all subspecies. The dark brown dorsal stripe is broad and often interrupted by a narrow, light vertebral line. The upper lateral stripe is broad, yellow or buff, and extends to midtail without much decrease in width then tapers to the tip of the tail. The lower light stripe is narrow and extends from the legs to the vent. The area between the lateral stripes is brown or grayish-green, with many small yellow or buff flecks. The venter is dark, but lighter than the dorsum, and is grayish-green with many small irregular yellow flecks. This subspecies occurs in southern coastal South Carolina and southeastern Georgia.

2. *Pseudobranchus striatus axanthus* Netting and Goin

Pseudobranchus striatus axanthus Netting and Goin, 1942:183. Type-locality, "Eastern edge of Payne's Prairie, where Prairie Creek enters the River Styx, about five miles southeast of Gainesville, Alachua County, Florida." Holotype, Carnegie Mus. 20339, adult female, collected 9 February 1940 by Coleman J. Goin.

• DEFINITION AND DIAGNOSIS. This is a slender, very elongated *Pseudobranchus*, with a truncate head. The maximum total length is 250 mm (Freeman, 1959). The costal grooves average 35 (34 to 37). Its stripes are pale and indistinct. It is the least strikingly patterned of all subspecies. In coloration, *axanthus* differs from all other subspecies by having a gray, rather than a brown ground color; both the lateral and ventrolateral light stripes are narrow and pale gray, rather than broad and yellow buff; a uniformly gray venter without yellow spots; and much less distinct head stripes. It inhabits central and northeastern Florida and the Okefenokee Swamp, Georgia.

3. *Pseudobranchus striatus belli* Schwartz

Pseudobranchus striatus belli Schwartz, 1952:1. Type-locality, "23.1 miles west of Miami, on the Tamiami Trail, Dade County, Florida." Holotype, Mus. Zool. Univ. Michigan 106000, adult male, taken by Philip C. Porter, L. Neil Bell, and Albert Schwartz on 17 May 1952.

• DEFINITION AND DIAGNOSIS. This is a small, slender *Pseudobranchus* with a maximum total length of 153 mm. Costal grooves only 29 to 33, average 31.5. The head is relatively long and narrow. The buffy, lateral stripes are distinct and wide, and the venter is gray. This subspecies differs from *axanthus* in having a narrower head and more distinct, wider lateral stripes. From *spheniscus* it differs in having markedly wider lateral and ventrolateral stripes which are yellowish other than buffy and in having a less pointed head. From *striatus* it differs in having a lighter color, lack of spotting on the venter, and in having a narrower head. From *lustricolus* it differs in having wider lateral stripes and a lighter venter. It inhabits the southern third of Florida.

4. *Pseudobranchus striatus lustricolus* Neill

Pseudobranchus striatus lustricolus Neill, 1951:39. Type-locality, "7.8 miles southeast of Otter Creek, Levy County, Florida." Holotype, Ross Allen's Reptile Inst. 14215; adult, sex not given, collected 8 September 1950 by Wilfred T. Neill and E. Ross Allen.

• DEFINITION AND DIAGNOSIS. The body is large and stout, the maximum total length is 217 mm. The head is flattened above; the snout is very blunt, almost truncate; a canthus rostralis is present. The forelimbs are relatively long and slender. The ground color is black with white flecks. The stripes are narrow and number more than 10. The three dorsal light stripes are sharply defined. The lateral light stripe is very broad and orange-brown. The ventrolateral light stripe is relatively wide and silvery white. The head stripes are distinct yellowish-tan. This subspecies differs from the others by having many distinct stripes and a black venter with white mottling. It is restricted to the Gulf hammock region of Florida at the junction of its peninsula and panhandle.

5. *Pseudobranchus striatus spheniscus* Goin and Crenshaw

Pseudobranchus striatus spheniscus Goin and Crenshaw, 1949: 277. Type-locality, "Seven miles south of Smithville, Lee County, Georgia." Holotype, Carnegie Mus. 29015, adult female, collected 4 July 1948 by George B. Rabb and James E. Mosimann.

• DEFINITION AND DIAGNOSIS. This is a small, slender *Pseudobranchus* with a maximum total length of 138 mm. The head and snout are narrow and wedge-shaped. The lateral stripes are distinct, tan, and tend to continue forward through the eye to the tip of the snout. Its narrow head, wedge-shaped snout, and slender body distinguish it from other subspecies. It also differs from *striatus* by having narrower and more somber lateral stripes. From *axanthus* it differs in being "more difficult to collect" and in having the lateral stripes tan rather than gray and tending to continue to the tip of the snout. It occurs in southwestern Georgia and the adjacent part of the Florida panhandle.

• ETYMOLOGY. The name *striatus* is derived directly from Latin and means "striped," an obvious reference to the longitudinal markings which distinguish this species from other living sirenids. The subspecific names are derived as follows: *axanthus*, Greek *a*, "without" and *xanthus*, "yellow"; *belli*, a patronym for L. Neil Bell; *lustricolus*, Latin *lustrum*, "bog or morass" and *colo* "to inhabit"; and *spheniscus*, Greek *spheniskos*, "a small wedge."

COMMENT

Geographic variation has not been adequately studied even though several subspecies have been described. For example, Goin and Auffenberg (1955) observed that the vertebra of *axanthus* and *spheniscus* differed greatly from those of *striatus* by being heavier and more robust and by having a median ridge between the aliform processes. Such differences suggest that the taxonomic status of these forms might be reinvestigated when more material becomes available. On the other hand, the adjacent subspecies are thought to intergrade (Conant, 1958). In summary, a comprehensive survey is needed.

LITERATURE CITED

Auffenberg, Walter. 1962. A review of the trunk musculature in the limbless land vertebrates. Amer. Zool. 2:183–190.

Austin, Colin R., and Clinton L. Baker. 1964. Spermatozoon of *Pseudobranchus striatus axanthus*. J. Reprod. Fertil. 7:123–125.

Bishop, Sherman C. 1943. Handbook of salamanders: the salamanders of the United States, of Canada, and of Lower California. Comstock Publ. Co., Ithaca, New York, xiv + 555 p.

Brattstrom, Bayard H. 1963. A preliminary review of the thermal requirements of amphibians. Ecology 44 (2) :238–255.

Carr, Archie Fairly, Jr. 1940. A contribution to the herpetology of Florida. Univ. Florida Publ. 3 (1) :1–118.

—, and Coleman J. Goin. 1955. Guide to the reptiles, amphibians, and freshwater fishes of Florida. Univ. Florida Press, Gainesville. ix + 341 p.

Chermock, Ralph L. 1952. A key to the amphibians and reptiles of Alabama. Geol. Surv. Alabama Mus. Paper (33) :1–88.

Cochran, Doris M. 1961. Living amphibians of the world. Doubleday Co., Garden City, N. Y., 199 p.

—, and C. J. Goin. 1970. The new field book of reptiles and amphibians. G. P. Putnam's Sons, N. Y. xxii + 359 p.

Conant, Roger. 1958. A field guide to reptiles and amphibians of the United States and Canada east of the 100th meridian. Houghton Mifflin Co., Boston, xv + 336 p.

Duellman, William E., and Albert Schwartz. 1958. Amphibians and reptiles of southern Florida. Bull. Florida State Mus. 3 (5) :181–324.

Estes, Richard. 1969. Prosirenidae, a new family of fossil salamanders. Nature 224 (5214) :87–88.

Folkerts, George W. In press. Notes on South Carolina salamanders. J. Elisha Mitchell Sci. Soc.

Freeman, John R. 1958. Burrowing in the salamanders *Pseudobranchus striatus* and *Siren lacertina*. Herpetologica 14 (3) :130.

— 1959. A record-size dwarf siren. *Ibid.* 15 (1) :16.

— 1964. Studies of respiratory mechanisms of the salamander *Pseudobranchus striatus*. Diss. Abstr. 25:40.

— 1967. Feeding behavior of the narrow-striped dwarf siren *Pseudobranchus striatus axanthus*. Herpetologica 23 (4) : 313–314.

Freytag, Günther E. 1965. Armmolche. Aquarien-Terrarien Zeitschr. 18 (12) :372–375.

Goin, Coleman J. 1947. Notes on the eggs and early larvae of three Florida salamanders. Nat. Hist. Miscellanea (10) :1–4.

—, and Walter Auffenberg. 1955. The fossil salamanders of the family Sirenidae. Bull. Mus. Comp. Zool. 113 (7) : 497–514.

—, and — 1958. New salamanders of the family Sirenidae from the Cretaceous of North America. Bull. Chicago Mus. Nat. Hist. 10 (33) :449–459.

—, and John W. Crenshaw, Jr. 1949. Description of a new race of the salamander *Pseudobranchus striatus* (Le Conte). Ann. Carnegie Mus. 31 (10):277–280.
—, and Olive B. Goin. 1962. Introduction to herpetology. W. H. Freeman and Co., San Francisco, Calif. ix + 341 p.
Gray, John E. 1825. Synopsis of the genera of reptiles and Amphibia, with the description of some new species. Ann. Philos. 10:193–217.
Harper, Francis. 1935. Records of amphibians in the southeastern States. Amer. Midland Nat. 16 (3):275–310.
Hilton, William A. 1948. The vertebrae of salamanders. J. Entomol. and Zool. 40 (3):47–65.
— 1952. The pulmonary respiratory system of salamanders. Herpetologica 8 (3):87–92.
— 1953. The choroid plexus of the lateral and third ventricles of tailed Amphibia. J. Comp. Neurol. 99 (3):545–551.
— 1956. Eye muscles of salamanders. Herpetologica 12 (4): 273–276.
Holbrook, John E. 1842. North American Herpetology. J. Dobson and Son, Philadelphia. Vol. 5. vi + 118 p.
Holman, J. Alan. 1962. Additional records of Florida Pleistocene amphibians and reptiles. Herpetologica 18 (2): 115–119.
Klingelhöffer, Wilhelm. 1956. Terrarienkunde. Alfred Kernen Verlag, Stuttgart. Part 2, 236 p.
Klots, E. B. 1966. The new field book of fresh water life. G. P. Putnam's Sons, N. Y. 398 p.
Le Conte, John. 1824. Description of a new species of *Siren*, with some observations on animals of a similar nature. Ann. Lyceum Nat. Hist. New York. 1:52–58.
Lynch, John D. 1965. The Pleistocene amphibians of Pit II, Arredondo, Florida. Copeia 1965 (1):72–77.
Martof, Bernard S. 1956. Amphibians and reptiles of Georgia. Univ. Georgia Press, Athens, Georgia. viii + 94 p.
— 1969. Prolonged inanition in *Siren lacertina*. Copeia 1969 (2):285–289.
Neill, Wilfred T. 1951. A new subspecies of salamander, genus *Pseudobranchus*, from the Gulf hammock region of Florida. Publ. Res. Div. Ross Allen's Reptile Inst. 1 (4): 39–46.
Netting, M. Graham, and Coleman J. Goin. 1942. Descriptions of two new salamanders from peninsular Florida. Annals Carnegie Mus. 29:175–196.
Noble, G. Kingsley. 1927. The value of life history data in the study of the evolution of the Amphibia. Ann. Acad. Sci. New York. 30:31–128.
— 1930. The eggs of *Pseudobranchus*. Copeia 1930 (2):52.
— 1931. The biology of the Amphibia. McGraw-Hill, New York. xiii + 577 p.
— and L. B. Richards. 1932. Experiments on the egg-laying of salamanders. Amer. Mus. Novitates (513):1–25.
Salthe, S. N. 1965. Comparative catalytic studies of lactic dehydrogenases in the Amphibia: environmental and physiological correlations. Comp. Biochem. Physiol. 16: 393–408.
— and N. O. Kaplan. 1966. Immunology and rates of evolution in the Amphibia in relation to the origins of certain taxa. Evolution 20 (4):603–616.
Schwartz, Albert. 1952. A new race of *Pseudobranchus striatus* from southern Florida. Nat. Hist. Misc. (115):1–9.
Seal, Ulysses S. 1964. Vertebrate distribution of serum ceruloplasmin and sialic acid and the effects of pregnancy. Comp. Biochem. Physiol. 13 (2):143–159.
Stejneger, Leonhard, and Thomas Barbour. 1917. A check list of North American amphibians and reptiles. Harvard Univ. Press, Cambridge, Massachusetts. iv + 125 p.
Ultsch, Gordon R. 1971. The relationship of dissolved carbon dioxide and oxygen to microhabitat selection in *Pseudobranchus striatus*. Copeia 1971 (2):247–252.
Viosca, Percy, Jr. 1925. A terrestrial form of *Siren lacertina*. Copeia (136):102–104.
Willett, Judith Ann. 1965. The male urogenital system in the Sirenidae. J. Tennessee Acad. Sci. 40 (1):9–17.

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