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TWO NEW HYDROBIID SNAILS (AMNICOLINAE) FROM FLORIDA AND GEORGIA, WITH A DISCUSSION OF THE BIOGEOGRAPHY OF FRESHWATER GASTROPODS OF SOUTH GEORGIA STREAMS

Fred G. Thompson and Robert Hershler

ABSTRACT

Two new freshwater snails are described. *Dasyscias franzi*, new genus and new species, is know from a single subterranean locality in Washington County, Florida. *Lyogyrus (Spirogyrus) latus*, new subgenus and new species, is recorded from the three rivers in south Georgia. A large area in south central Georgia is characterized by acidic epigean water systems and is devoid of freshwater snails. The depauperate fauna is attributed to a loss of a larger fauna during post Pliocene time due to solution of former calcareous geological deposits.

KEY WORDS – Freshwater snail, Gastropoda, Hydrobiidae, Amnicolinae, *Amnicola*, *Dasyscias franzi*, *Lyogyrus (Spirogyrus) latus*, biogeography, troglobite, Florida, Georgia, U.S.A.

The freshwater snail fauna of the southeastern United States is not well documented. Families such as the Pleuroceridae, Viviparidae, Planorbidae and Physidae remain poorly studied in this area. In fact they are taxonomically muddled and large geographic gaps in their ranges remain unsurveyed. In light of this, it is not surprising that a large number of small-sized species belonging to the Hydrobiidae have been discovered during recent years (Clench, 1965; Thompson, 1968; Thompson, 1969; Thompson, 1977; Hershler & Thompson, 1990). This family contains numerous species that are similar in appearance, and misidentifications frequently occurred in earlier surveys. For example, few of the species listed by Goodrich (1939, 1944) for the Ogeechee River and the Coosa River are correctly identified (Thompson, 1968, p. 123; Thompson, 1977, p. 129). In addition, many species occupy cryptic habitats and were overlooked in earlier surveys. This paper describes two such species. One occurs in west Florida, a region that was surveyed by many naturalists during the first half of this century. The second is from various rivers in south Georgia, which were visited by many collectors during the nineteenth and twentieth centuries. The discovery of the second species emphasizes a biogeographic problem, namely the absence of freshwater gastropods from a major area of south-central Georgia.

FAMILY HYDROBIIDAE

SUBFAMILY AMNICOLINAE

Six genera and subgenera currently are recognized in this subfamily. Three are European: *Bythinella, Parabythinella* and *Marstoniopsis*. Three are North American: *Amnicola, Lyogyrus* and a new genus described below. The new genus differs conspicuously from other amnicoline genera by its shell sculpture. In allusion to the appearance of the shell we name it:

Dasyscias, new genus

Type species: *Dasyscias franzi*, new species. The genus is monotypic and is known only from Blue Spring Cave System in Washington County, Florida.

Diagnosis: A monotypic genus of troglobitic snail. Minute; shell conical-globose; umbilicate; consisting of about 3.5 whorls separated by a deeply impressed suture. Protoconch sculptured with numerous closely spaced minute transverse fimbriations with superimposed vague spiral striation (Figs. 7-9). Teleoconch sculpture consisting of raised tufted spiral threads that are nearly uniformly spaced over the surface of the shell (Fig. 10).

Animal blind, lacking eyes at base of tentacles. Body unpigmented. Female reproductive anatomy lacking a bursa copulatrix. Radula with a single basocone on each side of central tooth.

Comparisons: The subfamily Amnicolinae contains three European genera and the North American genera discussed below. The European genera *Bythinella*, *Parabythinella* and *Marstoniopsis* are epigean snails that are similar to *Amnicola* in aspects of shell sculpture. *Bythinella* and *Marstoniopsis* are similar to *Amnicola* in their female reproductive anatomies, and need not be considered further in this discussion. *Parabythinella* resembles *Dasyscia* in lacking a bursa copulatrix. We suspect that this similarity is due to convergence, but anatomical data for *Parabythinella* are insufficient to examine this question more thoroughly. Data for European taxa are given in Fretter & Graham (1978) and Radoman (1983).

Amnicoline snails have few anatomical characteristics that differentiate supraspecific categories (Thompson, 1968; Hershler & Thompson, 1988). In this regard they are similar to the Lithoglyphinae (Thompson, 1984) but contrast with the Nymphophilinae and the Littoridininae which have highly divergent modifications of male and/or female reproductive morphology. In North America two genera have been recognized in the Amnicolinae, *Amnicola* Gould and Haldeman 1841 and *Lyogyrus* Gill 1863. The differences between the two are minor. The shells differ primarily by the diameter of the first whorl of the protoconch: *Amnicola* = 0.38-0.46 mm in diameter perpendicular to the initial suture; *Lyogyrus* = 0.29-0.36 mm. Anatomical differences also occur. *Amnicola* has a relatively stout penis and 2-3 basocones on each side of the radular central tooth. Live animals are pigmented with distinct patterns of black blotches and stripes on various parts of the body. *Lyogyrus* has a relatively slender penis and a single basocone on each side of the central tooth. Live animals are diffusely pigmented with melanophores. Both *Amnicola* and *Lyogyrus* have simple conical shells that are smooth or have barely detectable incremental striation on the teleoconch. Faint spiral striations are present on the protoconch of both (Fig. 39), but usually the trait is obscured in adults.

The shell of *Dasyscias* differs from *Amnicola* and *Lyogyrus* by having hirsute spiral sculpture on the teleoconch, and by having transverse fimbriations on the protoconch. The shell is similar to *Amnicola* in the diameter of the first whorl of the protoconch. The central tooth of its radula is similar to *Lyogyrus* and differs from *Amnicola* by having a single basocone on each side of the central tooth, and by having slender, lanceolate mesocones on the central and lateral teeth. The female reproductive system of *Dasyscias* lacks a bursa copulatrix, whereas this structure is present in *Amnicola* and *Lyogyrus*. *Dasyscias* also differs from *Amnicola* and *Lyogyrus* by lacking eyes and by being unpigmented. These are secondary modifications that accompany a troglobitic existence and cannot be weighed heavily within a phylogenetic context.

The available data suggests that *Dasyscias* is derived from *Lyogyrus* and not *Amnicola* because of similarities in the radular teeth. Other aspects of its morphology yield more equivocal interpretations of its phylogeny.

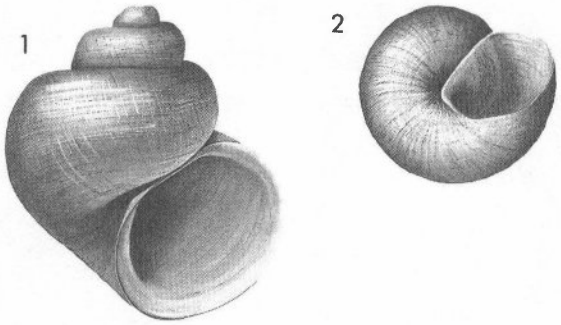
Species of Amnicolinae for the most part inhabit epigean habitats. Two species of cave snails from Missouri described as blind unpigmented *Amnicola* (*A. proserpina* Hubricht 1940, *A. aldrichi antroecetes* Hubricht 1940). These are species of *Fontigens* (Hershler, *in prep.*). Two other troglobitic species from Missouri, *Amnicola stygia* Hubricht, 1971 and *A. cora* Hubricht, 1979 are amnicolines, but their relationships within the subfamily are not clear at present. As noted above,

Dasyscias franzi differs from these as well as all other amnicolines by the sculpture on the protoconch and the teleoconch.

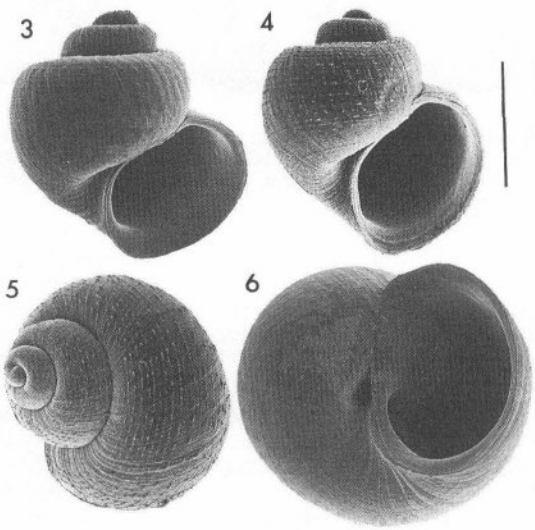
Entomology: The name *Dasyscias* (feminine) is derived from the Classical Greek *Dasys*, hairy or shaggy, and *skias*, a shadow, in allusion to the hirsute, colorless shell. We are pleased to name the species in honor of Richard Franz, Research Associate of the Florida Museum of Natural History, who first discovered it while exploring Florida caves for troglobitic organisms.

Dasyscias franzi, new species
Shaggy Ghostsnail

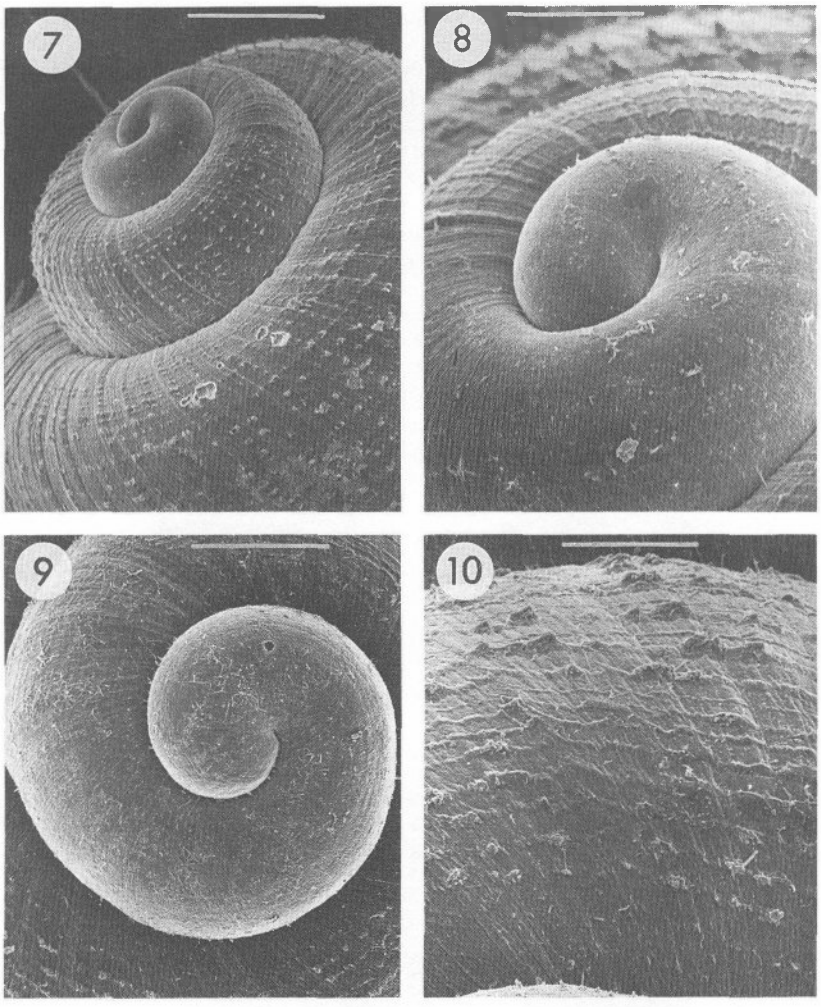
Shell (Figs. 1-10): Transparent and colorless in live animals. Shaggy in appearance. Minute, reaching a length of about 2 mm; very broadly ovate-conical, about 0.9 times as wide as high. Spire low; nearly straight-sided. Suture deeply impressed, more so than in other species of the subfamily (Figs. 5, 7). Umbilicus



FIGS. 1-2. Camera lucida drawings of shells of *Dasyscias franzi* n. gen., n. sp. Blue Springs Cave, Washington Co., Florida. FIG. 1. Holotype (UF 93964); shell height 2.05 mm. FIG. 2. Paratype (UF 93965); shell height 1.37 mm.



FIGS. 3-6. SEM micrographs of shells of *Dasyscias franzi* n. gen., n. sp.; paratypes (UF 93957). Blue Spring Cave, Washington Co., Florida. Bar scale = 1 mm for figs. 3-5; 1.25 for fig. 6.



FIGS. 7-10. SEM micrographs of protoconch and teleoconch sculpture of *Dasyscias franzi* n. gen., n. sp.; paratypes (UF 93957). FIG. 7. Apex and upper whorls (scale bar = 0.4 mm). FIGS. 8-9. Protoconch (scale bar = 120 and 150 μm respectively. FIG. 10. Teleoconch sculpture (scale bar = 75 μm).

open (Figs. 2, 6). About 3.2-3.5 whorls in adult shells; body whorl ample, strongly inflated and shouldered above. Protoconch containing 1.5 whorls; first whorl 0.42 mm in diameter perpendicular to initial suture. Protoconch microsculpture consisting of fine, densely compacted transverse fimbriations upon which may appear a few poorly defined spiral striations (Fig. 9). Teleoconch sculptured with distinct incremental growth striations and about 30 rows of raised spiral fimbriations that are broken into transversely synchronized tufts (Fig. 10). Spiral sculpture becoming indistinct near umbilicus. Aperture broadly elliptical in shape, about 0.84-0.92 times as wide as high, about 0.6 times height of shell; plane of aperture lying at an angle of about 10 1/2 to axis of shell in lateral profile. Peristome simple, incomplete across parietal wall except in a few older specimens; peristome bearing a weak callus internally.

Shell measurements for 11 specimens, including the holotype, are summarized in Table 1.

Operculum: Thin; light amber colored; nucleus subcentral with about 3.5 whorl.

Soft Anatomy: Animal consisting of about 2.5 whorls. Eyeless. The only body pigmentation consists of a few black granules concentrated on the dorsal surface of the stomach, gonoduct and gonad. Ctenidial filaments ca. 21. Osphradium elongate, filling about a third of ctenidium length. Style sac about half as long as remaining stomach. Caecal chamber absent. Central tooth of radula (Fig. 12) with a lanceolate mesocone, four ectocones and a single basocone on each side. Lateral tooth (Fig. 13) with three entocones, a slightly larger lanceolate mesocone and three ectocones. Inner marginal tooth (Fig. 14) with about 15 subequal cusps. Outer marginal tooth (Fig. 15) with about 17 cusps.

Prostate gland small, about half of its length overlapping the pallial cavity. Vas deferens entering and exiting near mid-point of gland. Anterior vas deferens with a coil in nape at base of penis. Penis large; form similar to *Lyogyrus* (Thompson, 1968); filament and lobe relatively elongate. Glandular caecum of penis having relatively numerous loops.

Ovary a small branched mass posterior to stomach; filling only about 25% of digestive gland length. Albumen gland about twice as long as capsule gland (Fig. 11). Sperm pouch elongate, with posterior edge oriented along edge of albumen gland; pouch having a pink sheen typical of seminal receptacle. Bursa copulatrix absent. Oviduct connected with sperm duct at base of sperm pouch duct. Distal to this the oviduct enters the right side of the anterior albumen gland.

TABLE 1. Shell data for *Dasyscias franzi* , new species. ApH = aperture height; ApW = aperture width; LBW = length of body whorl; SL = standard shell length; SW = shell width; WBW = width of body whorl; Wh = whorls. N = 11 specimens, including holotype.

	SL	SW	LBW	WBW	ApH	ApW	Wh	SW/SL	WBW/LBW	ApH/SL
X	1.98	1.76	1.70	1.36	1.18	1.03	3.20	0.89	0.80	0.60
S	0.13	0.10	0.07	0.09	0.07	0.07	0.14	0.03	0.04	0.02
min.	1.74	1.52	1.58	1.15	1.02	0.93	3.00	0.84	0.67	0.57
max.	2.17	1.89	1.83	1.46	1.30	1.12	3.50	0.95	0.83	0.64
type	2.05	1.83	1.67	1.40	1.18	1.09	3.30	0.89	0.83	0.58

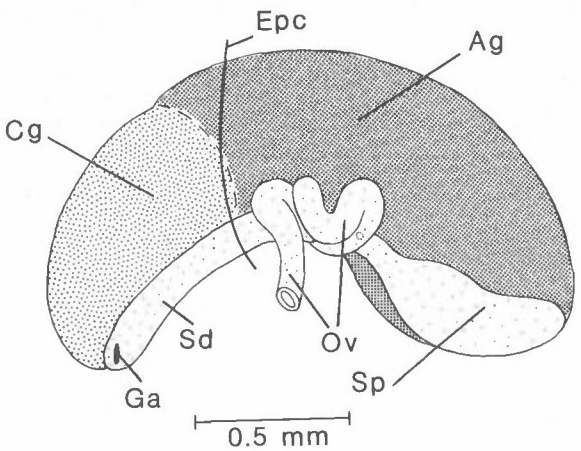
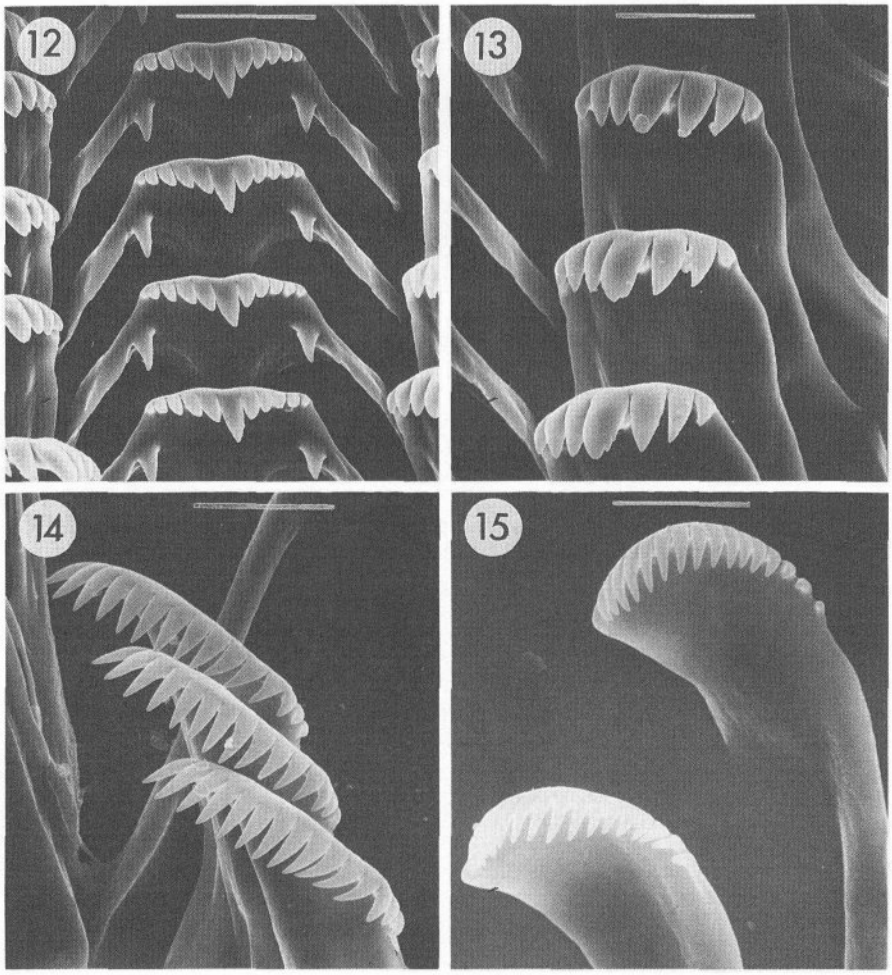


FIG. 11. Left lateral aspect of pallial oviduct complex of *Dasyscias franzi* n. gen., n. sp. Small dotted circle on oviduct indicates connection with sperm pouch duct. Connection between oviduct and albumen gland not shown. Abbreviations: Ag, albumen gland; Cg, capsule gland; Epc, posterior end of pallial cavity; Ga, genital aperture; Ov, oviduct; Sd, spermathecal duct; Sp, sperm pouch.



FIGS. 12-15. SEM micrograph of radula of *Dasyscias franzi* n. gen., n. sp. FIG. 12. Central teeth (scale bar = 12.0 μm). FIG. 13. Lateral teeth (scale bar = 8.8 μm). FIG. 14. Inner marginal teeth (scale bar = 7.5 μm). FIG. 15. Outer marginal teeth (scale bar = 5.0 μm).

Type locality: Florida, Washington County, Blue Spring Cave, 32 km by air NNW of Panama City; SE 1/4 SW 1/4 sec. 27, T1N, R13W (lat. 30° 27' 12" N, long. 85°31'52" W). Holotype: UF 93964; collected 4 May, 1977 by Fred G. Thompson. Paratypes: UF 93965 (1), UF 93622 (7), UF 93954 (1), UF 93955 (2), UF 93956 (4), UF 93957 (6), USNM 860468 (6); same locality as the holotype.

Distribution: Known only from the type locality (Fig. 40).

Habitat: Blue Spring Cave (Fig. 16) is located about 100 meters northwest of Blue Springs. It is formed at the contact between the Choctawhatchee Formation and the Chipola Formation (Alum Bluff group), both Miocene in age. The cave is part of a labyrinth of small chambers and tunnels that perforate the rock in the immediate area. Water from Blue Springs flows into the Econfina River, a small independent system that enters directly into North Bay northeast of Panama City. The entrances to the spring-outlets are large enough to admit beavers, which drag wood considerable distances into the cave passages. Live specimens of *Dasyscias franzi* were found on the surfaces of wood in the cave streams, apparently feeding on de-

FIG. 16. Photograph (November 14, 1986) of senior author entering Blue Spring Cave, Washington Co., Florida; type locality for *Dasyscias franzi* n. gen., n. sp. Opening of cave is approximately two meters long and one meter wide.

composer organisms. In life the snails have the appearance of small, nearly white "ghosts."

The only other aquatic snail found in the cave stream system is *Elimia curvicostata* (Reeve 1861). Snails found in the pool formed by Blue Spring are *Elimia curvicostata, E. floridense* (Reeve 1861), *Notogillia wetherbyi* (Dall 1885), *Rhapinema dacryon* Thompson, 1969, *Campeloma geniculum* Conrad, 1834 and *Physella gyrina aurea* (Lea, 1839).

Conservation: This species is not known to be under any environmental threat. We recommend that the State of Florida acquire Blue Springs under the Conservation and Recreational Lands Program (CARL) as a Habitat of Critical Concern because it is the only known locality for this species and the spring is a pristine natural habitat.

Lyogyrus Gill 1863

Previously Thompson (1968) and Burch & Tottenham (1980) and Burch (1982) treated *Lyogyrus* as a subgenus of *Amnicola* Gould & Haldeman 1840. The discovery of additional species of *Lyogyrus* and other amnicolines in the southeastern states emphasizes the generic distinctions of these two lineages. In light of the consistent differences in the width of the initial whorl of the protoconch, and the number of cusps on the central tooth of the radula, we revert to the earlier classification and regard them as separate genera.

Lyogyrus contains two distinct groups of species. One group consists of species that have a shell with a brown periostracum, a conical shell-shape that is higher than wide, a raised conical protoconch, a nearly complete absence of spiral sculpture on the teleoconch and a uniformly thickened peristome (Figs. 38-39). These are the typical species of *Lyogyrus*, and are listed by Burch & Tottenham (1980: 124-126). The second group is represented by the new species described below.

Spirogyrus, new subgenus

Type species. *Lyogyrus (Spirogyrus) latus*, new species. The subgenus is monotypic.

Diagnosis. Shell depressed-helicoid, wider than high. Protoconch depressed, nearly planular; first whorl 0.28-0.32 mm in diameter perpendicular to initial suture. Periostracum gray in color; shell translucent in life. Teleoconch sculptured with numerous fine but conspicuous wavy spiral threads. Peristome with a thickened, protracted columellar margin.

Comparisons. *Spirogyrus* is similar to *Lyogyrus* in its soft anatomical features, including reproductive systems, ciliation patterns on the tentacles (Fig. 28-29), radular features (Figs. 34-37), sculpture of the protoconch (Fig. 39) and the diameter of the first whorl. Other aspects of the shells (Fig. 38) are so dissimilar, a close relationship was not suspected until their anatomies were compared. The shell of *Spirogyrus* is very similar in shape and in features of the peristome to that of *Clappia*, a genus in the subfamily Lithoglyphinae. The thickened columellar margin of the peristome resembles most epigean genera of lithoglyphines, and is very unlike the peristome of the rest of the Amnicolinae (Thompson, 1984). The shell of *Spirogyrus* is readily distinguished from *Clappia* by the spiral threads on the teleoconch. *Clappia* has a smooth shell bearing very weak incremental striations.

Spirogyrus contains a single species that occurs in southern Georgia in Atlantic and Gulf of Mexico coastal streams.

Etymology. The name *Spirogyrus* (masculine) is from the Latin *spiralis*, spiral and *gyrus*, a turn or whorl. The name alludes to the spiral threads on the whorls of the teleoconch. The species name *latus* is from the Latin and refers to the relatively wide shell.

Lyogyrus (Spirogyrus) latus, new species
Cobble Sprite

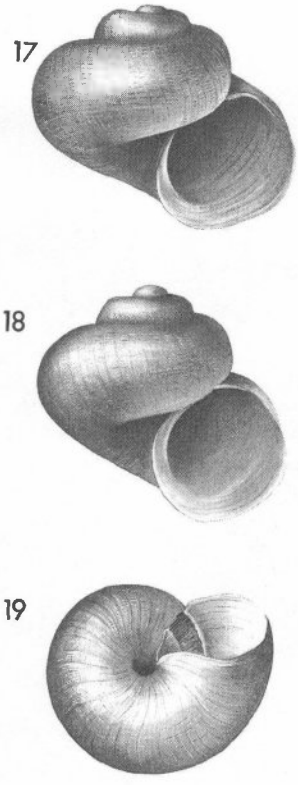
Shell (Figs. 17-23): Minute, adults about 1.5-1.9 mm in diameter. Depressed-helicoid, about 0.8-1.0 times as high as wide. Periostracum thin, light gray; live specimens translucent. Last quarter whorl noticeably descending toward the aperture. Base broadly umbilicate. Adult shells with about 3.0-3.2 strongly inflated whorls. Suture deeply impressed. Apical whorls flattened. First whorl of protoconch 0.28-0.32 mm in diameter perpendicular to initial suture. Protoconch sculptured with weak spiral striations (Figs. 24-25). Following whorls sculptured with distinct wavy raised spiral threads that are most distinct on the dorsal and outer surfaces of the whorls (Figs. 20-23). These are crossed by irregularly spaced incremental striations. Spiral and axial sculpture continuing into umbilicus, but diminished. Aperture broad, about as wide as high; broadly ovate-quadrangular in shape; about 0.6 times height of shell. Plane of aperture lying at an angle of about 19-28 1/2 to axis of shell in lateral profile. Peristome interrupted across parietal wall except in gerontic specimens. Columellar margin of peristome thickened. Basocolumellar lip protracted forward. Inner wall of peristome bearing a slightly thickened callus.

Shell measurements for the holotype and four population samples are given in Table 2.

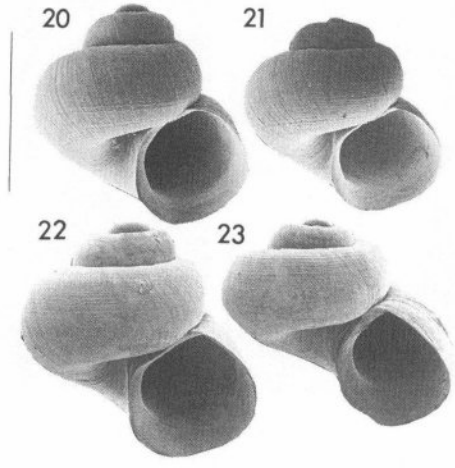
Operculum: Thin, membranous, amber colored; with about 3.0 whorls; nucleus subcentral.

Anatomy: Most of the anatomical data presented herein is based upon numerous specimens from the Ogeechee River at the type locality and the Altamaha River NE of Hazelhurst. Observations for the female are based on a single presumably adult specimen collected in the Altamaha River NE of Hazelhurst.

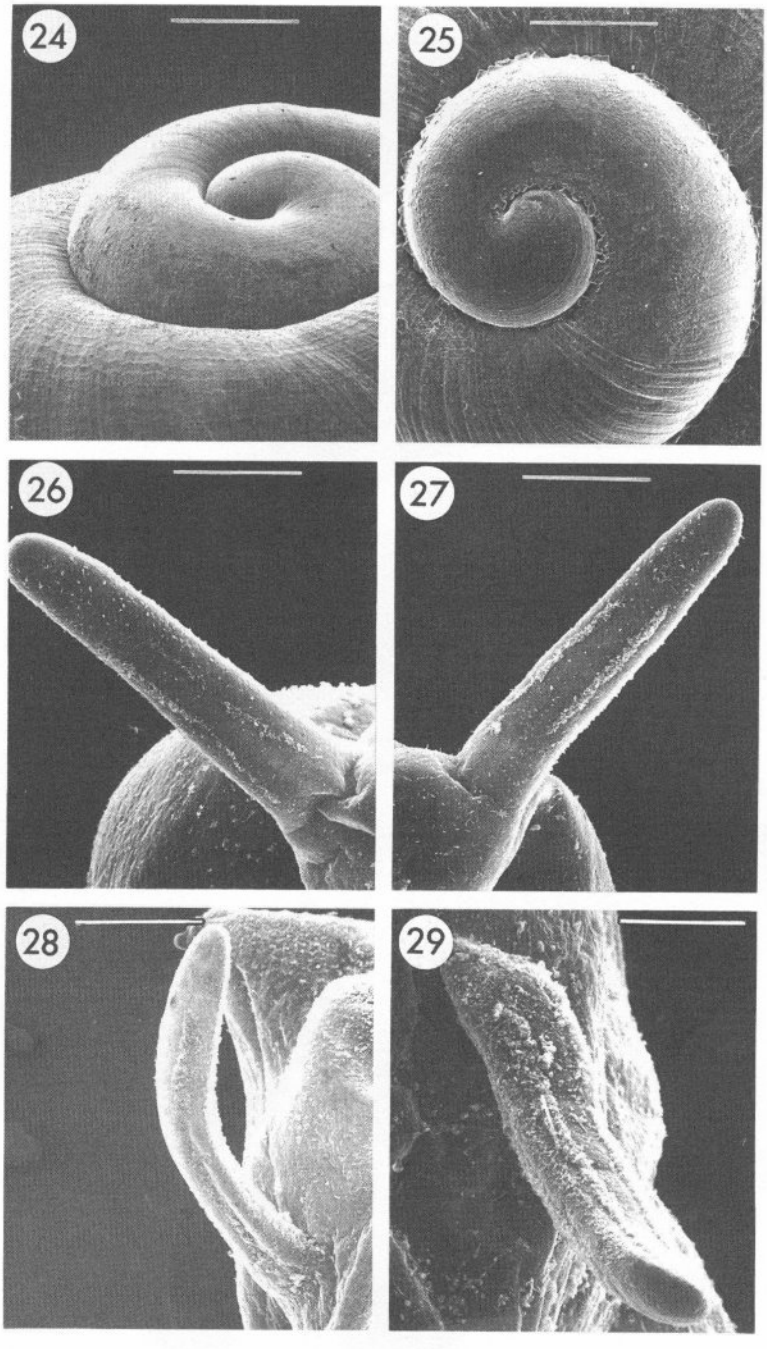
Animal with about three whorls. Head-foot unpigmented or with a light dusting of gray-black melanin on proximal snout and nape. Eye-spots present.



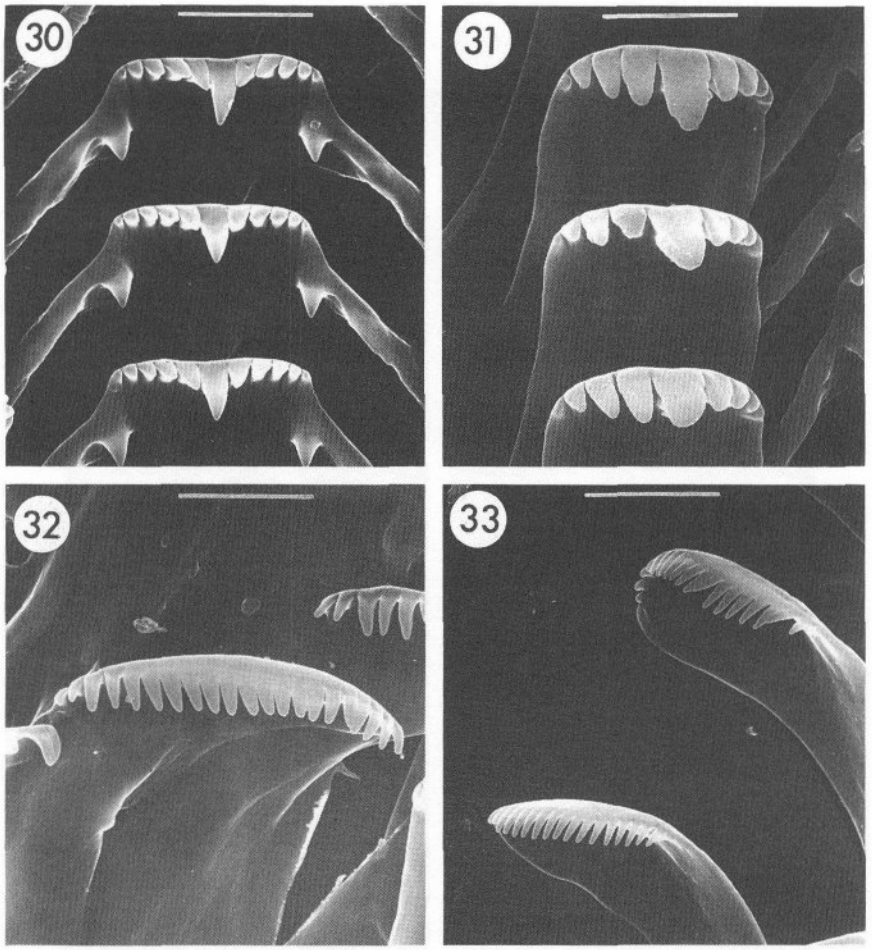
FIGS. 17-19. *Lyogyrus (Spirogyrus) latus* n. subgen., n. sp. Ogeechee River, 1.0 mi. SW of Rocky Ford, Screven Co., Georgia. FIG. 17. Holotype (UF 40253), shell height = 1.40 mm. FIGS. 18-19. Paratypes (UF 56917).



FIGS. 20-23. *Lyogyrus (Spirogyrus) latus* n. subgen., n. sp. SEM micrographs of shells. FIGS. 20-21. Paratypes (UF 56917), Ogeechee River, 1.0 mi. SW of Rocky Ford, Screven Co., Georgia. FIGS. 22-23. Referred specimens (UF 59120); Altamaha River, 6 mi. NE of Hazelhurst, Jeff Davis Co., Georgia. Scale bar = 1 mm.



FIGS. 24-29. Anatomical features of *Lyogyrus*. FIGS. 24-27. *Lyogyrus (Spirogyrus) latus* n. subgen., n. sp. SEM micrographs of specimens from the Ogeechee River, 1.0 mi. SW of Rocky Ford, Screven Co., Georgia. FIGS. 24-25. Protoconch and early whorl (scale bars = 136 μm and 150 μm respectively). FIGS. 26-27. Tentacle, showing longitudinal tracts of cilia (scale bars = 120 μm). FIGS. 28-29. *Lyogyrus* (s.s.) *granum* (Say). Tentacles showing longitudinal ciliary tracts (scale bars = 200 μm and 136 μm respectively).

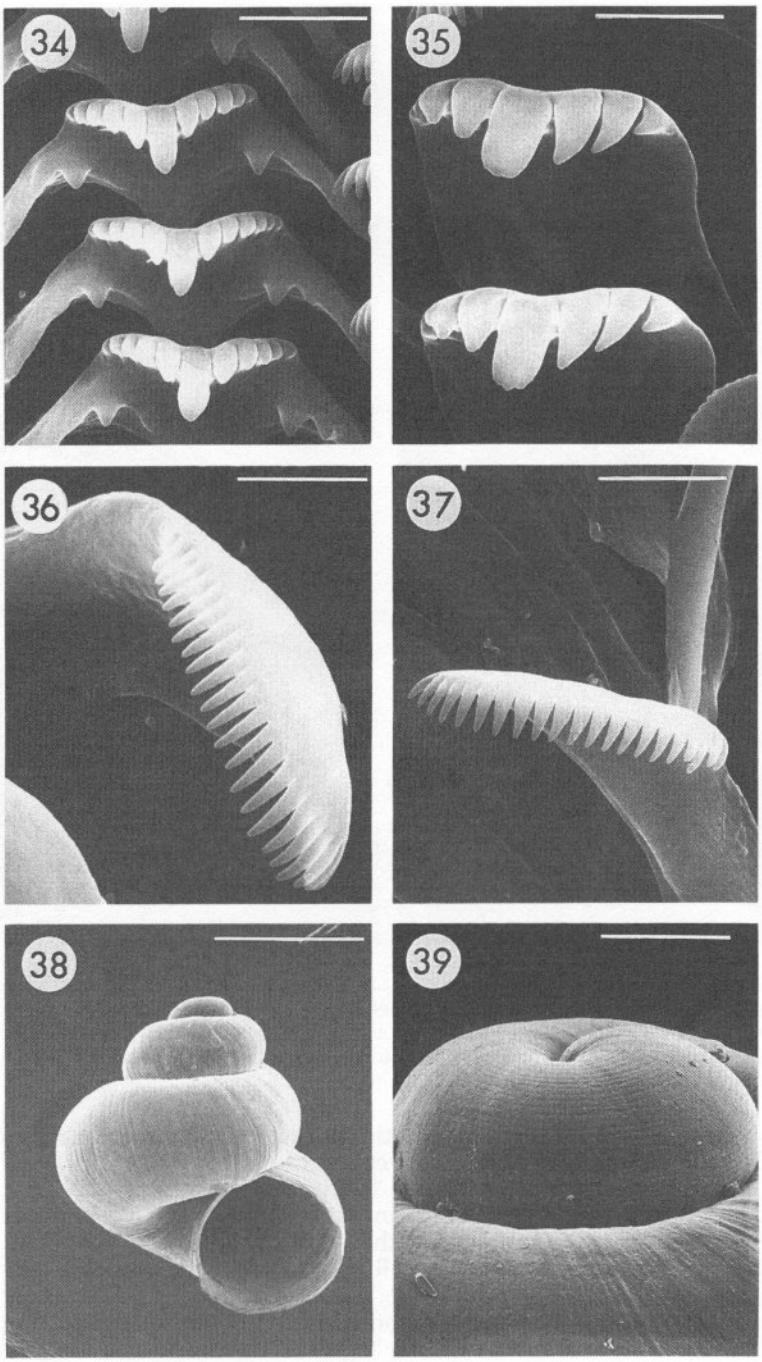


FIGS. 30-33. *Lyogyrus (Spirogyrus) latus* n. subgen., n. sp. SEM micrographs of radular teeth of specimen from the Ogeechee River, 1.0 mi. SW of Rocky Ford, Screven Co., Georgia. FIG. 30. Central tooth (scale bar = 7.5 μm). FIG. 31. Lateral teeth (scale bar = 6.7 μm). FIG. 32. Inner marginal tooth (scale bar = 5.0 μm). FIG. 33. Outer marginal tooth (scale bar = 5.0 μm).

Tentacles with two concentrated longitudinal tracts of cilia on dorsal surface (Figs. 26-27). Dorsal surface of visceral coil covered with gray-black pigment which becomes brown on testis. Ctenidial filaments triangular, 22-28; ctenidium extending to mantle collar. Osphradium large, filling about a third of ctenidial length. Style sac length somewhat less than that of remaining stomach. Digestive gland covering over half of stomach. Pallial intestine without a coil. Central tooth of radula with an elongate slender mesocone, 4-5 ectocones and a single basocone

Testis filling the uppermost half whorl of body, slightly overlapping posterior edge of stomach; testis consisting of about six simple lobes. Seminal vesicle consisting of a few coils positioned dorsal to anterior third of testis. Penis small relative to head-foot; form similar to *Lyogyrus* s.s. (see Thompson, 1968); filament longer than lobe. Glandular duct thin, with few coils in nuchal cavity.

Albumen gland and capsule gland about equal in length. Oviduct coil a single loop, with most of coil very swollen. Single sperm pouch small, positioned partly posterior to albumen gland. Spermathecal duct present.



FIGS. 34-39. *Lyogyrus (s.s.) granum* (Say). FIGS. 34-37. Radula of specimen from Roseland Lake, Woodstock, Windham Co., Connecticut (UF 29793). FIG. 34. Central teeth (scale bar = 7.5 μm). FIG. 35. Lateral tooth (scale bar = 6.0 μm). FIG. 36. Inner marginal tooth (scale bar = 3.0 μm). FIG. 37. Outer marginal tooth (scale bar = 6.0 μm). FIGS. 38-39. Shell specimen from Plum Rond, Rustin, New Jersey (USNM 506246) (scale bars = 600 μm and 100 μm respectively).

Geographic variation: This species is highly variable in size and in the relative proportions of its shell (Table 2, Figs. 7-8). The sample from the Altamaha River consists of adults that tend to be slightly larger and have a higher whorl count than specimens from the Ogeechee River collected only a few days apart. Otherwise we have found no differences that we consider significant taxonomically.

TABLE 2. Shell data for four samples of *Lyogyrus latus*, new species. ApH = aperture height; ApW = aperture width; LBW = length of body whorl; SL = standard length; SW = standard width; WBW = width of body whorl; Wh = whorls.

	SL	SW	LBW	WBW	ApH	ApW	Wh	SW/SL	WBW/LBW	ApH/SL
UF 56917 (Ogeechee River): N = 14 paratypes + holotype.										
X	1.25	1.40	1.04	1.08	0.76	0.74	3.00	1.13	0.97	0.61
S	0.11	0.09	0.25	0.08	0.06	0.05	0.13	0.06	0.03	0.03
min.	1.02	1.21	0.90	0.90	0.62	0.62	2.60	1.05	0.91	0.57
max.	1.43	1.58	1.21	1.21	0.87	0.84	3.10	1.19	1.03	0.66
type	1.40	1.58	1.21	1.21	0.87	0.84	3.10	1.13	1.00	0.62
UF 56918 (Ogeechee River): N = 17.										
X	1.29	1.44	1.13	1.12	0.77	0.76	3.04	1.12	0.99	0.60
S	0.11	0.10	0.09	0.07	0.06	0.05	0.13	0.07	0.04	0.04
min.	1.18	1.30	0.99	1.02	0.62	0.68	2.90	1.00	0.94	0.53
max.	1.55	1.77	1.36	1.33	0.87	0.90	3.30	1.28	1.10	0.70
UF 59120 (Altamaha River): N = 14.										
X	1.58	1.74	1.38	1.29	0.92	0.90	3.23	1.11	1.00	0.58
S	0.15	0.12	0.11	0.28	0.06	0.06	0.15	0.07	0.03	0.02
min.	1.36	1.55	1.24	1.24	0.81	0.81	3.00	1.04	0.94	0.55
max.	1.89	2.05	1.61	1.64	1.05	1.05	3.50	1.26	1.05	0.64
UF 57024 (Chickasawhatchee River) N = 1.										
	1.58	1.58	1.33	1.27	0.84	0.84	3.20	1.00	0.95	0.53

Variation within a population is greater than we have observed in populations of other epigean Hydrobiidae. Intra-population variation exceeds inter-population differences from the same river as well as from different rivers (Table 2). All of the samples that we examined from the Altamaha River and the Ogeechee River contain adult specimens that have a noticeable varix about an eighth of a whorl behind the peristome. A varix is lacking in the single specimen from the Chichasawhatchee Creek. The specimen from the Chichasawhatchee was collected in April, 1970 whereas the specimens from the former two rivers were collected in the fall months of September and October, 1974. The varix in the Ogeechee and the Altamaha populations may be due to an environmental factor that occurred earlier in that year.

Type locality: Georgia, Screven County, Ogeechee River 1.0 mile southwest of Rocky Ford. Holotype: UF 40253; collected 29 October, 1974 by Fred G. Thompson. Paratypes: UF 56917, USNM 860469; same data as the holotype.

Other specimens examined: Georgia: Baker Co.: Chickasawhatchee Creek, 9.4 mi. W of Newton (UF 57024). Jeff Davis Co.: Altamaha River, 6 mi. NE of Hazelhurst (UF 59120, USNM 860470). Jefferson Co.: Ogeechee River, 1.7 mi. WSW

of Louisville (UF 56958, UF 57005). Screven Co.: Ogeechee River, 3.0 mi. SW of Oliver (UF 56918); Ogeechee River, 4 mi. NW of Oliver (UF 57109).

Distribution and habitat: This species is found in low gradient streams in south Georgia (Fig. 40). It is known from three widely separated river systems, the Ogeechee River and the Altamaha River on the Atlantic Slope in southeastern Georgia, and the Chickasawhatchee Creek, a Flint River tributary (Apalachicola River System) on the Gulf Slope in southwestern Georgia. It is probably more widely distributed but has been overlooked because of its cryptic microhabitat. In the Ogeechee River it was found only on the underside of chert and sandstone cobbles and boulders in riffles. The single sample from the Altamaha River was collected from the underside of dead unionid shells along a sand-gravel shoal. In the Chichasawhatchee Creek a single specimen was found on the undersides of a chert cobble in a riffle. Shoals and rocky rapids are not common habitats on coastal plain streams in the southeast. This fact may account for the paucity of records. The species was not collected at other stations in these same rivers where the substrate consists of sand or silt, although many of these stations had abundant populations of other hydrobiid snails, including *Lyogyrus* (s.s.) sp. and *Amnicola* sp.

The microhabitat occupied by *L. latus* is unique within the Amnicolinae. Species of *Lyogyrus* s.s. and epigean species of *Amnicola* are diurnal. They occur in quiet water on live aquatic vegetation, dead leaves, stems and occasionally on sand or silt substrates. The ecological deployments of these other amnicolines contrasts strongly with the secretive behavior observed in *L. latus*.

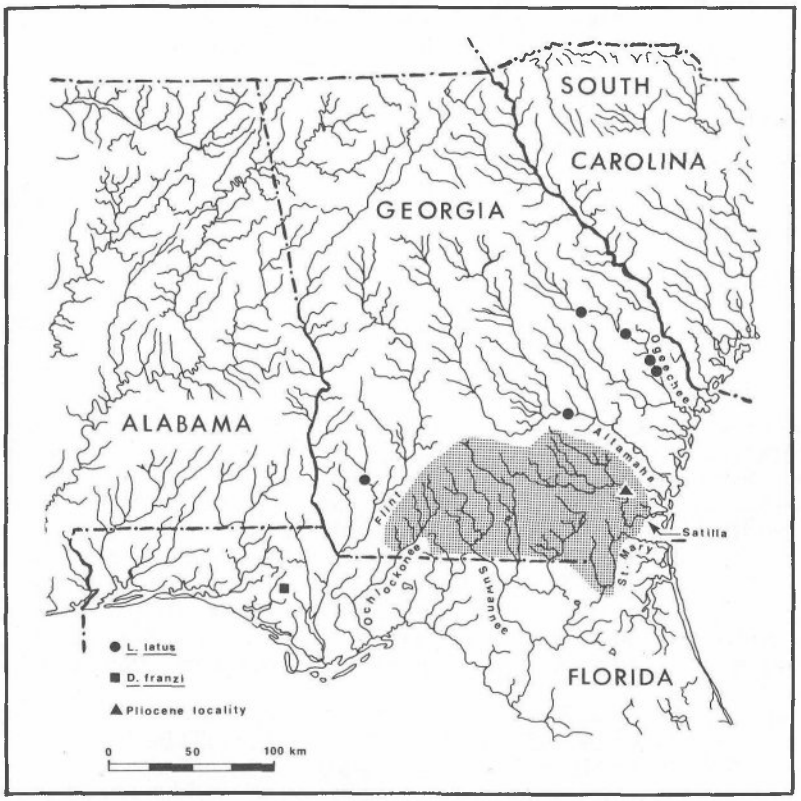


FIG. 40. Map showing the known distributions of two hydrobiid snails: circles = *Lyogyrus latus* n. sp.; square = *Dasyscias franzi* n. gen., n. sp. Field data indicate that the shaded area apparently is devoid of freshwater snails.

BIOGEOGRAPHY OF PROSOBRANCH MOLLUSKS IN SOUTH GEORGIA STREAMS

The occurrence of *Lyogyrus latus* in the Chickasawhatchee Creek is surprising in light of the distributions of other prosobranch gastropod snails. The Flint and the Altamaha river systems are inhabited by many of the same genera of prosobranchs (Table 3). With the exception of *L. latus*, *Viviparus georgianus* (Lea 1834) and *V. intertextus* (Say 1829), they have no species in common. Distributional data for *Viviparus* are given in Clench (1962) and Clench & Fuller (1965).

TABLE 3. Genera of freshwater gastropods in various river systems of south Georgia. Records are based on specimens in the Florida Museum of Natural History. Data are not provided for the ANCYLIDAE, which is undercollected almost invariably. Abbreviations for river systems in order of occurrence are: Oge = Ogeechee; Alt = Altamaha; Sat = Satilla; StM = St Marys; GSu = Georgia section of Suwannee; FSu = Florida section of Suwannee; Fli = Flint.

Genus	River Systems						
	Oge	Alt	Sat	StM	GSu	FSu	Fli
VALVATIDAE							
Valvata	+	+	-	-	-	-	-
VIVIPARIDAE							
Viviparus	+	+	-	-	-	+	+
Lioplax	-	-	-	-	-	+	+
Campeloma	+	+	-	-	-	+	+
PILIDAE							
Pomacea	-	-	-	-	-	+	+
PLEUROCERIDAE							
Elimia	+	+	-	-	-	+	+
HYDROBIIDAE							
Aphaostracon	-	-	-	-	-	+	-
Cincinnatia	+	-	-	-	-	+	-
Pyrgulopsis	+	+	-	-	-	-	+
Notogillia	-	+	-	-	-	+	-
Spilochlamys	-	+	-	-	-	+	+
Somatogyrus	+	+	-	-	-	-	+
Amnicola	+	+	-	-	-	+	+
Lyogyrus (s.s.)	+	+	-	-	-	+	+
(Spirogyrus)	+	+	-	-	-	-	+
LYMNAEIDAE							
Fossaria	-	+	-	-	-	+	+
Pseudosuccinea	+	+	-	-	-	+	+
PHYSIDAE							
Physella	+	+	-	-	-	+	+
PLANORBIDAE							
Planorbella	+	+	-	-	-	+	+
Gyraulus	+	+	-	-	-	+	+
Micromenetus	+	+	-	-	-	+	+

The absence of records for *Lyogyrus latus* from the Suwannee, St. Marys and Satilla river systems is consistent with biogeographic patterns shown by other freshwater gastropods. These river systems drain a major area in south-central Georgia between the Altamaha River and the Flint River (Fig. 40). This area is approximately a tenth of the state of Georgia. In Georgia, the freshwater sections of the Suwannee, St. Marys and Satilla drainages are devoid of snails. We speculate that this area may have isolated populations of *Campeloma, Amnicola, Physella,*

Gyraulus, *Micromenetus* and *Pseudosuccinea*, but to date none have been found. Some genera in the Suwannee system occur upstream in the Withlacoochee and the Alapaha rivers to a distance of a mile or two north of the Florida state line, but not further north. The Satilla drainage is similarly depauperate, except for the presences of *Campeloma limum* (Anthony 1860) in its lower-most course (personal communication, Harry G. Lee, Jacksonville). The Georgia section of the Ochlockonee River appears to be similarly depauperate, but our data from there is not as extensive as it is for the other streams. These observations are based on the fact that there are no published records for this area, and on the field experience of the senior author, who has conducted extensive field work in southern Georgia over the last quarter century. These streams also were visited by William Clench and Peter Okelberg in 1929 (personal communication to FGT by Clench) and by Clench and others in 1954 (Clench & Turner, 1956), who had similarly bleak results. In contrast the Altamaha River, the Flint River and the Florida section of the Suwannee River have highly diverse gastropod faunas (Table 3).

This region of Georgia is covered by the Hawthorne Formation, which is Miocene in age (Goddard, 1965). The Hawthorne Formation is a clastic deposit of clays, sands and gravels that form an impervious lens overlying lower geological strata that contain freshwater aquifers. Most surface soils consist of sands and clays. Surface waters are derived entirely from rainfall and drain flatwood swamps. Streams typically have loose shifting sand bottoms and are acidic because of organic acids and the absence of any source of buffering carbonates. North and west of the region the Fall Line consists of exposed Cretaceous-Eocene limestones, but none of the headwaters of these streams intersect these carbonate sources. In Florida, the Suwannee River cuts through the Oligocene Suwannee Limestone, and the water chemistry rapidly changes to basic with a high carbonate content.

The absence of gastropods from this region probably is due to water chemistry factors. This area had a rich freshwater snail fauna during the Pleistocene, which was similar in composition to the modern faunas of rivers to the northeast, northwest and south (Aldrich, 1911). The absence of gastropods appears to be a relatively recent phenomenon in the Georgia freshwater sections of the Suwannee, St. Marys and Satilla systems. Aldrich described a diverse freshwater fauna of Hydrobiidae, Pleuroceridae and Planorbidae from a Pliocene (or Miocene?) clay stratum along the middle section of the Satilla River (Fig. 11, Pliocene locality). The Hydrobiidae include apparent species of *Lyogyrus* s.s. (*Amnicola georgiensis* Aldrich), *Tryonia* (*Paludestrina plana* Aldrich), *Cincinnatia* (*Amnicola saltillensis* Aldrich) and *Notogillia* (*Amnicola expansilabris* Aldrich). Two apparent species of *Elimia* (Pleuroceridae) are *Potamides saltillensis* Aldrich and *P. cancelloides* Aldrich. A species of *Helisoma* (Planorbidae) was also present (*Planorbis antiquitus* Aldrich). Currently the genus *Helisoma* does not occur in southern Georgia southwest of the Savannah River (we follow current usage in recognizing *Helisoma* as a genus distinct from *Planorbella*).

The presence of a diverse Pliocene gastropod fauna in the Satilla River suggests a water source with high pH and high dissolved mineral content. These conditions were very different from those of the present. The freshwater section of the Satilla now has a pH below neutral and lacks any significant trace of calcium or carbonates. The reported diverse fauna (Aldrich, 1911) indicates that there was an upstream geological deposit of carbonate rock along the Satilla River during the

Pliocene. Geological data support the hypothesis that extensive limestone deposits were eroded from this region during the Pleistocene. Opdyke, *et al.* (1984) present data indicating that there has been an isostatic uplift of north Florida and adjacent south Georgia of approximately 36 m during the Pleistocene and Holocene due to off-loading of carbonate rocks through solution. The amount of uplift was about equal to the amount of elevation that was lost through solution so that the elevation of the land mass remained unchanged relative to sea-level. The current absence of gastropods, including *Lyogyrus latus,* from these streams in south Georgia can be attributed to post-Pliocene water chemistry changes that were associated with the loss through erosion of carbonate deposits.

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FRED G. THOMPSON

Florida Museum of Natural History
University of Florida
Gainesville, Florida 32611, U.S.A.

ROBERT HERSHLER

Department of Invertebrate Zoology
National Museum of Natural History
Smithsonian Institute
Washington, DC 20560, U.S.A.