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EXTINCT OR NEAR EXTINCT COLONIES OF TREE SNAILS, *LIGUUS FASCIATUS,* IN EASTERN BROWARD AND NORTHERN DADE COUNTIES, FLORIDA[1]

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THE rate of destruction of the natural environment in southeastern Florida has increased incredibly in recent years. There now seems little probability that any of the subtropical jungle hammock or subtropical hammock associes or, for that matter, even the distinctive pinelands, stand a chance of survival. Some facies of the plant and animal associations, fortunately, are preserved within the Everglades National Park, but the distinctive assemblages of the rocky ridge which forms the eastern "Rim of the Everglades" will soon be irretrievably lost. Stands or fragments of stands which as little as six years ago seemed fairly safe from destruction have now been completely removed due to the rapid expansion of housing developments around the urban centers. Since continuation of long-term studies of the various hammocks and their associated faunas is now futile, the following notes are published in the hope that they may be of use to future workers.

The tree snails, *Liguus fasciatus* (Müller), were one of the characteristic animal groups associated with the intermediate stages in the hammock sere. With disappearance of the hammocks they are, of course, unable to survive. I have already discussed the composition of the former colonies in the area from around Arch Creek to below Coconut Grove (Young, 1951). This summary has proved to be relatively complete, and only a few additional localities need be added to it. In the present paper I list and locate the hammocks and briefly describe the *Liguus* colonies, if any, associated with them in the region between Hillsboro Inlet and Arch Creek, in eastern Broward and northern Dade counties, and those immediately to the west of Miami in Dade County. In a later paper, I hope to make available informa-

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tion on the colonies occurring in the area outside the Everglades National Park, south of Miami.

Brief descriptions of the subspecies and color forms (and their variants) of *Liguus fasciatus* found north of the Miami River are given in my earlier report (1951: 2–3). The names used in this paper are essentially as outlined there; they follow Clench and Fairchild (1939) rather than Pilsbry (1946). As in the 1951 account, subspecies are, for the most part, merely referred to by the subspecific designation. Color forms of *L. f. roseatus* are, where ambiguous, preceded by *roseatus.* Variants of these forms are enclosed in quotation marks. It is suggested that readers make use of the descriptions in my previous publication. Plant names and general ecological concepts follow Davis (1943).

Material employed in determining the composition of the various colonies of *Liguus* is deposited chiefly in the University of Michigan Museum of Zoology (UMMZ) and in the Charles Torrey Simpson Collection at the University of Miami, Florida. I am indebted, however, to a number of local collectors for information concerning various hammocks from which I have been unable to obtain any material. Ralph H. Humes of Miami has been particularly helpful.

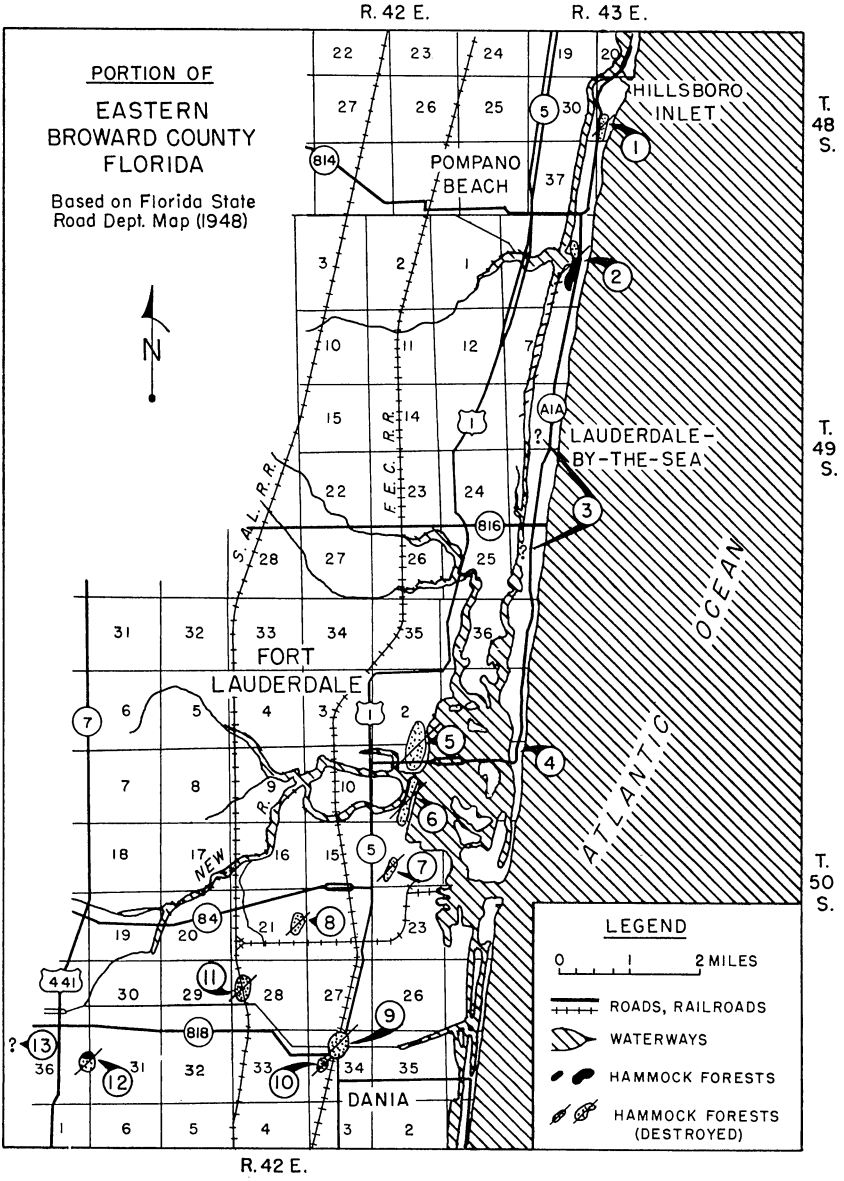
HAMMOCKS IN EASTERN BROWARD COUNTY

(Map 1, Locs. 1–13)

The stands of subtropical hammock associes in Broward County represent, or represented, a number of vegetational types, unfortunately, not completely differentiated by botanists. They can also be divided into groups on the basis of their topographical location as follows: (1) Hammocks between the Atlantic beach and intracoastal marshes, (2) along the Pleistocene Silver Bluff shoreline, (3) along the estuaries and main courses of streams crossing the coastal ridge, (4) inland along the edges of the transverse glades crossing the ridge, and (5) on Indian mounds or natural elevations in the Everglades proper. Since, however, the present paper is mainly concerned with the tree snail colonies, the hammocks will be discussed in groups without special regard to their relation to topographical features.

COASTAL AREA NORTH OF FORT LAUDERDALE

Hammocks in the coastal area of northeastern Broward County are close to the northern limit of *Liguus* in Florida. Records from Palm Beach County are few and in part questionable. Pilsbry (1946) recorded *Liguus fasciatus septentrionalis* Pilsbry from Yamato, apparently on the basis of fragments of dead shells. Ralph Humes informed me that



MAP 1. Eastern Broward County, Florida, showing location of stands of the jungle hammock associes. Numbers refer to hammock localities described in the text. Based on Florida State Road Department Map (1948).

he has seen fragments of *septentrionalis* found in a hammock near the ocean just south of Palm Beach. G. B. Fairchild found living *Liguus* in the latter locality about 1932, but these were *L. f. roseatus* Pilsbry and included color forms that obviously had come from southern Dade County (specimens in Museum of Comparative Zoology). Living *septentrionalis* occurred, however, in very small numbers in a hammock near Boca Raton in southern Palm Beach County at least until fairly recently (specimens in Ralph Humes' collection). The paucity of records probably indicates that living *Liguus* did not occur on the east coast of Florida north of Boca Raton in the present century, and nearly all specimens preserved in museums are from localities south of Hillsboro Inlet.

From Hillsboro Inlet south, the original hammock apparently was an almost continuous strip back of the beach to a point below the present beach developments opposite Fort Lauderdale. Typical *Liguus fasciatus septentrionalis* is represented in collections examined from the following localities (1–4) in this hammock area:

1. Coastal hammock 1 mile south Hillsboro Inlet, sec. 29, T. 48 S., R. 43 E. Specimens in Simpson Collection.

A small fragment of this beach hammock was searched in 1950, but no *Liguus* found. The rest of the area is almost completely cleared.

2. Coastal hammock 3 miles south Hillsboro Inlet, E. ½ sec. 6, T. 49 S., R. 43 E. Specimens in UMMZ and other collections.

A fragment represents the former beach hammock cited by Davis (1943:148) as "Coastal Hammock." The area in which *Liguus* was most abundant was west of Florida Highway A1A along the Intracoastal Waterway. Davis (1943) also referred to this type of hammock, occurring on relatively dry sands, as "thicket hammock." The particular stand involved contained gumbo-limbo *(Bursera simaruba),* mastic *(Sideroxylon foetidissimum),* some Jamaica dogwood *(Ichthyomethia piscipula),* and other large trees, with a dense underbrush in places composed of wild lime *(Zanthoxylum fagara)* and other thorny small trees and shrubs. The hammock was partly cleared in 1950 and only fragments of shells could be found.

3. Coastal hammock northeast of Fort Lauderdale. Specimens in Simpson Collection.

Labels in the Simpson Collection indicate that the *septentrionalis* was obtained approximately 3 and 4 miles northeast of Fort Lauderdale, now partly in a state park. No trace of hammock suitable for *Liguus* now exists in these areas, and the specimens collected by Simpson have been lost or misplaced.

4. Coastal hammock on beach opposite Fort Lauderdale. Specimens in Simpson Collection.

This region is now completely occupied by houses, stores, and other buildings, with no suggestion of any former hammock.

FORT LAUDERDALE AND VICINITY

A series of hammocks formerly occurred between the pinelands and the Pleistocene Silver Bluff shoreline in what is now the city of Fort Lauderdale. The factors favoring the development of these hammocks were similar to those which produced Brickell Hammock and the hammocks along the Silver Bluff shore north of the Miami River at Miami. The high ground, probably a series of bars during late Silver Bluff time, was relatively protected from fire and drought by its proximity to the bay or inlet of the rivers. The hammock sites were early recognized as favorable for human habitation because of their elevation, large trees, and proximity to the shore, and in both Fort Lauderdale and Miami they still represent the most desirable residential property. The former extent of the Silver Bluff shore hammocks can usually be determined by the presence of large native trees in the yards of older residences; new clearings, however, have often been completely flattened by bulldozers with flagrant disregard for the large oaks, gumbo-limbos, and mastics.

Specimens of *Liguus* have been examined from the following localities (5–8) in the vicinity of Fort Lauderdale:

5. Great (or Big) Hammock in Fort Lauderdale, secs. 2–11, T. 50 S., R. 42 E. Specimens in Simpson, UMMZ, and other collections.

This large hammock north of New River was apparently never as tropical as Brickell Hammock at Miami, but contained a great many tropical trees and shrubs. The more tropical portions were probably originally surrounded by a protective zone of oaks, primarily the live oak *(Quercus virginiana)* which was abundant throughout the area to judge from the surviving trees. Gumbo-limbo, mastic, pigeon plum *(Coccolobis laurifolia),* and wild fig *(Ficus aurea),* doubtless, were also widespread. The understory, from the existing fragments, seems to have contained many tropical hardwood shrubs such as the stoppers (*Eugenia* spp.) and others.

That *septentrionalis* was once abundant throughout the hammock is indicated by the old collections and the many dead shells which could formerly be picked up on vacant lots. Living snails occurred in fragments of the hammock between cleared areas as late as 1937.

6. Hammock south of New River in Fort Lauderdale, sec. 11, T. 50 S., R. 42 E. Specimens in Simpson and probably other collections.

This hammock south of New River seems to have been similar to the Great Hammock, but possibly may have had more tropical trees and shrubs. Large fragments of it were still intact in 1950, but it had been wholly cleared and occupied by residences by the summer of 1957. Large hammock trees, however, remain in yards along Ponce de Leon Boulevard and elsewhere.

All shells from the locality that were examined are *septentrionalis*. None has been reported in recent years.

7. Hammock 1 mile south of New River, sec. 14, T. 50 S., R. 42 E. Specimens in Simpson and UMMZ collections.

Only a minute fragment of this hammock existed in the vicinity of SE 15th Street and Miami Road in the summer of 1957. It represents part of a narrow Silver Bluff shoreline hammock which formerly extended for some distance to the north and south. Large hammock trees still survive in some of the yards. The general vegetation was similar to that of the shoreline hammocks in Miami, that is, an abundance of tropical trees and shrubs at the center of the strip and a zone of live oaks on either side. The edge toward the coastal prairies was probably low oak scrub similar to that still intact at Snake Creek Hammock (Map 2, Loc. 21) farther south.

No living *Liguus* has been found in recent years, although the remaining hammock seems suitable for them. One lot in the Simpson Collection is composed entirely of *septentrionalis,* but old fragments collected in 1957 indicate that *roseatus* color form *castaneozonatus* (variant *"elegans")* had also occurred. Available material is too scanty to determine whether or not interbreeding occurred.

In addition to the preceding hammocks located on the Silver Bluff shoreline the following hammock, and probably others, were located along the edges of transverse glades inland:

8. Hammock in southwestern section of Fort Lauderdale, sec. 21, T. 50 S., R. 42 E. (Locally called "Taylor's Hammock"?). Specimens in several collections.

The area in which this hammock stood has been about as heavily burned, cleared, and otherwise abused as was possible without removing all of the larger trees. In 1950 the large oaks and figs still remaining showed signs of burning up into the higher branches. Even fragments of *Liguus* were scarce.

The original colony was apparently a mixture of *septentrionalis* and several forms of *roseatus*. Fragments in the UMMZ represent *lossmani-*

cus (variant *"luteus"*), *castaneozonatus* (possible typical), and *septentrionalis*. C. N. Grimshawe of Miami informed me that he had collected *elliottensis* (variants *"mosieri"* and *cingulatus"*) in this hammock in the past. Simpson (1929) mentioned that Karl Squires collected *roseatus* (variant *"livingstoni"*) at Fort Lauderdale, and the hammock presently under discussion may be the source. Specimens of *lossmanicus* (variant *"luteus"*) in the Simpson collection marked "Hammock N.W. of Dania" may also be from this locality. Not enough material is available to determine whether interbreeding with *septentrionalis* occurred. This hammock and the preceeding (Loc. 7) must represent the northern limits of the range of the subspecies *roseatus* on the east coast of Florida, unless the *"livingstoni"* collected by Squires actually came from Great Hammock (Loc. 5). South of here there is a break of at least 6 miles before color forms of *roseatus* showing colored axial regions or dark pigments are, or were, found in the hammocks. This may be significant biogeographically or it may simply mean a complete loss of records for the heavily urbanized environs of Hollywood. Mixed colonies may still survive east of U. S. Highway 1, but it seems doubtful since none have ever been reported.

Another hammock, locally called "Black Snake Hammock" was also located in sec. 21, T. 50 S., R. 42 E. I have been unable to locate it, but specimens of large, inflated, and highly polished *roseatus* color form *lossmanicus* (variant *"luteus"*) are so labelled in several collections.

DANIA-DAVIE AREA

Hammocks supporting colonies of *lossmanicus* (variant *"luteus"*) and possibly other color forms of *roseatus,* together with *septentrionalis,* once surrounded Dania and extended to the west. Around Dania, they have been completely destroyed except for larger trees surviving in yards. Since there has also been some succession in places and gumbolimbos have been planted as ornamentals, it is now difficult to locate the former sites. To the west of Dania only one hammock is now certainly known to support *Liguus,* but others may possibly still persist in the gladelands around Davie.

Material is available in various collections from the following localities (9–13):

9. Hammock ¾ miles north of Dania, secs. 27–34, T. 50 S., R. 42 E. Specimens in the Simpson Collection.

Remnants of this hammock persist about 0.3 mile north of the Dania cutoff canal west of the Florida East Coast Railroad and old U. S. Highway 1, in the area between the railroad and present U. S. High-

way 1, and to the east of it. The hammock was probably originally on the Silver Bluff shoreline and extended west along the edge of a transverse glade. Large oaks, gumbo-limbos, and other hammock trees remain in yards, but most smaller trees and shrubs have been removed.

Two lots of shells in the Simpson Collection probably represent this locality. One marked "Hinkley Hammock, N. of Dania (Old Hinckley Hammock)" is composed entirely of *lossmanicus* (variant *"luteus"*) of an inflated type. The other, marked "Hammock ¾ mi. N. Dania" consists of one large dead shell which is possibly *elliottensis,* (variant *"mosieri"*) but is so faded that it may be *lossmanicus.* No snails or fragments have been found here in recent years.

10. Hammock ½ mile north of Dania, center sec. 34, T. 50 S., R. 42 E. Specimens in Simpson Collection.

The former site of this hammock is now entirely within the town of Dania and is indicated only by the presence of large hammock trees in the region between NW. 4th and 7th Avenues, 2d and 3d Streets. It is difficult to define the exact limits because hedgerows of gumbo-limbo, now large trees, have been planted.

An interesting lot of shells in the Simpson Collection is from this locality. Five are dead shells, presumably picked up off the ground, which show no color pattern and could be either *roseatus* color form *lossmanicus* or *septentrionalis.* The sixth is definitely a young specimen of *septentrionalis.* No snails or fragments have been reported of late.

11. Hammock 1½ miles west of Dania, sec. 28, T. 50 S., R. 42 E. (Locally called "Fort Lauderdale Airport Hammock"). Specimens in several collections.

This hammock, now completely destroyed, formerly supported a colony of *roseatus* color form *lossmanicus* (variant *"luteus"*). Ralph Humes informed me that its location on Map 1 is not exact, but that it should be located in the S. W. corner of sec. 28.

12. Hammock 3½ miles west of Dania, sec. 31, T. 50 S., R. 42 E. and sec. 36, T. 50 S., R. 41 E. (Locally called "Moore's Hammock"). Specimens in Simpson, UMMZ, and other collections.

This hammock, visible from U. S. Highway 441 just south of the Dania power plant, is now largely cleared and built up with residences. A small part on the north side, east of Tarboux Road is still fairly untouched and supports *roseatus lossmanicus* (variant *"luteus"*). The hammock was in general more northern in aspect than those to the east. Large oaks, figs, mastics, and other trees still persist in yards and elsewhere, and snails can sometimes be observed from the street. In the more natural areas there is a fairly heavy understory of wild lime, satin

leaf (*Chrysophyllum olivaeforme*), marlberry (*Icacorea paniculata*), wild coffee (*Psychotria* sp.), and other tropical hardwood shrubs. Pigeon plum and gumbo-limbo are relatively infrequent. The ground is densely covered with ferns, and lianas (*Munsoniana, Rhus, Vitis*) and air plants (*Tillandsia* spp., *Dendropogon usneoides*) are more abundant than in the eastern hammocks.

Shells examined from this hammock were mostly small, highly polished, and rather intensely colored and inflated. The green lines are conspicuous. Except for the color and the characters of the orifice and columella they could be readily mistaken for *septentrionalis*.

13. Hammock 5 miles west of Dania, sec. ?, T. 50 S., R. 41 E. Specimens in Simpson Collection.

This hammock has not been located exactly, but Dr. John M. Goggin told me that small hammocks in the vicinity of Davie supported colonies of *roseatus lossmanicus* in the past. The lot of shells in the Simpson Collection is also marked "Hammock and grapefruit grove." The snails, all of the variant *"luteus,"* are heavy and not highly colored nor very inflated.

About Davie is gladeland and the hammocks are low and considerably unlike those on the rocky ridge to the east. A cleared oak hammock along the glade edge in the Seminole Indian Reservation just west of U. S. Highway 441 on Stirling Road (sec. 36, T. 50 S., R. 41 E.) may also have supported *Liguus*.

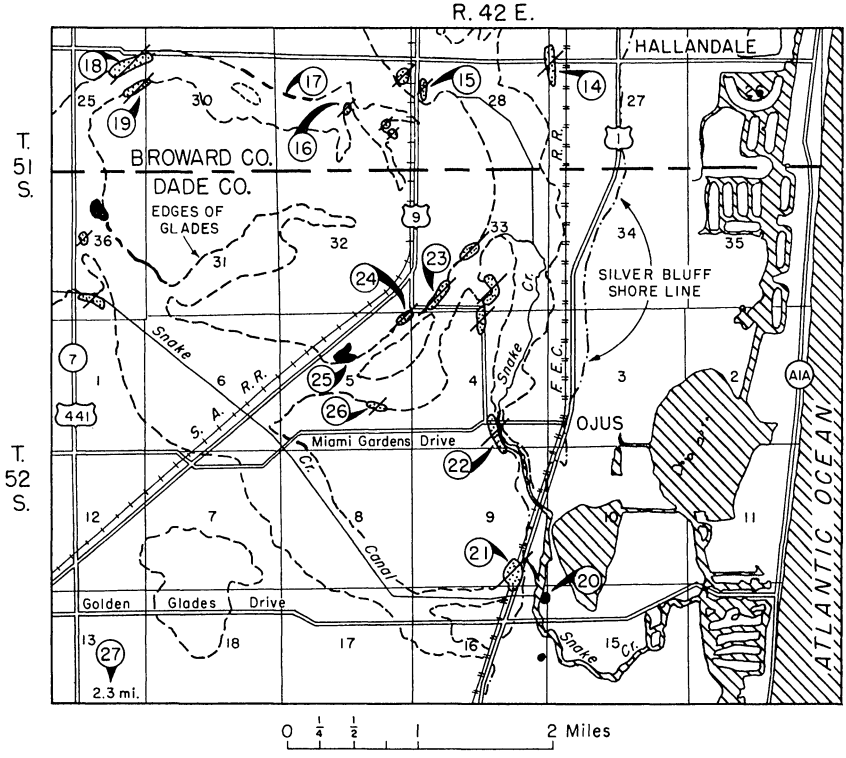
Characters of the snails in the Dania-Davie area suggest that this was an area of massive interbreeding between *septentrionalis* and *roseatus*. Inflated, deeply green-lined specimens from some of the hammocks can scarcely be distinguished from *septentrionalis* except by the intense yellow-wash ground color and the shape of orifice and columella. The problem of intergradation is complicated, however, since the thin, porcellaneous, inflated character of the shells here may be a response to the environmental conditions rather than to genetic factors. Heavier nonporcellaneous, constricted shells may be merely a response to greater availability of calcium. Just such a relationship has been observed in the old "Watson's Hammock" at Miami (Young, 1951: 12).

HOLLYWOOD AREA

In the vicinity of Hollywood, remnants of hammocks remain, between Stirling Road and Pembroke Road (Florida Highway 824), but no specimens of *Liguus* from them have come to my attention.

HAMMOCKS IN SOUTHERN BROWARD AND NORTHERN DADE COUNTIES
(Map 2, Locs. 14–25)

The hammocks in southern Broward and northern Dade counties are or were essentially similar to those in northern Broward. One additional type in relation to topography is apparent, however, a



MAP 2. Southern Broward County and northeastern Dade County, Florida, showing location of stands of the jungle hammock associes. Legend as for Map 1, except for scale and that dashed lines indicate approximate edges of transverse glades and dashed and dotted line the approximate Silver Bluff shoreline. Some jungle hammock stands not mentioned in text are shown. Numbers refer to hammock localities described in the text.

Based on U. S. Soil Conservation Service Map (1946) and aerial photographs by U. S. Department of Agriculture (1953).

hammock on an Indian mound in the intracoastal marshes (Loc. 20). No great increase in tropical plants is evident, nor are hammocks developed in the open pinelands around sinkholes as in the region to the south.

HALLANDALE AND VICINITY

This area has been very intensively modified in recent years. Just west of the town of Hallandale extensive borrow-pit operations have removed a number of hammocks and subdivision developments have destroyed others. The original hammock system was extensive and consisted, for the most part, of oak hammocks along transverse glades with hardwood fringes on the edge toward the pinelands. After intensive pineland fires had been controlled and before modern development, considerable succession of these hammocks took place. At present, former sites can be recognized only by the persistence of large hammock trees. No evidence of hammocks has been found east of U. S. Highway 1. Those along the Silver Bluff shore, if any ever existed, apparently were destroyed long ago by fire and clearing.

14. Hammocks ½ mile west of Hallandale, sec. 27, T. 51 S., R. 42 E. No specimens available.

Remnants of hammock edge the transverse glade just west of the Florida East Coast Railroad about ½ mile west of U. S. Highway 1. The hammocks themselves are now largely cleared and their sites enclosed in the inhabited part of the town, but *Liguus* probably occurred in places in the past. Similar hammocks extend south along the glade edge into Dade County (sec. 33, T. 51 C., R. 42 E.), and probably originally connected with the Ojus-Snake Creek Hammock System.

15. Hammocks 1½ miles west of Hallandale, secs. 28–29, T. 51 S., R. 42 E. No specimens available.

Several hammocks, partly cleared and planted to citrus groves, formerly existed here. Originally, only a single large hammock may have been involved, one centering around a peculiar slough that now exists and which may represent an underground stream the roof of which collapsed. Most of the natural vegetation is now destroyed.

16. Hammock 2 miles west of Hallandale, center of sec. 29, T. 51 S., R. 42 E. Specimens in UMMZ and probably other collections.

A small hammock formerly existed on the edge of the glade about ¼ mile south of Hallandale Beach Boulevard. Vegetation was fairly natural in 1948–1950, except for the encroachment of a borrow pit along the south end. Large figs, gumbo-limbos, oaks, and mastic were growing together with pigeon plum, wild lime, marlberry, and many other tropical trees and shrubs. The disturbed edges had an abundance of *Trema floridana*. The entire area has now been destroyed by borrow-pit operations.

The tree-snail colony consisted entirely of *lossmanicus,* and snails were observed ovipositing in the forest floor duff in September, 1950. The shells are moderately large and inflated, but not so highly colored as others from nearby. The green lines, however, are strong and in many individuals show the typical distribution of lines characteristic of *septentrionalis.*

17. Hammock fringe about 3.0 miles west of Hallandale, sec. 29, T. 51 S., R. 42 E. Specimens in UMMZ.

A fringe of hammock formerly occurred in this area along the north edge of the glade and was explored about 1933 from County Line Road to the south. The exact locality is now uncertain. On the glade side, this hammock was thinly grown up in willows (*Salix* spp.), pond apple (*Anona glabra*), and other wet-foot plants. Back of the swampy zone were narrow strips of tropical hardwoods, including gumbo-limbo and mastic intermixed with oaks. The strips had been severely burned, the palmettos often extending out to the glade edge, and all the trees were scraggly and showed signs of having been exposed to fire. The hammock strips were seldom more than 20 feet wide, but many of the trees were quite large in diameter although less than 30 feet in height. Such surroundings are particularly interesting, because they indicate the ability of *Liguus* to survive under extremely unfavorable conditions, and the distribution of the strips suggests the kind of long-term mechanism by which colonies may move along the edges of the glades. That is to say, as Pilsbry wrote (1946), the hammocks moved as well as the tree snails. The edges of the transverse glades may have completely grown up in long strips of forest during favorable periods, thus furnishing highways for the migration of snails and other animals. Even though now considerably disturbed by building operations, there is evidence of succession in many places. On the south edge of the glade large pine trees are now enclosed in the spreading oak hammocks.

The few examples available from this locality, all of *roseatus* color form *lossmanicus* (variant *"luteus"*), reflect the unfavorable conditions. They are small, dull, heavy, and bleached to whiteness on the upper whorls. Only the lower whorls and new lip growth show the typical yellow wash. No green lines can be detected even on the new lip growth. No snails have been collected in recent years.

18. North Hammock, 3½ miles west of Hallandale, sec. 25, T. 51 S., R. 41 E and R. 42 E. Specimens in UMMZ and other collections.

North Hammock, formerly visible from U. S. Highway 441, along the north edge of the transverse glade, has now been partly cleared. The vegetation was a combination of tropical hardwoods mixed with

oaks. The understory was relatively open probably due to frequent fires which penetrated from both the pineland side and the glade.

In the hammock along the north edge of the glade, the tree snails were apparently all of *roseatus* color form *lossmanicus*. The specimens at hand are small, moderately inflated, polished, and with a rather light yellow wash. Green lines are strong and numerous, but few shells show the *septentrionalis*-type of line distribution.

19. South Hammock, 3½ miles west of Hallandale, sec. 30, T. 51 S., R. 41 E. Specimens in UMMZ.

In 1933 oak growth extended into the glade south of North Hammock, across an "island" of higher ground, almost to its south edge; it was difficult to tell where one hammock stopped and the other began. However, no *Liguus* was found in the more open growth. The hammock along the south edge of the glade was rather narrow but fairly dense in places. Vegetation was like that in North Hammock.

The following color forms and variants of *roseatus* are represented in the UMMZ collection:

2 *ornatus,* fairly typical with pink tips and columellas, but rich brown or beige.
1 *ornatus,* with pink tip and white columella and light yellow wash.
2 *castaneozonatus,* variants *"elegans"* and *"miamiensis."*
3 *elliottensis,* variant *"mosieri."*

If all these snails were native to the vicinity, this represents the northernmost locality for the color form *ornatus,* but there is a distinct possibility that the snails were introduced from some other region of Florida. All have the typical shape and surface luster of shells from the area, but one specimen of *ornatus* has the pink of the tip concentrated into a small point (locally called "jewel" by collectors) as in many snails from the Pinecrest region of the Everglades. On the other hand, this "jewel" tip is also found in shells from Ojus Hammock (2½ miles south and a similar distance east). Since some of those from the latter were collected before amateur collectors began "planting" shells in various hammocks, it is possible that the "jewel" tip condition was a local mutation in the Hallandale and Snake Creek systems. The rich brown or beige color of these *ornatus* occurs also in shells from Ojus Hammock (*ornatus*), North Miami Hammock (*roseatus*), as well as from Brickell Hammock at Miami (*roseatus* and *ornatus*).

Although no living tree snails have since been found in South Hammock, a small lot, collected in 1950, from a hammock about 1 mile south in Dade County, casts further doubt on the authenticity of the original lot. This small hammock, now completely destroyed by borrow-pit operations, was in sec. 36, T. 51 S., R. 42 E., just east of U. S.

Highway 441. Specimens of *Liguus* from it are *castaneozonatus* (*"miamiensis"*) and *elliottensis* (*"mosieri"*) which could be native, but with them were associated specimens of a related tree snail of the genus *Orthalicus,* which could not conceivably be from northern Dade County.

OJUS—SNAKE CREEK HAMMOCK SYSTEM

The edges of Snake Creek (sometimes called Oleta River) and the associated transverse glades supported a very extensive hammock system. The large hammock near the former mouth of Snake Creek has been dissected by roads and the old Ojus Hammock is now enclosed in Greynolds Park. Inland, there are ten or more fragments of hammocks along the glade edges, which probably supported colonies of *Liguus* in the past. The composition of the various known colonies shows an interesting east to west trend, perhaps significant zoogeographically.

20. Indian Mound east of Snake Creek, NE. corner sec. 16, T. 52 S., R. 42 E. Specimens in UMMZ and probably other collections.

A small island opposite the mouth of Snake Creek Canal in the marshes of the upper part of Biscayne Bay is partly covered with hammock growth, consisting of gumbo-limbo, wild lime, and other tropical hardwoods. The island partly represents an Indian mound or midden over which the tropical hammock has grown. Ralph Humes told me that this is the "Angel Key" of the Simpson Collection.

The colony of *Liguus* that lived on the mound was composed entirely of *roseatus* color form *roseatus*. Younger shells show rich yellow banding onto the 6th whorl, but mature shells do not have the bands continued beyond this point so that they resemble Simpson's variant *"livingstoni."* The sutural brown line characteristic of *roseatus* color form *lineolatus* is suggested in some. Specimens available could readily be mistaken for a lot from Marco Island, or other Florida west coast colonies. This group may have been very old, because a heavily stained shell was found about a foot beneath the surface of the mound by Dr. John M. Goggin, when he was excavating for artifacts. Possibly, the original snails may have been brought here by the Indians.

21. Snake Creek Hammock, secs. 9–16, T. 52 S., R. 42 E. Specimens in Simpson, UMMZ, and other collections.

High ground north and west of Snake Creek and the Snake Creek Canal once supported a large hammock which was cleared and otherwise modified many years ago, but in which *Liguus* persisted until the late 1950's. Snake Creek Hammock originally extended from the Silver Bluff shoreline, just west of Snake Creek, over 1/4 mile north and west.

It was apparently protected from fire by sloughs or glades that cut it off from the pinelands. The original vegetation was no doubt similar to that of other hammocks in the area, but citrus and other plants have been introduced in recent years. Main highways, railroads, and secondary roads have divided the original hammock into several portions.

One lot of shells in the Simpson Collection contains the following color forms of *roseatus:*

3 *castaneozonatus,* variant *"miamiensis."*
1 *elliottensis,* variant *"mosieri."*

Specimens in the UMMZ are of the same variants as those above except that one dead shell, collected in 1957, and some fragments are close to typical *castaneozonatus* and one fragment may represent *"livingstoni."* The shells are large, only moderately inflated, and show a distinct sutural brown line except in the *"mosieri."* Younger specimens of *castaneozonatus* are brilliantly colored and with strong green lines so that they resemble shells from Brickell Hammock rather than from Arch Creek. The proportions in all lots seen are approximately: *"miamiensis,"* 12; *"mosieri,"* 2; *"livingstoni?"*, 1. Nearly all unidentifiable fragments had pink tips and/or pink columellas.

22. Hammock ½ mile west of Ojus (now in Greynolds Park), secs. 4–9, T. 52 S., R. 42 E. Specimens in Simpson, UMMZ, and other collections.

Hammock probably originally existed along both sides of Snake Creek running northwest from the old Dixie Highway. Several fragments still remained when Greynolds Park was developed. At that time, 1933, snails were abundant in the part being cleared in the N. ½ of sec. 9 and the SE ¼ of sec. 4, T. 52 S., R. 42 E. A few small remnants of the hammock are preserved around the camp in sec. 4, but the rest is now obliterated and the area used as a picnic ground. No *Liguus* were obtained in 1933 in the southeastern part of the park, although the hammock growth in places looked favorable. The vegetation was similar to that of other hammocks in the neighborhood, and many large oaks, gumbo-limbos, and other trees are still standing in the park.

The Simpson Collection contains two old lots of shells marked: "Hammock south of road west of Ojus" (1) and "Hammock N. W. of Ojus" (2). The following variants of color forms of *roseatus* are represented:

1.—10 *castaneozonatus,* variant *"miamiensis."*
10 *elliottensis,* variant *"mosieri."*
1 *roseatus,* fairly typical.
2.— 1 *castaneozonatus,* variant *"miamiensis."*
1 *lossmanicus,* variant *"luteus"* (faded and not very inflated).

In addition there is a single shell in the Simpson Collection labeled: "Back of Ojus (Deckert and Farnum)." It is the color form *ornatus* and is brown or beige, as those previously noted from west of Hallandale.

The UMMZ has one lot of shells from this hammock collected in November, 1933, which comprise the following color forms of *roseatus:*

1 *marmoratus,* typical (found dead in clearing).

9 *castaneozonatus,* which show various degrees of development of dark bands ranging from typical *castaneozonatus* to fairly typical *"miamiensis."* Older shells are badly faded and resemble those from Arch Creek. Six young specimens have the pink of the tip concentrated ("jewelled") as indicated for *ornatus* under Hammock 19, a condition which may fade in mature shells.

13 *elliottensis,* mostly variant *"mosieri"* with faint yellow banding and numerous fine green lines, but one without color.

6 *lossmanicus,* variant *"luteus,"* all small moderately inflated shells with numerous green lines similar to those from the Hallandale hammocks. One specimen was brilliantly flamed with orange on the lip when collected.

In general, the shells from this colony are small, rather strongly inflated, and highly colored but with the surface texture rather matte. Occurrence of the "jewelled" tips in the UMMZ specimens of *castaneozonatus* is interesting.

To the north and west of Greynolds Park, the Ojus–Snake Creek System included a considerable number of hammocks some of which probably originally contained colonies of *Liguus.* The localities explored are indicated on Map 2.

23. Oak Haven Hammock, SW. 1/4 sec. 33, T. 51 S., R. 42 E. Specimens of *roseatus* color form *elliottensis* were observed in 1948, but not collected.

This hammock is now mostly cleared. Hammocks to the north and east along the glade edge were explored, but neither living *Liguus* nor fragments were found.

24. Hammock in NE. 1/4 sec. 5, T. 52 S., R. 42 E. Specimens in UMMZ.

A small strip of hammock between the glade and pineland survived until about 1955. It has since been cleared. The vegetation was similar to that described for the hammock No. 12.

The lot in the UMMZ includes the following color forms of *roseatus:*

12 *elliottensis,* all but one variant *"mosieri";* 1 pure white and polished.

5 *lossmanicus,* variant *"luteus,"* pale with few green lines; little inflated.

25. Hammock 1 3/4 miles west of Ojus, W. 1/2 sec. 5, T. 52 S., R. 42 E. Specimens in UMMZ and probably other collections.

The present large size of this hammock is apparently due to succession. *Liguus* persists along the edge of the glade in the southern por-

tion, where a hammock strip containing large figs, gumbo-limbos, and mastics, with a heavy undergrowth of tropical hardwoods and ground cover of ferns, lies between the glade edge and the oak succession to the north. Signs are that this area is to become a housing development.

Snails collected in 1957 are all of *roseatus* color form *lossmanicus* variant *"luteus."* They are small, brightly colored, and with numerous green lines. Even the larger specimens are inflated. As a group the shells are very similar to those from the hammock at locality 12, and apparently represent the most southern locality for a pure colony of this type. This may also be the locality for specimens of *lossmanicus* in the Simpson Collection that are simply marked "West of Fulford."

26. Hammock 1½ miles west of Ojus, SE. ¼ sec. 5, T. 52 S., R. 42 E. Specimens in UMMZ.

The area occupied by this hammock has now been obliterated by borrow-pit operations. It was on the south edge of the glade on which the hammocks at localities 23 to 25 are located.

Very old fragments of *Liguus,* collected in 1948, indicate snails with a colored axial region, so that the original colony was probably mixed.

Along the edges of the glades in this area there is evidence of numerous other small fragments of hammock, which have either been cleared or are in the process of being destroyed. No records of *Liguus* have been found for them so far. Many small hammocks and hammock fringes are indicated on the aerial photographs (U. S. Department of Agriculture, 1953) but many of these have been or may be lost before they can be checked for *Liguus* (some of them are shown without numbers on Map 2).

OTHER HAMMOCKS IN DADE COUNTY

With the exception of a hammock in the vicinity of North Miami and a few in the Everglades west of the ridge, all of the hammocks between Arch Creek and the Miami River have been described (Young, 1951). These are discussed here to complete the previous account.

27. North Miami Hammock, NE. ¼ sec. 25, T. 52 S., R. 41 E. Specimens in the UMMZ, Simpson Collection, and probably other collections.

This moderately large hammock formerly situated on the edge of the glade bordering Little Arch Creek (now Biscayne Canal) has been completely destroyed. Even the larger trees have been removed so that it is impossible to locate the former site.

The Simpson Collection contains three small lots of shells from this

locality marked "Freeman Hammock" or "Hammock west of Arch Creek." The lots contain the following color forms of *roseatus:*

1.—1 *castaneozonatus,* variant *"miamiensis."*
2 *elliottensis,* variant *"mosieri."*
1 *roseatus?,* a peculiar form with pink tip and faintly pink columella, marked with conspicuous green lines; possibly a hybrid of *roseatus* × *septentrionalis.*
2 dead shells, which cannot be identified.
2.—4 *elliottensis,* variants *"mosieri"* and *"cingulatus."*
3.—3 *roseatus,* variant *"livingstoni."*
4 *elliottensis,* variant *"mosieri."*

One small lot of 37 shells in UMMZ, collected in 1933–34, contains approximately the same variants plus 1 *lossmanicus* variant *"luteus"* and 1 *roseatus* in which the usual yellow pigment is replaced by brown or beige, as in the *ornatus* mentioned from the hammock at locality 19, and the one at locality 22.

EVERGLADES IN THE VICINITY OF HIALEAH AND OPA LOCKA

There are, or were, a few hammocks in the vicinity of Hialeah and Opa Locka, in Dade County, which formerly supported *Liguus.* I have been unable to locate any of them exactly, but material in various collections is from the following locations:

28. Hammock 5 miles N.W. of Hialeah, T. 52 N., R. 40 E. Specimens in Simpson Collection.

Seven specimens of *roseatus* color form *elliottensis* in the Simpson Collection are from northwest of Hialeah. Although several hammocks are indicated in the approximate area on the aerial photographs, (U. S. Department of Agriculture, 1953), most of them have been cleared.

29. Farnum Hammock, possibly sec. 19, T. 52 S., R. 41 E. Specimens in several collections.

This location has probably been completely obliterated by building operations. The original snail colony was apparently always small and consisted principally if not entirely of *roseatus* color form *lossmanicus* variant *"luteus,"* according to reports of local collectors.

EVERGLADES WEST OF MIAMI

Hammocks suitable for *Liguus* do not occur generally in the Everglades near Miami. I have been told that a number of colonies of *lossmanicus* occur in hammocks between the western limit of the pinelands and Krome Avenue, but only one has been located exactly:

30. Flagami Hammock, NW. 1/4 sec. 2, T. 54 S., R. 40 E. Specimens in Simpson, UMMZ, and other collections.

This hammock formerly centered around a Tequesta Indian mound, north of West Flagler Street and west of NW. 72d Avenue, and it may have extended into Lot 2 north of section 2. The former extent is clearly shown on the aerial photographs of 1938 (U.S. Department of Agriculture) and its dissection and destruction on those of 1953. The subtropical hammock growth was originally encircled by an extensive zone of mixed hardwoods including hackberry (*Celtis* sp.) and other trees and shrubs, extending out into the surrounding gladelands. In recent years the snails have survived mostly in this border and are still often found on the hackberry trees.

The colony was composed entirely of *roseatus* color form *lossmanicus* of a rather peculiar type. The coloring is generally similar to typical variant *"luteus,"* but the shells are often large (up to 68 mm. long) and elongate, even though the lower whorls may be moderately inflated. In appearance, they contrast strongly with the short, inflated shells of the Dania and Hallandale areas. Shells collected in the summer usually have a light yellow wash on the lower whorls, while those taken in winter are nearly while, and lightly banded with yellow except on the extreme lip.

SUMMARY

Stands of subtropical and jungle hammock associes, which now or formerly supported colonies of *Liguus fasciatus* in the area of southeastern Florida between Hillsboro Inlet and Arch Creek, were located as exactly as possible and the composition of the colonies determined whenever authentic material was available. Since the colonies in this area are now almost all extinct and the hammocks are rapidly being destroyed by the expansion of urban centers, these data may be of value for future students in completing the records of the distribution of *Liguus* in southern Florida.

Northern limits for the subspecies and color forms of *Liguus fasciatus* discussed here are still indefinite because the evidence is contradictory, but may be summed up for the east coast as follows:

Liguus fasciatus septentrionalis Pilsbry.—Northern limit definitely at Boca Raton just north of Hillsboro Inlet in Palm Beach County, but possibly to Palm Beach in historic times.

Liguus fasciatus roseatus Pilsbry.—Northern limit in vicinity of New River, Broward County:

Color forms: *castaneozonatus.*—Hammock 1 mile south of New River (Loc. 7). *roseatus, elliottensis,* and *lossmanicus.*—Hammock 1 mile south of New River (Loc. 7), but *roseatus* may have lived in Great Hammock (Loc. 5), north of New River.

ornatus.—Hammock ½ mile west of Ojus in Dade County (Loc. 22), but possibly the hammock 3½ miles west of Hallandale (Loc. 19) in southern Broward County.

marmoratus.—Hammock ½ mile west of Ojus (Loc. 22).

The southern limit of *septentrionalis* is still uncertain, and probably cannot now be established. It is suggested, however, that the inflated *roseatus* color form *lossmanicus* occurring between New River and the Snake Creek Canal are the result of hybridization between *septentrionalis* and *roseatus*. All of the evidence seems to indicate that *septentrionalis* was once widely distributed south of New River, but was in the process of being displaced or absorbed by the more adaptable *roseatus* even before human intervention occurred.

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