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Dedicated to the memory of

ROBERT W. LONG, JR.

(1927-1976)

Past President
and
Devoted Servant of the Academy

ROBERT W. LONG, JR., 1927–1976

Our friend and colleague, Robert W. Long, died in his sleep July 21 after a long and incapacitating illness. Dr. Long served as Secretary (1970-1973) and President (1973-1974) of the Florida Academy of Sciences and was an active participant and strong supporter of the Florida Academy of Sciences. Because we have been privileged to work and socialize with him for the past twenty or so years, we feel obligated to write the following testimonial to him and his life work. Although we believe Bob would have expected only a forthright assessment of his contributions to his beloved botany and not a personal eulogy, we are compelled to say some things about his personal qualities as well as his professional accomplishments.

Bob Long was a complete man both in work and play. He enjoyed good food, drink, books, music and company as well as mild sports. He was something of a romantic and was addicted to history. We recall, after the AIBS meetings at College Park, Maryland, spending three days with him touring Civil War battlefields. No matter where he journeyed he detoured to visit the scenes of the past. A pleasant companion, he could also be a blunt critic and his bluntness could hurt. But he was never petty and he was always a defender of human rights and professional standards. He always supported and advocated the position that the rights of faculty were paramount in the life of the university, and he spent much of his valuable time in support of his colleagues, his students and his university.

We, Bob's friends, colleagues, and family, have known for several years that we would lose him. Since 1973, he was on a heavy dialysis schedule (12 hours a week) due to nearly complete loss of kidney function. However, we had thought we would have more warning of the end, which came after he had put in a normal day of teaching, research and advising students. His last professional act was to arrange for the next day's botany laboratory which he was reorganizing along audio-tutorial lines. During his years of illness he continued to work a full schedule although repeatedly urged to slow down. In the past year, six books and at least five articles were published under his authorship without letting up on his teaching duties. He had his work and he was bound to do it. How he managed and at what a cost in misery we can only imagine. Yet he was always the optimist and though not a stoic took a dispassionate view of his difficulties. To us his courage was completely magnificent and we will never forget it.

Robert W. Long, Jr. was born in Ashland, Kentucky on November 23, 1927, the only son of Naomi Long and Robert W. Long, Sr., the Chief Accountant for the Allied Chemical and Dye Corporation. Both parents are deceased. In 1953, he married Gloria Overstreet whom he met at the University of Indiana where she was an undergraduate music major, and he was a graduate student in botany working under the tutelage of Charles Heiser. Bob and Gloria have four children, Alice Ann, 20; Nancy Kathleen, 19; Robert W., 15; and Celia Rose, 12. When Bob was just a youngster, the family moved to Ironton, Ohio, where he completed grammar school and high school. He then entered Ohio Wesleyan University where he studied under Claude Neal, a botany teacher whom he greatly admired. After his graduation in 1950, he attended the University of Indiana and received the Ph.D. in 1954. The title of his dissertation is "A biosystematic investigation of *Helianthus giganteus* L. and related species." Biosystematics continued to be his chief research interest and he was occupied for a number of years with investigations of breeding systems in *Helianthus*. Later in his career he worked with the Acanthaceae, in particular members of the genus *Ruellia*, as well as floristic and ecological studies of the vegetation of South Florida. During his career, he authored more than 35 technical papers, about 20 non-technical articles, a number of book chapters and nine books. Foremost among the latter is the *Flora of Tropical Florida* published in 1971 with Olga Lakela. It will no doubt stand as a monument to the authors for years to come.

In his teaching career, Bob served as Instructor at Southern Methodist University (1953-54); Associate Professor at Ohio Wesleyan University (1954-62); and as Professor at the University of South Florida (1962-76). He played a major role in the establishment of botanical sciences as a viable field in the University of South Florida, and served as first Chairman of the Department of Botany and Bacteriology. He guided and developed the proposals that lead to the establishment of the undergraduate and graduate degrees in Botanical Science and was highly instrumental in the establishment of the Ph.D. in Biology at the University of South Florida. He became Curator of the Herbarium in 1963, and was appointed its Director in 1965. During this period (1963-present) the Herbarium has been recognized one of the most important in the Southeast; in 1974 it contained over 100,000 specimens. In addition, Bob was directly instrumental in the establishment of the Botanical Garden in 1968. He took an active part in the hiring of its first director and has served as Chairman of the Botanical Garden Committee.

Although Bob was a tireless research scientist, and the author of numerous technical papers, popular articles and books, he considered himself first and foremost a teacher, both of undergraduate and graduate students. He served botanical education at the national level as a commissioner of CUEBS (Commission on Undergraduate Education in the Biological Sciences) during the years 1970-1971, as a consultant for the Office of Biological Education of AIBS, and as a panelist and consultant for the National Science Foundation. At the University of South Florida, Bob was active in the formation of the botany and biology curricula and he guided many students, both undergraduate and graduate to the successful conclusion of their botanical academic programs.

Throughout his teaching career, Bob maintained an active interest in academic affairs in the University. He was very active in the early years of the University of South Florida in the formation of a faculty constitution and senate. He served on many University committees including the Undergraduate Council. Because of his experience in directing and administering of departmental affairs, he acquired a strong reputation for consistent and wise counseling and his advice was often sought.

Until his recent illness, Bob was an active field botanist, traveled and collected extensively in the southern and mid-western United States and in the Caribbean, especially Mexico and Central America. His field and laboratory studies were continuously supported since 1953 by grants from the National Science Foundation as well as other funding agencies. He is a world recognized authority in his area of study.

Bob was an active and recognized member of several professional societies including the Botanical Society of America, American Association of University Professors, Association for Tropical Biology. He served as Treasurer for the American Society for Plant Taxonomists, Secretary and later as President of the Florida Academy of Sciences, and Editor of the *Plant Science Bulletin* of the Botanical Society of America.

One of Bob's great professional concerns was that botanical studies not be lost in the current trend toward the merging of biological disciplines. While he had no strong objections to the concept behind such mergers, he was greatly disturbed over the frequent loss of botanical curricula as a consequence of departmental mergers. He had no personal fear for his position in a biology department, having faith in his own worth and that of this work, but he worried that students would not have the opportunity for the same exposure to botanical subjects that he had enjoyed. He was always the champion of Botany as a valid, nay indispensible, discipline and readers of the *Plant Science Bulletin* will remember the thought provoking articles on the subject that appeared during his editorship. Regardless of future trends in biological education, Robert Long's work as a student and teacher of botany will endure and, though we could have wished many more years for him, his work was essentially complete.—Clinton C. Dawes, Department of Biology, University of South Florida.

EDITOR'S NOTE: The Robert W. Long, Jr., Memorial Lecture Fund has been established with the Biology Department, USF, by friends and colleagues. The purpose of the fund is to sponsor an annual Botanical Lecture. Individuals or groups who would like to contribute may send contributions made out to the Robert W. Long Memorial Fund, c/o Biology Department, University of South Florida, Tampa, Florida 33620.

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FLORIDA SCIENTIST

QUARTERLY JOURNAL OF THE FLORIDA ACADEMY OF SCIENCES

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Original articles containing new knowledge, or new interpretation of knowledge, are welcomed in any field of Science as represented by the sections of the Academy, viz., Biological Sciences, Conservation, Earth and Planetary Sciences, Medical Sciences, Physical Sciences, Science Teaching, and Social Sciences. Also, contributions will be considered which present new applications of scientific knowledge to practical problems within fields of interest to the Academy. Articles must not duplicate in any substantial way material that is published elsewhere. Contributions from members of the Academy may be given priority. Instructions for preparation of manuscripts are inside the back cover.

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Biological Sciences

A DIGENETIC TREMATODE FROM A WEST INDIAN RACER

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Abstract: *The digenetic trematode,* Ochetosoma kansense *(Crow, 1913), is reported from a West Indian racer,* Alsophis vudii *Cope, from South Bimini Island, Bahamas; apparently the second record for the parasite family from the West Indies. The snail,* Physa cubense, *and the frog,* Osteopilus septentrionalis, *may serve as intermediate hosts on South Bimini.*

An adult West Indian racer, *Alsophis vudii* Cope, which L. W. Porras collected on South Bimini Island, Bahamas, yielded 48 ochetosomatid trematodes. These flukes were flushed from the mouth of the snake during preservation. They were stained in Semichon's carmine, cleared in oil of wintergreen and mounted onto slides with Permount. The slides are preserved in the Florida State Museum collection. Dr. Albert Schwartz has retained the snake in the Miami-Dade Community College collection.

The trematodes are similar to the description of *Ochetosoma kansense* (Crow, 1913) based on the position and structure of the metraterm, genital pore and vitellaria. Description of the *Ochetosoma kansense* specimens from South Bimini Island follows:

Genital pore marginal, at level of pharynx, slightly posterior to oral sucker; vitellaria undivided, beginning approximately midway between bifurcation of ceca and acetabulum, usually ending slightly posterior to the testes; ceca short, ending just in front of testes; uterus with a few wavy coils; acetabulum 20-31% (avg. 28.3) larger than oral sucker; metraterm barely differentiated from cirrus sac and often joined to it over its entire length. Measurements of 10 adults (with eggs in uterus): total length, 1.789-3.782 mm (avg. 2.763 mm); width, 651-992 μm (814 μm); oral sucker diam., 248-324 μm (avg. 280 μm); acetabulum diam., 310-465 μm (avg. 390 μm); distance between oral sucker and acetabulum, 328-781 μm (avg. 581 μm); anterior to acetabulum, 589-1116 μm (avg. 908 μm); ovary diam., 117-155 μm (avg. 134 μm); ova, 31-37 μm (avg. 35 μm) by 18; right testis length, 187-372 μm (avg. 253 μm); width, 198-465 μm (avg. 326 μm); left testis length, 179-372 μm (avg. 248 μm); width, 248-434 μm (avg. 355 μm); anterior to beginning of vitellaria, 508-992 μm (avg. 857 μm); distance between ovary and testes, 49-248 μm (avg. 147 μm).

Ochetosomatid trematodes are typically parasites of western hemisphere snakes, although one species is known from Europe. I am aware of only one prior record of the family from the West Indies based upon Perez Vigueras' (1942) description of *Ochetosoma adenodermis* isolated from *Alsophis angulifer* Bibron from Cuba. My report seems also to represent the second record of ochetosomatid trematodes from *Alsophis.*

On South Bimini Island, *Alsophis vudii* Cope utilizes a variety of open habitats but does not shun wooded situations (= coppice in the Bahamas). They are frequently found in grassy areas, in herbaceous or shrubby growths or even along beaches (Schwartz, personal communication). Several workers have investigated the life cycles of most of the genera and numerous species belonging to the family Ochetosomatidae and found that in each case both snails and larval amphibians or scaleless fishes were required as intermediate hosts. McCoy (1928), studying the developmental history of *Ochetosoma kansense* (Crow), found that it utilized the freshwater snail, *Physa,* as its first intermediate host, a tadpole or catfish as its second host, and the snake as its definitive host. On South Bimini Island, the snail, *Physa cubense* d'Orbigney, and the frogs, *Eleutherodactylus planirostris* Cope and *Osteopilus septentrionalis* Dumeril and Bibron, are available as intermediate hosts. Since *Eleutherodactylus* passes through the larval stage within a terrestrial egg, it seems doubtful that this frog is a host.

Acknowledgements—I thank Dr. Albert Schwartz, Miami-Dade Community College, for calling my attention to this series of helminths and Dr. Donald J. Forrester, Department of Veterinary Science, University of Florida, for his constructive criticisms of the manuscript.

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PELAGIC CAPTURE OF YOUNG ROUGH TRIGGERFISH IN THE CARIBBEAN[1]

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ABSTRACT: *The pelagic capture and subsequent behavior of two young individuals of the rough triggerfish* (Canthidermis maculatus) *from the Caribbean Sea is described and discussed.*

THE ROUGH TRIGGERFISH, *Canthidermis maculatus* (Bloch), ranges from New Jersey to Argentina in the western Atlantic, and also occurs in the eastern Pacific and Indo-Pacific (Moore, 1967). Because it is an offshore species, the rough triggerfish is rarely encountered and thus little is known of its life history and general ecology. I report here on the pelagic capture of several young rough triggerfish and on subsequent observations of their behavior in captivity.

During late February of 1974, two young specimens of *C. maculatus* were taken at midday near the surface in a neuston net towed through the open waters of the Caribbean at approximately 78°W, 14°N. The depth in this area exceeds 3,000 m, and the nearest shallow reef areas are over 200 km away. The two individuals were recovered from the net alive and without apparent damage. The larger of the pair was about 30 mm SL, the other slightly smaller. Identification was based on the description in Moore's (1967) review of the family. The fish were placed in a 15 gal aquarium below decks and observed for about 3 wk.

The coloration of the fish at the time of capture (Fig. 1) differed in several respects from Moore's (1967) description. These discrepancies are probably due to the fact that he examined preserved material only, and may be summarized as follows: (1) the ground color was a light blue-to-violet rather than the grey-to-brown described by Moore; (2) the axillae were white; (3) two prominent white saddles were present along the dorsal midline, one just anterior to the trigger and one between the trigger and the second dorsal fin; and (4) the dorsal, anal, and caudal fin membranes were light at the base and black along the outer margins.

The addition of *Sargassum* to the aquarium a few days after the fish were captured appeared to precipitate an adaptive color change in the larger individual. The ground color darkened considerably while the soft dorsal and anal fins took on an amber hue, punctuated by a series of large white spots. Breder (1969) has commented on the possible adaptive function of a general darkening in pelagic species which freely associate with drifting objects. The smaller individual did not respond in this manner, although the black margins of the median fins lightened considerably.

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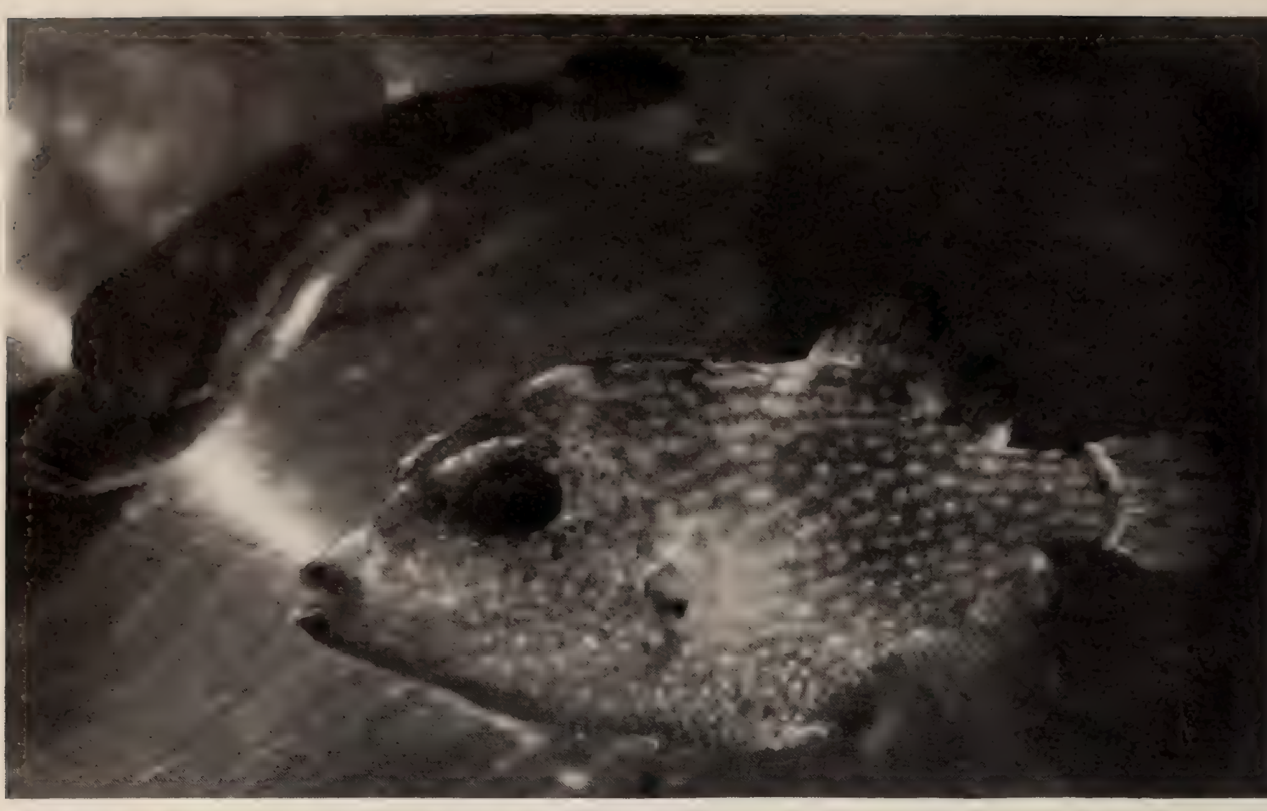

Fig. 1. Young rough triggerfish, *Canthidermis maculatus*, shown in a pan of water several minutes after removal from neuston net.

The fish were observed at first to spend most of their time swimming slowly about the tank just below the surface. However, the *Sargassum* became the favored habitat immediately upon its addition to the tank. The fish were frequently seen to forage in the algae and to eat the small shrimp found there. They were also regularly fed bits of raw conch (*Strombus gigas*). Both individuals were generally aggressive, and quickly attacked (and, in one case, killed) small filefish (*Monacanthus sp.*) which were occasionally trapped with *Sargassum* placed in the aquarium. The pair showed no signs of aggressiveness towards each other, however.

These observations suggest that rough triggerfish may lead a planktonic existence during the early part of their lives, inhabiting the upper few cm of the water column. Balistids are not adapted for sustained high-speed swimming, and individuals in this size range must be nearly entirely at the mercy of winds and currents. They may opportunistically associate for a time with *Sargassum* or other floating objects encountered, and possibly become somewhat territorial at such times. These suggestions are supported by the work of Dooley (1972), who concluded that although *C. maculatus* was occasionally found associated with *Sargassum*, it was not a regular member of the *Sargassum* community. Drifting objects could serve as an important source of food organisms as well as providing a measure of protection from larger predators (Magnuson and Gooding, 1971). Several other balistids are known to commonly form such association at certain stages of the life cycle (Clarke, 1950; Breder, 1969, Dooley, 1972). Grant Gilmore (personal communication) has reported that a number of larger specimens (60-80 mm) of *C. maculatus* were recovered from a celery crate found drifting in the Gulf Stream about 12-15 miles off southeastern Florida.

Although 30 min neuston tows were made thrice daily (at 0700, 1200, 1900 hours) as we traversed the Caribbean between Puerto Rico, Venezuela, Curacao, Honduras, Cozumel, and Miami, no other specimens of *C. maculatus* were captured. It is possible that the two individuals were taken independently during the single 30 min tow. However, in view of the single capture and the subsequent behavior of the fish, it seems more likely that they were closely associated prior to capture and taken simultaneously. No *Sargassum* or other floating objects were collected in the net with the fish, indicating that they were not associated with such material at the time of capture.

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Biological Sciences

AQUARIUM FEEDING BEHAVIORS OF THE CORNETFISH, *FISTULARIA TABACARIA* AND SOUTHERN STARGAZER, *ASTROSCOPUS Y-GRAECUM*

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Abstract: *Feeding behaviors of juvenile cornetfish,* Fistularia tabacaria *and southern stargazer,* Astroscopus y-graecum *were observed in aquaria. Both species stalk their prey and usually attempt head-on strikes. Strikes were attempted from 10° above or below the horizontal by the cornetfish and within a 0-30° range above the horizontal by the southern stargazer.*

Feeding behaviors of aquarium-held juvenile cornetfish, *Fistularia tabacaria* Linnaeus and southern stargazer, *Astroscopus y-graecum* (Cuvier) were observed during May and July 1974. Both species were seined in an eel glass (*Zostera marina*) bed near the Institute of Marine Sciences, Bogue Sound, Morehead City, North Carolina. Lengths were taken in the field upon collection. Behavior observations were made after the fishes were transferred to a 110 l aquarium containing Bogue Sound water maintained at approximately 22.5°C and 30‰ salinity. No growth was observed during the 45 days the *Fistularia* (220 mm standard length) was studied; the *Astroscopus* grew from 28 to 48 mm SL in 27 days.

Several investigators have discussed the food habits of cornetfishes. Suyehiro (1942) postulated that Pacific *Fistularia petimba* feed on minute, floating biota using the snout as a pipette. This was refuted by Hiatt and Strasburg (1960) and Hobson (1968, 1974) who found it to be wholly piscivorous. Randall (1967) confirmed this in West Indian *F. tabacaria*. The *F. tabacaria* reported here ate fishes (*Fundulus heteroclitus, F. majalis, Mugil cephalus*) and shrimp (*Palaemonetes pugio*) while in captivity.

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No direct observations have been recorded on the feeding behavior of *Fistularia tabacaria*. The cornetfish in this study usually hovered in the water column, using its pectoral fins to maintain a horizontal position well above the bottom. The feeding sequence began when it tried to herd a school of fishes against a side of the aquarium. Singling out a victim, it then bent its body laterally in an "S" shaped curve in preparation for striking. This is the same posture observed by Hobson (1974) in *F. petimba*. The *Fistularia* often held this pose for up to 5 sec before striking or unbending without striking. No color changes like those reported in *F. petimba* (Hobson 1968, 1974) were noted. Strikes were attempted within a 20° range, 10° above or below the horizontal. Strikes were quick and often unsuccessful (approximately half the time). After a miss the cornetfish relocated its prey and repeated the striking sequence. All but one prey fish were swallowed head first. The strike sent small fish (15-20 mm SL) down the entire length of the nearly transparent snout. Larger prey (20-30 mm SL), however, were forced only part way down the snout by the sucking action of the strike. They were then moved further into the snout by opening and closing the mouth and lowering and raising the gular-branchiostegal region of the snout. The cornetfish in several instances struck and captured a second fish while the first was still in the snout. Counts of prey fish at night and in the morning revealed that feeding generally occurred only during the daylight hours. One to six 15-30 mm SL fishes were consumed each day. Grass shrimp, *Palaemonetes pugio*, were eaten only when fishes were not available.

White and Angelovic (1967) previously reported on the feeding behavior of a 28 mm SL *Astroscopus y-graecum*. Their specimen buried in a sand-bottomed aquarium and used movements of the eyes and dorsal fin as lures. Pickens and McFarland (1964) also noted stargazer burying behavior in sand; however, a different behavior pattern was observed in the present study.

The young stargazer swam constantly during its stay in the aquarium. It appears that this behavior was directly influenced by the broken shell substrate in the aquarium, which inhibited burying. On several occasions it was seen attempting to settle into the shells, but to no avail. The stargazer quickly settled into an experimental patch of sand when it was added to the bottom.

The *Astroscopus* usually swam with its head up at a 30° angle and showed a deep black lateral coloration. When hungry the stargazer changed to a light yellow-grey laterally, singled out an individual prey and began stalking it. Prey were always about the same size as the predator, and were always fish. Dahlgren (1914) previously commented on the *Astroscopus* habit of attacking large prey. All attacks on prey were attempted head on. This often required considerable maneuvering on the part of the stargazer; many times it literally swam circles around its victim in attempting to get into proper position. Occasionally prey fish distracted by feeding were attacked by the stalking *Astroscopus*. The actual strike occurred within a 0-30° range above the horizontal, and was accompanied by erection of the first dorsal fin. At least half of the prey was swallowed in the initial strike in an estimated 90% of strikes. Larger struggling prey often spiralled the stargazer about for 5-10 sec. The prey was then moved straight into the stomach, greatly distending the abdomen. Time from strike to complete swallowing varied from 10-26 sec. Curling of the prey into a "U" then occurred in the stomach (verified by dissection), and the lateral coloration of the *Astroscopus* returned to deep black. Collections of young stargazers from elsewhere in North Carolina revealed that curling of the prey also occurred in *Astroscopus* in nature. Alternate brief periods of swimming and sinking during the ensuing 30 to 60 sec were followed by a return to its usual cruising activity and swimming angle. At 48 mm SL the stargazer broke from this pattern by settling to the bottom and trying to bury directly after swallowing, seemingly too full to swim.

The *Astroscopus* refused to eat anything but similar-sized live fishes (*Caranx hippos, Cyprinodon variegatus, Lagodon rhomboides, Leiostomus xanthurus*) despite being offered dead fishes and live and dead shrimp. This differed from Pickens and McFarland's (1964) observations of stargazers eating dead, moving food. There was no apparent use of an electrical discharge. This was in agreement with Pickens and McFarland (1964), who found that no electric discharge was recorded when the prey was greater than half the body length of the stargazer. The *Astroscopus* never ate more than one fish per day, consuming 11 fishes in 27 days of captivity. It successfully captured fishes in approximately two-thirds of its strike attempts. The stargazer died at 60 mm total length (48 mm SL) after eating a 52 mm TL *Leiostomus*.

ACKNOWLEDGEMENTS—I wish to thank Frank J. Schwartz and Garnett W. Link for comments on the manuscript.

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SOCIAL BEHAVIOR OF BAHAMIAN HUTIAS IN CAPTIVITY

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Abstract: *Small groups of a rare, hystricomorph rodent, the Bahamian hutia* (Geocapromys ingrahami), *were studied in captivity. A repertoire of social behavior was determined for the species. Agonistic behavior was generally minimal in established groups except when estrous females were present. Social hierarchies and amicable, cohesive behavior were probably important in minimizing agonistic behavior. The cohesive wrestling behavior of hutias may be unique.*

The Bahamian hutia (*Geocapromys ingrahami*) is a nocturnal, hystricomorph rodent of the family Capromyidae (Clough, 1969). This gregarious, rabbit-sized, herbivore now occurs naturally on only one island (Clough, 1972), East Plana Cay, and has no predators or competitors there.

Clough (1972) suggests that hutia social behavior minimizes agonistic encounters in the relatively dense, natural population. This study describes the social behavior of small groups of wild-caught hutias in captivity.

Materials and Methods—Three small groups of hutias were established at different times on the floor of a (8 × 4.33 m) room. Each group of 3-4 animals contained both males and females. The floor was covered with wood chips and two wooden shelters were provided. Lighting (12L-12D cycle) consisted of two white, shaded 40 watt bulbs in the dark phase and panels of bright fluorescent bulbs in the light phase. Further details are given elsewhere (Howe and Clough, 1971).

I observed the hutias from behind a sound-dampening blind which contained a small, oneway-glass window. Behavioral descriptions and data were dictated into a tape recorder. Individual hutias were recognized by the removal of fur from different regions of the body. The three groups were observed for a total of 112 hr.

During initial observations behavioral acts and postures were described. In later observations the frequencies of these acts and postures were recorded. A social hierarchy was determined for each group by comparing the frequencies of threat, attack and flight exhibited by each animal in that group.

Results—*Types of social behavior*: Table 1 lists the acts and postures comprising hutia social behavior. These behavioral types are described below if they are not self-explanatory. Most of the terms are from Eisenberg (1967) and have been previously applied to other rodents.

The category of cohesive behavior includes all interactions tending to bring animals together (King, 1955). I have included in this category naso-nasal, an act in which one animal appears to sniff the nasal region of another. I have also in-

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TABLE 1. Types of social behavior exhibited by hutias.

Cohesive	Sexual	Agonistic
Naso-nasal	Follow and driving	Threat
Naso-anal	Male patterns	Mild
Marking	Flanking	Strong
Urine marking	Intent to mount	Cut-in
Perineal drag	Attempted mount	Chase
Circling	Mount	Attack
Non-circling	Grip with forepaws	Flight
Approach	Copulation	Turn away
Wrestling	Female patterns	Move away
Mutual grooming	Raising tail	Bite
Head over-under	Lordosis	Spar
Turn toward	Post copulatory wash	Escape leap
Contact (huddle)		Tooth chatter
Follow		

cluded naso-anal, an act wherein one animal apparently sniffs the ano-genital region of another. Naso-anal can vary from a brief sniff to a lengthy, pronounced sniff which occurs as the head is turned under the ano-genital region of a sexually attractive female. Frequently a mutual naso-anal encounter occurs wherein two animals investigate each other. Naso-nasal and/or naso-anal often occur after one hutia has approached or followed another.

I have included scent marking in the cohesive category since it takes place frequently when animals initially come together in a non-agonistic behavioral context and is often exhibited simultaneously by two or more animals (Howe, 1974). Scent marking is exhibited by either males or females as they deposit trails of urine or drag the perineum. Urine marking and perineal drag commonly occur in the same marking sequence which may last for over a minute. A circling variation of perineal drag is exhibited most often by a male as he drags his perineum around a sexually attractive female while sniffing her deposited scent.

Wrestling is a complex and variable cohesive behavior involving much activity and contact. It never occurs with agonistic behavior even when a third animal replaces one of the original pair. It is exhibited among all animals regardless of sex or reproductive condition. In a typical encounter two animals sit upright facing each other with legs apart (Fig. 1C). One animal may tilt its head back with its mouth open while the partner climbs over its ventral surface. Often partners rest or rub their chins on each other's shoulders (head over-head under). Mutual grooming and wrestling may occur independently, however, they usually occur together. Some 51 of 111 instances of wrestling were initiated when one hutia moved under the ventral surface of a second animal grooming itself in an upright position (Fig. 1).

Flanking is a term applied to a male who moves parallel to a sexually attractive female and turns his head toward her head. This behavior usually occurs with intent to mount and other acts leading to copulation. Intent to mount is the act of a male placing a forepaw slowly on the female's back, then removing it. Attempted mount is similar but less ambiguous and generally is terminated as the female pulls away. Receptive females and occasionally juveniles and submissive males elevate their tails (raising tail). Raising tail is usually preceded or followed by olfactory investigation by another animal.

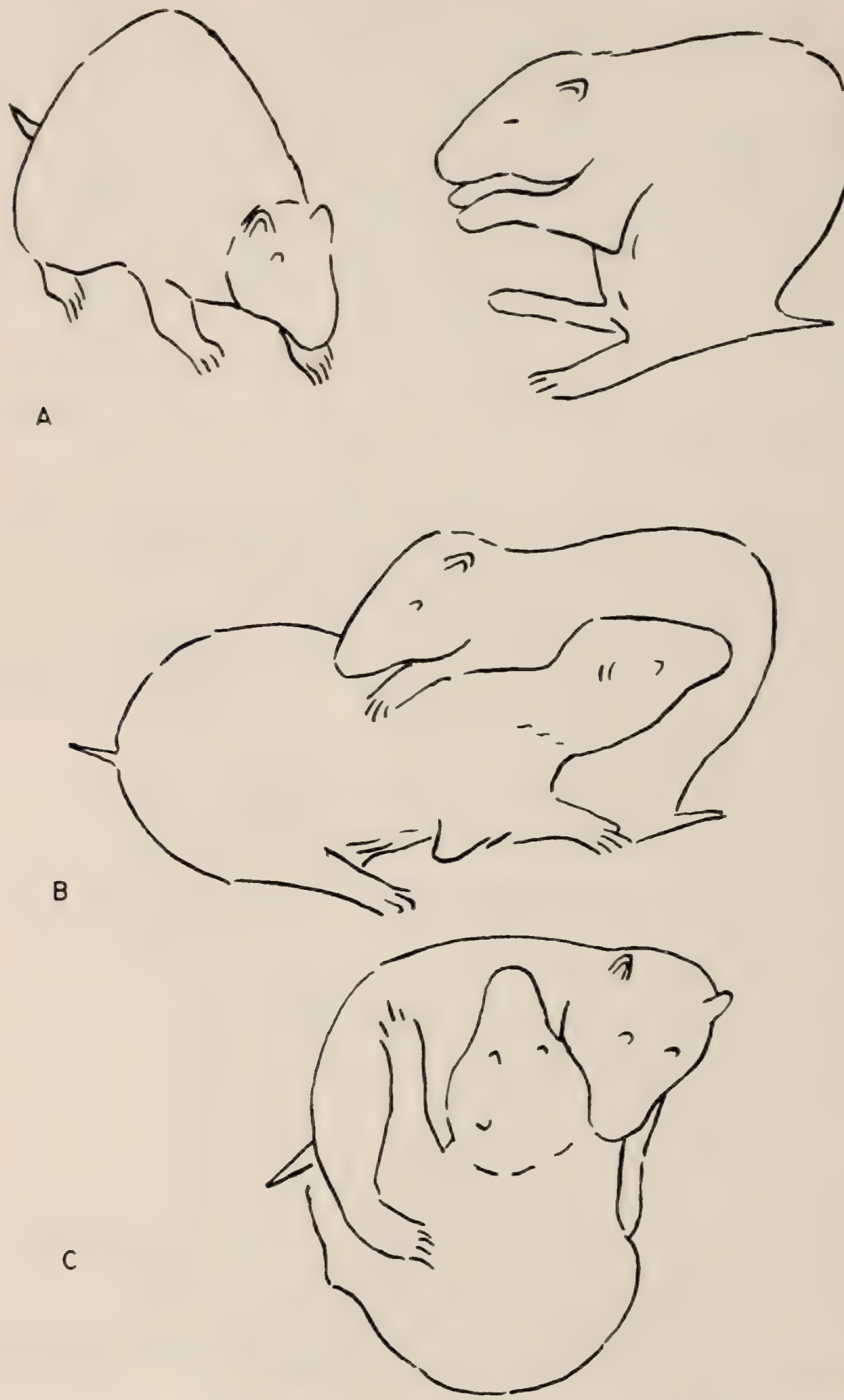

Fig. 1. Behavior leading to wrestling (A) approach to second hutia grooming itself (B) moving under the grooming hutia (C) wrestling.

Most agonistic behavior in established groups was of low intensity (e.g., mild threat, move away and turn away). Mild threat is defined as a turning of the head and shoulders toward another animal. Strong threat is more pronounced and includes exposure of the teeth. In the act of sparring, two upright individuals face and push each other with the forepaws.

The more intense types of agonistic behavior (e.g., strong threat, chase, attack and flee) occurred when groups were being established, when strangers were added to established groups, and, to a lesser degree, when sexually attractive females were present. Cut-in is a behavioral act exhibited by a dominant male as he moves between a sexually attractive female and a submissive male approaching her, while turning his head to threaten the submissive male.

Social organization: After 1 or 2 days of considerable agonistic behavior, a social hierarchy with a dominant male was established in each group. Once social hierarchies were set up, they remained unchanged as long as the same animals remained together. With few exceptions agonistic behavior was mild and infrequent once hierarchies were established. A mild threat was then usually sufficient to cause a submissive animal to turn or move away. During most of the time the hutias rested and fed compatibly together or took part in cohesive activities.

There were close relationships between the dominant male and the females in each group. This was most apparent when females were sexually attractive although it was also noticeable at other times. Figure 2 shows an example of the relatively high frequencies of cohesive behavior which occurred between the female 67 and the dominant male 69 as compared to the other males in that group. Just before giving birth 67 approached and spent more time in contact with the

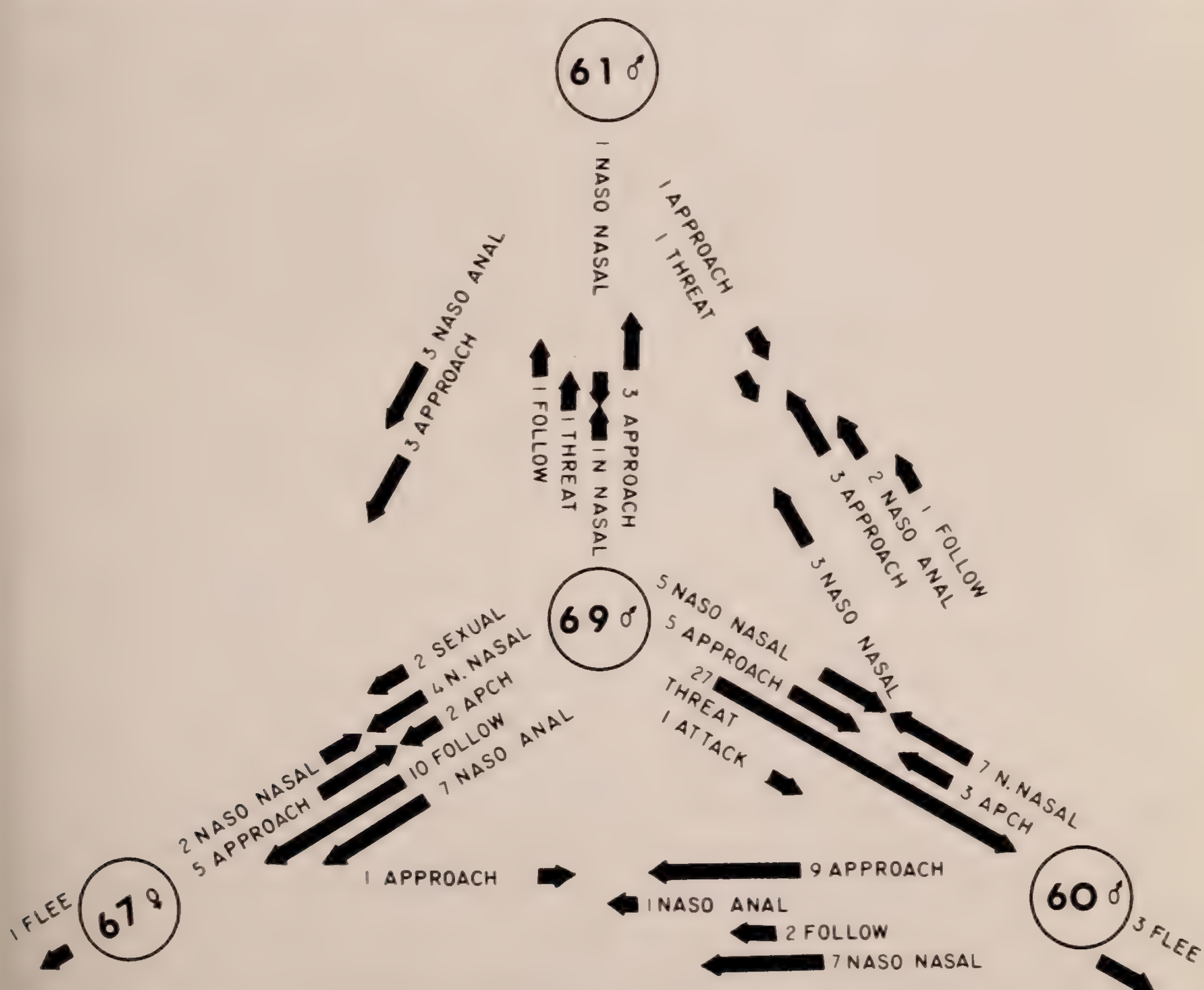

Fig. 2. Social behavior in a group during a typical one-hour period with an estrous female (67) present.

male 69 than with any other male. In the same period she spent much time in the shelter and the vicinity was the locus of much social behavior including marking. The male 69 appeared to enter the shelter containing the gravid female with less hesitation than other males.

Social behavior during estrus: For one or more days before a female was sexually receptive, behavior of males toward her was altered. They frequently sniffed the female and her deposited scent for longer than normal periods, indicating that the onset of estrus is determined through olfaction. The males exhibited, on the avg, about twice the normal frequencies of naso-anal, marking, follow and approach to the estrous female (see Fig. 2). They also exhibited sexual behavior toward the female in the form of flanking, intent to mount and attempted mount. Sexually attractive females tended to avoid the nearly constant attention of males by retreating to the shelter, although copulations eventually took place.

Agonistic behavior increased between most individuals in groups containing a sexually attractive female (see Fig. 2). This usually occurred as threat between competing males. Sometimes, however, it occurred as threat between the estrous female and other animals of either sex or even between non-estrous females and males. While pursuing a sexually attractive female, one male (60) threatened a second female (91) who appeared to be competing for his attention.

Female 91, during the above period, attempted to mount male 60 which suggested approaching estrus (see Jarvis, 1969). Approaching estrus appeared verified 2 days later as male 60 shifted his sexual pursuit to female 91. After 2 more days 91 exhibited lordosis and male 60 copulated with her.

Discussion—Most sexual and agonistic behavior of hutias is not unique although hutias may lack a submissive posture. The raising of the tail by hutias may have a submissive function under certain conditions, however. Kleiman (1974) points out that a tail-up rump display is common among hystricomorph rodents in a variety of functional contexts.

The cohesive behavior of hutias is more unique. Scent marking is exhibited by many different mammals, usually, however, it appears to have primarily an agonistic function. In agreement with my conclusions on the Bahaman hutia (Howe, 1974), Kleiman (1974) suggests that hystricomorph scent marking functions primarily to increase social cohesion. Hutia wrestling, considering all of its components together is probably unusual both in motivation and execution.

Mutual grooming, often a component of hutia wrestling, occurs without wrestling in many social species (Ewer, 1968). Eisenberg (1962) describes aggressive grooming in mice wherein only one animal grooms the other. The same mice exhibit mutual grooming with minimal aggressive behavior. Since social grooming in the wrestling of hutias is mutual, and occurs in a non-aggressive and primarily non-sexual, behavioral context, a cohesive function is probable for wrestling.

Aside from the utilitarian aspect of grooming difficult areas, hutia wrestling provides tactile stimulation and exchange of olfactory information among all individuals in stable groups. Ewer (1968) refers to sensitive "pleasure spots", such as under the chin, where stimulation in social grooming may be important in "friendly" relationships. Prairie dogs (King, 1955) solicit grooming by crawling under the nose of a partner. Hutias may be soliciting when they approach and move under animals who are grooming themselves (Fig. 1) since the usual result is wrestling along with mutual grooming. The initiation of hutia wrestling may have some basis in the behavior of neonates as they move under the chin of a resting adult. Adults of both sexes tolerate neonates climbing over them. A similar climbing over has been described in the gregarious desert cavy (Rood, 1970). Since hutias normally have a litter of one (Howe and Clough, 1971), early cohesive interactions between adults and neonates may be important for integrating the latter into an established group.

The gregariousness of hutias in the wild (Clough, 1972) and cohesive activities between captive hutias of the same and opposite sexes suggest such activities and probably some kind of gregarious social organization occur in nature. Although the composition of groups of hutias in the wild is not known, it is reasonable to assume that related individuals from several generations may be the nucleus of a group. Clough (1974) retrapped a hutia which was at least 6 years old, suggesting a slow population turnover in the absence of predators.

In summary, the repertoire of social behavior of the Bahamian hutia was determined. Agonistic behavior was generally minimal in established groups except when a female in estrus was present. Social hierarchies and cohesive behavior between individuals of the same and opposite sexes appeared important in minimizing agonistic behavior. Wrestling demonstrated by hutias may be unique.

ACKNOWLEDGMENTS—I wish to thank Dr. G. C. Clough for advising me on the research and manuscript and Dr. G. Bateman, Dr. T. Goslow, and Dr. R. Balda for providing helpful comments concerning the manuscript. I am grateful also to the Bahama Ministry of Fisheries and Agriculture for authorizing field trips to East Plana Cay. NSF research grant no. GB-7065 made the study possible.

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Conservation

DETERMINING STAGES AND FLUCTUATION SCHEDULES FOR REGULATED LAKES IN CENTRAL AND SOUTH FLORIDA

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ABSTRACT: *Approaches are discussed for integrating biological, hydrological, and cultural features of lakes in central and south Florida to determine operating stages and fluctuation schedules designed to approximate historical conditions.*

LAKES in Florida fluctuate in response to rainfall, evapotranspiration, surface water inflow and outflow, and ground-water inflow and outflow (Hughes, 1974; Anderson et al., 1965; Kenner, 1961). These fluctuations range from as little as 2 ft on some lakes to more than 30 ft on others. A recent study of 110 Florida lakes with hydrographic records covering 10 yr or more demonstrated that 80% of the lakes fluctuated over a range of 5 ft or more (Hughes, 1974). Principle factors that contribute to the magnitude of fluctuation include the topography, permeability of geological materials and the relationship between the lake level and the potentiometric surface of the confined aquifer. Alterations in the size of the natural surface outlet of a lake can also change the range of fluctuation of a lake (Hughes, 1974).

As the activities of man have increased in Florida, many lakes have been prevented from fluctuating naturally. For a variety of reasons, including flood control, navigation and recreation, normal lake-level fluctuations have been reduced and stabilized. While the obvious benefits of stabilized lakes were soon noted (Kenner, 1961), the negative aspects of reducing the periods of peak high and low water levels were not realized and adequately documented until much later.

Lack of fluctuation of water levels (stabilization) has been implicated as a major cause of undesirable changes in lake and wetland biological communities (Agar, 1970; Chamberlain, 1960; Dineen, 1974; Goodrick and Milleson, 1974; Holcomb and Wegener, 1971; Kahl, 1964; Odum, 1971). Such changes include accelerated accumulation of unconsolidated bottom sediments, decline in dissolved oxygen (especially in the deeper parts of the lake), nutrient enrichment, vegetational changes, and reduction of fish and wildlife populations.

Early methods for establishing lake level controls on artificially regulated lakes included the establishment of two legal lake levels (Kenner, 1961). These maximum and minimum desirable levels were based primarily upon cultural needs. Lake fluctuation was made to follow a schedule almost solely dictated by standard flood-control practices. Criteria utilized by those charged with setting such levels included elevations of cultural features such as homes, docks and seawalls, and historical lake stages as derived from stage-duration curves and the examination of stratified beach deposits (Bishop, 1967). The biological system of the artificially regulated lake was not considered in management of lake levels.

Techniques for integrating cultural, hydrological and biological features (Davis, 1973) into possible development of regulation levels and fluctuation schedules for artificially controlled lakes are presented here.

Procedures for Determining Lake Stages—Four stages are established for operating purposes: maximum operating, maximum desirable, minimum operating, and minimum desirable. A description of these stages and criteria employed in their determination follows:

Maximum Operating—This stage represents lake elevations historically equalled or exceeded about 5-10% of the period of record as determined from a stage-duration curve. Maximum operating stage is designed to provide for those years when rainfall is above normal, but not for periods of flood. In the absence of sufficient hydrographic record, this stage may be determined by field reconnaissance of the lake itself. Indeed, stages obtained from stage-duration curves must always be field-checked. Maximum operating stage roughly corresponds to those elevations immediately below wax myrtle (*Myrica cerifera*) bushes 4-6 ft tall and/or fringes of palmetto (*Serenoa repens*). At such stages, the soil around these plants will be damp. In extremely wet yr, not represented by maximum operating level, even these plants will have water standing around their roots. If cypress (*Taxodium* sp.) trees are standing so close to the shoreline so as to be almost in the lake itself, they may be used to determine maximum operation as this stage would be approximately equivalent to the elevation at a point about two-thirds up the buttress. Cypress trees may not be zoned to determine this stage if they exhibit no buttressing or if they have been filled in around their buttresses.

For lakes where at least patches of natural vegetation still exist or for which adequate stage records (10 yr or more) are available, maximum operation may be established with some accuracy.

Even so, the stage actually recommended as maximum operation may have to be much lower than historical information would indicate because development (primarily residential) may have intruded into areas within the upper elevations of natural lake-fluctuation ranges.

For lakes where no natural vegetation remains and for which no stage records exist, this stage is set arbitrarily below flood stage and above maximum desirable stage, whichever stage is more easily established as described below.

Maximum Desirable—This stage represents that elevation historically which is usually equalled or exceeded 10-30% of the time as determined from stage-duration curves. In the field, the maximum desirable stage is established from observation of the elevations of: (1) structures built close to the water (docks, seawalls) and (2) natural vegetation such as willow (*Salix* sp.), buttonbush (*Cephalanthus* sp.) and cypress. In addition, long-term lake residents are consulted regarding their knowledge and desires concerning lake stages.

In using docks and seawalls as indicators of previous lake elevations, it is assumed that: (1) docks were built so as to insure (a) their extension distally (relative to shoreline) into the water, (b) that their landward extensions rested upon dry land most of the time, and (c) that the deck was 1-2 ft above avg water levels; (2) seawalls are assumed to have been built so as to insure some freeboard in times of usual high water, enough to guard against the eventual crumbling of the structure as a result of wave action. Elevations are taken on several docks and seawalls. Usually structures of comparable age will be found at similar elevations. From this information, one dock and/or seawall is chosen, and the maximum desirable is then set at 1 ft below dock deck or about 0.5-1.0 ft below the top of the seawall. These elevations are recorded and checked against those obtained from questioning lake residents concerning: (1) previous lake stages, and (2) their conception of where they would like the lake to come to on their property. Further check of tentative stages is made by taking elevations of certain areas covered with natural vegetation. Maximum desirable stages should: (1) affect soil saturation around *Salix* and *Cephalanthus*; (2) approach the elevation of *Blechnum* fern; (3) back up water into bordering swamps where interior vegetation is indicative of seasonal flooding, e.g. St. John's Wort (*Hypericum fasciculatum*). Areas of swamps with true aquatic (*Utricularia*) or emergent vegetation (*Pontederia*) should be flooded all year round. The effects of lake stages upon the maintenance of bordering swamps need further study, but maximum desirable should be established so as not to dewater such wetlands.

The stage finally recommended is a reconciliation of all tentative stages determined by the above procedures.

Minimum Desirable—The minimum desirable stage is that historically equalled or exceeded 80-90% of the period of record. Criteria similar to those utilized in establishing maximum desirable are employed: docks and seawalls, consultation with residents, and observation of natural vegetation. This stage is set about 2-5 ft below the top of the dock, assuming that the dock was constructed so as to make it possible to float and to board boats moored to the last two or three pilings. Lake residents are consulted about previous lake stages and their desires. Natural vegetation is observed and the minimum desirable is determined to be that elevation ensuring yr-long flooding of emergent vegetation such as *Pontederia* and *Sagittaria* or just landward of stands of such plants.

Minimum Operating—The minimum operating stage is that low elevation equalled or exceeded about 90-95% of the time. This stage roughly corresponds to the elevation of the lakeward extent of emergent vegetation. The nature of the lake bottom should be observed for accumulation of organic material. If contour maps of the lake's basin are available in an appropriate scale, they can be of great value in determining this stage as well as drawdown stage if necessary.

Procedure for Establishing Lake Fluctuation Schedules—Lake fluctuation schedules are based on: (1) recognition that central and south Florida has a wet season and a dry season; and (2) assumptions that (a) to a degree, the prevailing rainfall regime greatly affects lake stages, and (b) on the avg, there will be yr wetter than usual and yr drier than usual. Fluctuation schedules attempt to approximate natural historical conditions and make no attempt to provide for catastrophic conditions of rain or drought. A sample fluctuation schedule is shown in fig. 1.

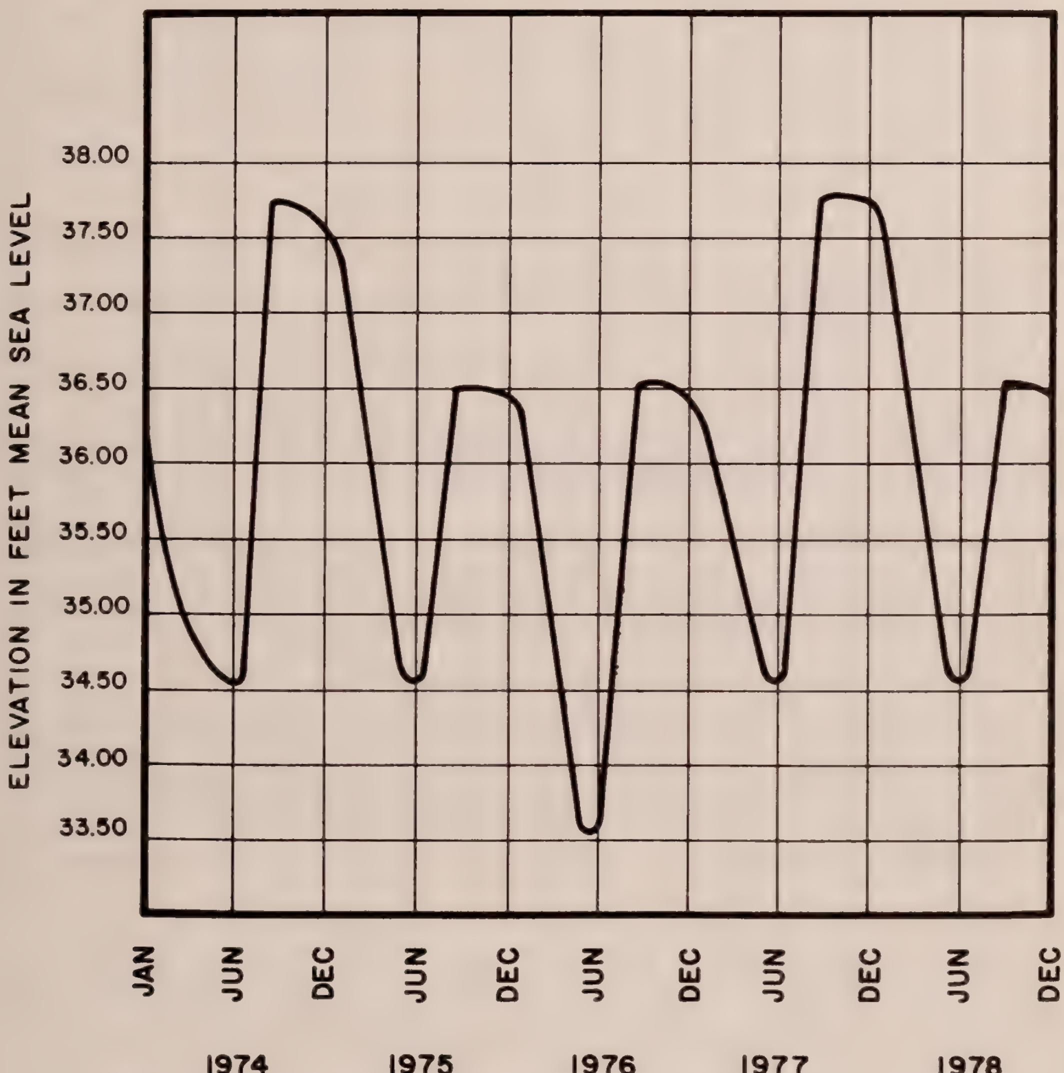

Fig. 1. Regulation schedule for Lake Thonotosassa; 5 yr cycle.

Maximum and minimum desirable stages represent avg conditions; maximum and minimum operating stages, conditions of above avg rainfall and below avg rainfall, respectively. Schedules are drawn to maintain avg conditions a majority of the time; lakes will be at or between maximum desirable and minimum desirable well over 50% of the time. Maximum desirable will be approached a little after the beginning of the rainy season. Lakes will be at high stage by the slackening of the wettest period of the yr and normally will begin to drop by the end of November. Similarly, minimum desirable stage will be approached by the middle of the dry season and the lake will be at this stage by the end of the driest period of the yr, about May.

Maximum and minimum operating stages are included twice and once during a typical 5 yr period, respectively, as observation of hydrographs indicated this frequency to be fairly representative of historical conditions. Statistical analysis of hydrographs should be performed for several lakes in a region in order to determine actual significant frequency of these stages.

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AN ANALYSIS OF THE VEGETATION AT TURTLE MOUND

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ABSTRACT: *Turtle Mound, a shell midden built by the Timucua Indians is now covered by dense vegetation. Many of the dominant species are of tropical origin. Climatic and edaphic conditions have allowed these species to flourish. The remainder of the species on the mound are elements from coastal dune, salt marsh, temperate hammock, mangrove and ruderal communities.*

SHELL MOUNDS, remains of Indian activity in Florida and elsewhere, have drawn the attention of archeologists for a long time. Occasionally botanists also have been intrigued by them because of the interesting plant associations found growing there. It was primarily to find out more about these plant associations that this study of Turtle Mound was undertaken—i.e., (1) what are the dominant species on the Mound and what is their distributional pattern? (2) what are the ranges of the tropical species, and is Turtle Mound their northern limit? (3) what factors allowed so many tropical elements to be established that far north in Florida? and (4) how does the flora of Turtle Mound compare with that of other shell mounds?

Turtle Mound is located 9 miles southeast of New Smyrna Beach, Florida, on the narrow peninsula which separates the Atlantic Ocean from Indian River North. It borders on the river, rises to a maximum elevation of 35 ft, extends 330 ft in a north-south direction and 180 ft to the east, and is thickly covered by tropical vegetation.

HISTORY—Goggin's map (1952) records 132 mounds for the area south of St. Augustine to Mosquito Lagoon on the coast and similar latitudes along the St. Johns River. Many of these mounds have been destroyed, primarily for road building purposes. According to Goggin northeastern coast of Florida was first occupied during the St. John I Period (100-1100 A.D.). He states that the Timucuas, the inhabitants of north central Florida, were agriculturists, producing large crops of maize. During the winter months, the Indians near the coast occupied sites along the brackish rivers that parallel the Ocean. Bullen and Sleight (1959) in their archeological work on Castle Windy Midden, 4 miles south of Turtle Mound, reinforce this idea of seasonal occupation. They point out that bones of several migratory birds and the lack of antlers with the deer remains indicate that these animals were taken in the winter months. Castle Windy Midden was occupied from approximately 1000-1350 A.D. according to radiocarbon dating. Green Mound, 20 miles north of Turtle Mound, also studied by Bullen and Sleight (1960) was occupied several centuries earlier than Castle

Windy. Turtle Mound has never been excavated and its age has only been ascertained from pottery fragments collected at the site. Goggin designates it as being from the St. John II Period (1000-1600 A.D.). Brinton (1859) mentions the observations of a "gentleman of the vicinity" who stated that after a strong gale had caused considerable erosion of the mound on the river end he found low at the bottom and as high as he could observe numberless pieces of Indian pottery, and quantities of bones, mostly fish, but no human ones, also charcoal and beds of ashes.

Mexia, a Spanish soldier who traveled in 1605 from St. Augustine to south of Cape Canaveral wrote a report of his trip and drew a map of the east coast of Florida. He referred to Turtle Mound as Baradero de Surruque. Mexia wrote (Higgs in Rouse 1951) "the river passes close by the old Indian habitation which is named Surruque which is a mound of oyster shells and low shrubs[1]. At the foot of this mound the Indians launch their canoes to go out to sea." *The Travels of William Bartram* published in 1791 contains a map on which Mt. Turtle appeared at the appropriate location. This as far as we know is the earliest reference to the Mound under its modern name. According to Harper (1958) Bartram was in the vicinity of New Smyrna Beach in December 1766 and referred to two mounds in the area (XXVIII, 144). The one mentioned in the introduction may be Turtle Mound. In his book Bartram reminisced:

"crossing over a narrow isthmus of sand hills which separated the river from the ocean, I passed over a pretty high hill, its summit crested with a few palm trees, surrounded with an orange grove; this hill whose base was washed on one side by the floods of the Musquitoe river, and on the other side by the billows of the ocean, was about one hundred yards diameter and seemed to be an entire heap of sea shells. I continued along the beach, a quarter of a mile, and came up to a forest of *Agave vivipara.*"

Today orange trees are not uncommon on the Mound, there are large cabbage palms at its base and agaves can be found nearby but more convincing that this is Bartram's location is that the peninsula is quite narrow in this area. In fact, from the descriptions of Mexia and Bartram, it would seem to have been even narrower in earlier days.

In the early decades of this century John K. Small made numerous trips to Florida and soon began to note the tropical vegetation covering the still numerous middens. He attributed the tropical vegetation in these habitats to the "blanket of warm air which is radiated from the stored up interior heat in the spaces between the shells of the mound" (1927). In the spring of 1921, Small made the first botanical exploration of Turtle Mound (1923). He wrote:

"There are over thirty kinds of woody plants and perhaps twice as many herbs on the Mound. The vegetation, although the locality is pretty far north along the coast, is largely of a tropical character—the snowberry (*Chiococca*), butterbough (*Exothea*), torchwood (*Amyris*), marlberry (*Icacorea*), wild coffee (*Psychotria*), black mangrove (*Avicennia*), white mangrove (*Laguncularia*), red mangrove (*Rhizophora*) and spice tree (*Anamonis*) were among the more abundant shrubs and trees. Among the herbs of a tropical flavor were the poor-man's patches (*Mentzelia*) and the wild plumbago (*Plumbago scandens*). A broom grass (*Andropogon*) was not rare. This may have been the grass that covered the mound in Baldwin's time."

[1]Mexia wrote 'yerba menuda' which is best translated as low herbs.

(Small confused the Baldwin reference with Mexia's report, with which he was familiar, since he cited an account of it in the New Smyrna News in 1921. There is no mention of Turtle Mound in Baldwin's work (1843).) Small also mentioned seeing papaya, wild orange, *Urtica chamaedryoides, Eugenia axillaris, Xanthoxylum fagara.*

The Mound was saved from destruction by the efforts of Mrs. Jeannette T. Connor, John B. Stetson, Jr. and others. It was acquired by the state of Florida in 1951 and is now designated as a State Historic Memorial. A 6 ft high wall was erected on the northwest side in 1964 to stop erosion. Two lookout towers were built in 1972 to offer the public a panoramic view of the river and the ocean.

Environmental factors—Thirteen soil samples were collected from the Mound and neighboring areas and were analyzed at the Soil Laboratory of the University of Florida. These data are given in Table 1.

Table 1. Soil Analysis from Turtle Mound.

Sample	Organic Matter	pH	Ions in ppm				
			Ca	Mg	P	K	NO_3
1. Dunes, surface	1-2%	7.3	2000	182	29.7	86	<4
2. Dunes, profile 8″-19″	1-2%	7.4	2000	174	22.9	86	<4
3. Dunes, profile 19″-4′	1-2%	8.0	2000	128	11.4	70	<4
4. Palmettos, w. of paved road	1-2%	8.0	2000	120	17.0	84	<4
5. Palmettos, profile 4″-18″	0.2-1%	7.9	2000	50	24.0	46	<4
6. Palmettos, profile 18″-3′	0.2-1%	8.2	2000	30	22.1	18	<4
7. Oaks, e. of Mound, surface	2-4%	6.9	2000	540	32.8	62	<4
8. Oaks, e. of Mound, profile 8″-4′	2-1%	6.6	510	56	15.3	30	<4
9. E. base of Mound, surface	17%	7.3	8000	2160	139.6	184	4
10. E. base of Mound, 5″-2.5′	4-8%	7.7	2000	4000	134.9	126	4
11. E. side of Mound-halfway	17%+	7.8	8000	4000	139.6	314	4
12. Top of Mound	17%+	7.8	8000	3700	139.6	172	4
13. W. side of Mound-halfway	17%+	8.0	8000	3700	139.6	324	4

The large increases in organic matter, calcium, magnesium, phosphorus and potassium on the Mound are due to the weathering of shells and decaying vegetation. These findings are in general similar to those obtained from soils of south Florida at Boynton Beach Hammock and surrounding dunes and scrubs (D. F. Austin, personal communication). Although calcium and magnesium concentrations are considerably higher on the Mound than at Boynton Beach, low levels of nitrates are found in both localities; this differs from soil analysis at Pompano Beach Hammock in which Alexander (1958) reports 60 ppm for this ion.

Because boundaries of plant distribution are often determined climatically, data were obtained on minimum temperatures which might control the spread of tropical species. Records for 1910-1926 from New Smyrna Beach (Mitchell and Ensign, 1928) and for 1935-1973 from Daytona Beach (Daytona Beach Weather Station) showed a mean minimum of 28° F (–2°C) for the 55 year period. During this time the temperature fell below 20° F (–7°C) only twice, 18° (–8°C) in January and 19° F (–7°C) in February 1917. The temperature on the Mound probably never falls as low as that at the weather stations because of its elevation and its sheltered position next to the river.

These data indicate that only every few decades is the temperature low enough to injure some of the tropical species. Probable evidence of these extremes can be seen in the dead central trunks of several specimens of *Exothea, Xanthoxylum fagara* and *Mastichodendron.* New branches have sprouted from the bases however.

Dr. Small's hypothesis that the soil on the mound was warmer than in nearby areas was tested by burying three maximum-minimum thermometers about 6 in below the surface. One was placed near the top of the Mound under a hackberry, in almost pure shells. The second was buried near dwarf live oaks about 25 ft from the Mound. The third was added later near the base of the Mound in a mixture of soil and broken shells near a red bay. The data are given in Table 2.

Comparisons show that soil temperatures on the Mound are not only warmer but also colder. This would be expected as the shells are rather loosely arranged thus allowing air to penetrate more readily than in soil of finer particles. We probably added to this factor by not compacting the shells after each reading as much as they were originally. But in any case, judging from the data obtained, it would seem very unlikely that soil temperatures in this area would be a limiting factor in the spread of tropical species.

Looseness of the soil of shell mounds provides good aeration of roots. This is probably an important requirement for species which are normally associated with limestone soils.

TABLE 2. Minimum-Maximum Soil Temperatures for 3 locations on or near Turtle Mound.

Dates	Top of Mound		Base of Mound		Off Mound	
	°F	(°C)	°F	(°C)	°F	(°C)
3-16-72	58-80	(14-27)			64-82	(18-28)
4-20-72	60-90	(16-32)			70-88	(21-30)
5- 5-72	58-84	(14-29)			66-78	(19-26)
6- 2-72					72-88	(22-31)
6-27-72	70-87	(21-31)			77-79	(25-26)
7-14-72	74-87	(23-31)			77-81	(25-27)
8- 8-72	72-87	(22-31)			77-83	(25-28)
8-28-72	75-84	(24-29)			78-82	(26-28)
9-24-72	68-86	(20-30)			78-83	(26-28)
10- 5-72	74-92	(23-33)			78-84	(26-29)
12- 1-72	55-88	(13-31)			65-82	(18-28)
12-28-72	50-76	(10-24)			60-76	(16-24)
1-19-73	56-72	(13-22)	56-72	(13-22)	56-74	(13-23)
2-23-73	49-70	(9-21)	55-68	(13-20)	53-72	(12-22)
2-28-73	52-63	(11-17)	53-63	(12-17)	57-64	(14-18)
3-13-73	50-78	(10-26)	59-71	(15-22)	64-72	(18-22)
3-19-73	51-78	(11-26)	54-74	(12-23)	64-77	(18-25)
4- 3-73	54-85	(12-29)	58-72	(14-22)	60-72	(16-22)
4-13-73	53-79	(12-26)	58-72	(14-22)	63-74	(17-23)
4-20-73	62-80	(17-27)	64-71	(18-22)	63-74	(17-23)
5- 4-73	59-85	(15-29)	61-76	(16-24)	66-77	(19-25)
5-14-73	62-86	(17-30)	66-85	(19-29)	66-79	(19-26)
7-14-73	60-84	(16-29)	64-83	(18-28)	64-82	(18-28)

VEGETATION—The vegetation consists of a mixture of floristic elements which are characteristic for several plant communities as follows: 30% from tropical hammocks, 20% from salt marshes, 18% ruderals, 15% temperate hammocks, 12% dunes and 5% mangrove. In all, 108 species in 56 families were identified as shown in the Annotated List of Species.

To determine the geographical ranges of the tropical hammock elements, specimens at New York Botanical Garden, Missouri Botanical Garden, University of Florida and University of South Florida Herbaria were examined. Most of these taxa have widespread distributions in the Caribbean, South America, Central America, Mexico and even southern Texas. These data are tabulated in Table 3.

Approximately one third of the species reach their northern extension at Turtle Mound. Another third are known from collections made by Curtis in 1878 from shell islands at the mouth of the St. Johns River. His botanical explorations in that region are described vividly (1879). The last third have their northern limits on shell mounds or in one case, on limestone outcrops, between Turtle Mound and Jacksonville. These tropical species probably range further north on the east coast than on the west coast of Florida because of the Gulf Stream and the prevailing easterly winds. Harper had noted decades ago (1921) that the northernmost tropical hammocks are all on shell mounds and that most of the woody species of such a community have fleshy fruits which are spread by birds.

TABLE 3. Distribution of Tropical Hammock Elements.

Species	Bahamas	Greater Antilles	Lesser Antilles	South America	Mexico & C. America	Northern Limit
1. *Forestiera segregata*	x	x	x			Bermuda; Sapelo Isl. Ga.
2. *Passiflora suberosa*	x	x	x	x	x	Bermuda; s. Tex. Isl. mouth of St. John R.
3. *Mentzelia floridana*	x					Isl. mouth of St. John R.
4. *Eugenia axillaris*	x	x	x		x	Isl. mouth of St. John R.
5. *Myrcianthes fragrans*	x	x	x	x	x	Isl. mouth of St. John R.
6. *Capsicum frutescens*		x	x	x	x	Isl. mouth of St. John R. Bermuda; Ariz.; Tex.
7. *Chiococca alba*	x	x	x	x	x	Isl. mouth of St. John R. Bermuda; Tex.
8. *Psychotria nervosa*	x	x	x	x	x	Isl. mouth of St. John R.
9. *Ipomea alba*	x	x	x	x	x	Welaka, Putnam Co.
10. *Leiandra cordifolia*		x		x	x	Citra, Marion Co.
11. *Zanthoxylum fagara*	x	x	x	x	x	Tomoka S.P.; s. Tex.
12. *Ardisia escallonioides*	x	x			x	Tomoka S.P.
13. *Plumbago scandens*	x	x	x	x	x	Cedar Key; s. Tex. s. Ariz.
14. *Myrsine floridana*	x	x	x	x	x	Green Mound
15. *Amyris elemifera*	x	x	x		x	Turtle Mound
16. *Cissus trifoliata*	x	x	x	x		Turtle Mound
17. *Cereus eriophorus*		? Cuba				Turtle Mound
18. *Exothea paniculata*	x	x	x		x	Turtle Mound
19. *Heliotropum angiospermum*	x	x	x	x	x	Turtle Mound; s. Tex.
20. *Mastichodendron foetidissimum*	x	x	x			Turtle Mound
21. *Nectandra coriacea*		x	x		x	Turtle Mound
22. *Schoepfia chrysophylloides*	x	x				Turtle Mound

In order to obtain more precise data on the composition of the vegetation of Turtle Mound, 24 transect lines were established. The transects all began at the base of a large sour orange tree in the small hump between the north-south summits and were made at 15° intervals from that point to the base of the Mound. The transects on the steep western exposure were approximately 90 ft long while the others were often up to 200 ft long. The plants within 1.5 ft of either side of the line were recorded; seedlings of woody plants were not counted if less than 3 ft high. Only an estimate of herbaceous plant density was made.

The most common species are listed below. The first number is actual number of plants encountered. The second figure refers to the number of transects in which it was found.

TREES AND SHRUBS

Eugenia axillaris 175-24
Myrcianthes fragrans 152-19
Amyris elimifera 105-19
Celtis laevigata 95-23
Xanthoxylum fagara 90-23
Ardisia escallonoides 64-12
Yucca aloifolia 57-20
Forestieria segregata 49-21
Chiococca alba 46-13
Persea borbonia 34-10
Opuntia stricta var *dillenii* 34-17

VINES

Parthenocissus quinquefolia 69-18
Sageretia minutiflora 46-14
Passiflora suberosa 45-20
Plumbago scandens 44-20
Cissus trifoliata 35-18
Cynanchum scoparium 27-14

HERBS

Parietaria praetermissa 290-23
Leiandra cordifolia 50-4
Oplismenus setarius 50-4
Malvastrum coromandelianum 28-13
Galium hispidulum 20-6
Bidens pilosa 15-7

Some of the dominant woody species have been mapped to show their distributional pattern on the Mound. (Fig. 1). Notes on individual species follow.

Eugenia axillaris grows in both shade and exposed areas. In the latter instance the plants are shorter with smaller leaves. On other shell mounds along Mosquito Lagoon south of Turtle Mound this species often grows in almost pure stands.

Myrcianthes fragrans attains a height of 25 ft on the Mound. It grows on dunes as well, but there it is a stunted shrub about 3 ft high.

Amyris elimifera grows best on the exposed northern and southern slopes.

Celtis laevigata, a deciduous species, is most common on the arid western slope of Turtle Mound. Many of the trees are approximately 20 ft high and 14 in in diameter. Borings were made with an increment borer to determine the age of these plants. A maximum of 40 annual rings was counted. Dr. Small did not mention this species for Turtle Mound. If it was there 50 yr ago it must have been much less conspicuous than it is now.

Xanthoxylum fagara, a prickly shrub, thrives in the exposed areas near the top of the Mound.

Ardisia escallonoides is a shade loving shrub which does best in areas of high organic contents. It resembles *Myrsine floridana* which is considerably less common here—22 plants in 7 transects. The latter grows in more exposed areas at the base of the Mound.

Parietaria pratermissa, the most common herb during our study is an ephemeral species, appearing from February to May. It is almost completely absent the rest of the year and is replaced partially by *Galium hispidulum* later in the season. The presence of *Leiandra cordifolia* is also variable; it becomes much less conspicuous during periods of low rainfall.

COMPARISON WITH OTHER MOUNDS—It can be seen that Turtle Mound is dominated by a tropical woody flora. This is replaced on the river side by herbaceous and woody brackish species and on the eastern exposure by more temperate woody taxa such as Red Bay, Live Oak and Cabbage Palm. Why are tropical hammock species more successful than temperate hammock elements? It has

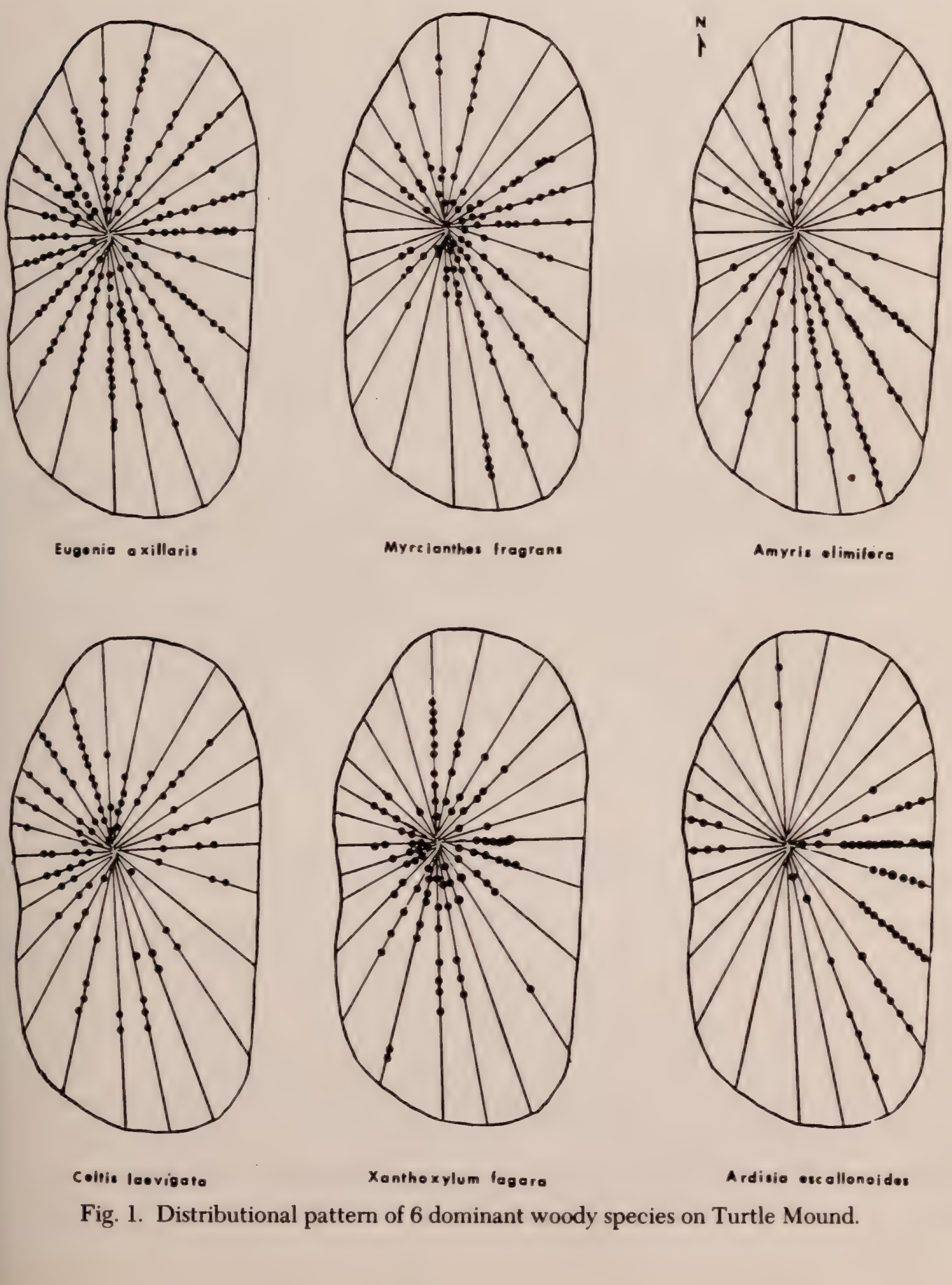

Fig. 1. Distributional pattern of 6 dominant woody species on Turtle Mound.

been suggested by several authors (Rorison, 1969; Salisbury, 1921) that when a species is close to its climatic limits it can survive competition only in edaphic extremes of which it is tolerant and of which its competitors are less tolerant. At Turtle Mound edaphic conditions promote the spread of tropical hammock species. Does the same situation hold for mounds at the same latitude on the Gulf Coast and along the St. Johns River? Judging from Small's description of the mounds around Crystal River, the flora there is temperate. The mound at Hontoon Island State Park along the St. Johns River made up of snail shells (*Vivipara*) was investigated by S. Smith, S. Acree, L. M. Carlton, and R. Thompson, students at Stetson University. The soil analysis (unpublished data) for pH and mineral contents revealed very similar values to those found on Turtle Mound yet the only tropical hammock species here is *Psychotria nervosa*. There are probably several factors for the almost total absence of southern elements on these mounds. First of all the climate is somewhat harsher inland and on the Gulf Coast than it is for comparable latitudes along the Atlantic coast. Secondly, the source of tropical species is further away in the former areas. Thirdly, it may be that the distribution and movement of birds, which are thought to be responsible for the northern transport of the tropical taxa, are more common along the East Coast.

Discussion—Small had suggested (1928) that some of the species now growing on kitchen middens might be there because they had been used by the Indians. There is no evidence to support his hypothesis. The only plants now found on the mound that are known to have been used by the Timucua Indians are cacti, and yaupon. These species are found off the Mound as well.

Judging from the vegetation on eroded area on the western side of Turtle Mound and the excavated areas of Green Mound, probably the first invaders of shell middens in this area of Florida are weedy species such as *Bidens pilosa, Malvastrum coromandelianum, Andropogon virginicus*. This was probably the stage of succession that Mexia observed in 1605. Somewhat later shrubby species that grow on calcareous dunes such as *Yucca aloifolia, Myrsine floridana, Ilex vomitaria, Myrcianthes fragrans* and *Forestiera segregata* moved in. The tropical hammock species are probably introduced over a long period of time and grow when conditions become favorable.

Shell mounds can be considered comparable to islands. Even though many have been partially or completely obliterated they have acted, and still act, as stepping stones in the northern distribution of widespread tropical species. The factors discussed by MacArthur (1972) for species distribution on islands are clearly applicable here. In general these are: chance, size and elevation of island, age, distance from source of species, extinction of species, amount of competition and climate. With all these variables we would expect the flora to be somewhat different on each of the mounds and this is what we find as we continue to explore the area. Probably one of the reasons why Turtle Mound is floristically rich is because its height has been a landmark for birds as well as for man.

ANNOTATED LIST OF SPECIES

Plant collections were made during 1971-73 (with permission of the Florida Department of Natural Resources) to obtain a complete inventory of the vascular flora. The 108 species in 56 different families listed below represent a rich variety of species for an area only slightly larger than an acre.

Polypodiaceae

Phlebodium aureum (L.) J. Smith. Golden Polypody. Rare epiphyte on *Persea.*
Vittaria lineata (L.) J. Smith. Shoe String Fern. Rare epiphyte on *Persea.*

Cupressaceae

Juniperus silicicola (Sm.) Bailey. Southern Red-cedar. Occasional on river side.

Gramineae

Andropogon virginicus L. Broomsedge. Occasional on river side.
Cenchrus echinatus L. Sandspur. Rare.
Chloris petraea Swartz. Fingergrass. Occasional on river side.
Distichlis spicata (L.) Greene. Saltgrass. Occasional on river side.
Oplismenus setarius (Lam.) Roem & Schult. Frequent in shade.
Panicum fasciculatum Swartz. Browntop Panicum. Rare.
Setaria geniculata (Lam.) Beauv. Knotroot Bristlegrass. Occasional on river side.
Setaria macrosperma (Scribn. & Merr.) Schum. Foxtail. Occasional on river side.
Sporobolus poiretii (Roem. & Schultes) Hitchc. Smutgrass. Occasional.

Cyperaceae

Cyperus ligularis L. Frequent on river side.
Cyperus strigosus L. Occasional on river side.

Palmae

Sabal palmetto (Walt.) Todd. ex Schult. & Schult. Cabbage Palm. Occasional at base of mound.
Serenoa repens (Bartr.) Sm. Saw Palmetto. Occasional at base of mound.

Bromeliaceae

Tillandsia fasciculata Sw. Giant Air Plant. Rare.
Tillandsia simulata Sm. Rare.
Tillandsia usneoides (L.) L. Spanish Moss. Occasional on river side.

Commelinaceae

Commelina diffusa Burm. f. Common Dayflower. Rare.
Leiandra cordifolia (Sw.) Raf. Frequent on shells in shade.

Liliaceae

Smilax laurifolia L. Bamboo Briar. Occasional at base of mound.

Agavaceae

Yucca aloifolia L. Spanish Dagger. Abundant.

Amaryllidaceae

Hymenocallis sp. Spider Lily. Rare, has not flowered.

Myricaceae

Myrica cerifera L. Wax Myrtle. Occasional, base of mound.

Fagaceae

Quercus laurifolia Michx. Laurel Oak. Occasional, base of mound.
Quercus virginiana Mill. Live Oak. Occasional, base of mound.

Ulmaceae

Celtis laevigata Willd. Hackberry. Dominant.

Urticaceae

Parietaria praetermissa Hinton. Pellitory. Dominant in shade.
Urtica chamaedryoides Pursh. Stinging Nettle. Rare near southern overlook.

Olacaceae

Schoepfia chrysophylloides (A. Rich.) Planch. Whitewood. Rare.

Chenopodiaceae

Chenopodium album L. Lamb's Quarters. Occasional on river side.

Amaranthaceae

Iresine diffusa H. & B. ex Willd. Juba's Bush. Occasional near base.

Nyctaginaceae

Boerhavia diffusa L. Red Spiderling. Rare.

Phytolaccaceae

Phytolacca americana L. Pokeweed. Rare.
Rivina humilis L. Rouge Plant. Occasional.

Aizoaceae

Sesuvium portulacastrum (L.) L. Seaside Purslane. Occasional near base.

Portulacaceae

Portulaca pilosa L. Pink Purslane. Occasional along trail.
Portulaca phaeosperma Urban. Yellow Purslane. Rare on trail.

Caryophyllaceae

Arenaria lanuginosa (Michx.) Rohrb. Sandwort. Rare on trail.

Lauraceae

Nectandra coriacea (Sw.) Griseb. Lancewood. Rare.
Persea borbonia (L.) Spreng. Red Bay. Abundant.

Cruciferae

Lepidium virginicum L. Peppergrass. Abundant along trail.

Crassulaceae

Kalanchoe pinnata (Lam.) Pers. Life Plant. Rare on northern side of mound.

Leguminosae

Canavalia maritima (Aubl) Urb. Seaside Bean. Occasional on river side.
Erythrina herbacea L. Coral Bean. Occasional.
Galactia regularis (L.) BSP. Milk Pea. Occasional on river side.
Vigna luteola (Jacq.) Benth. Cow Pea. Occasional on river side.

Oxalidaceae

Oxalis dillenii Jacq. Sour Grass. Rare along trail.

Rutaceae

Amyris elemifera L. Torchwood. Dominant.
Citrus aurantium L. Sour Orange. Occasional.
Xanthoxylum fagara (L.) Sarg. Wild Lime. Dominant.
Xanthoxylum clava–herculis L. Hercules Club. Occasional.

Euphorbiaceae

Chamaesyce hirta (L.) Millsp. Rare.
Euphorbia cyathophora Murr. Wild Poinsettia. Occasional along trail.

Anacardiaceae

Rhus copallinum L. Winged Sumac. Occasional, base of mound.

Aquifoliaceae

Ilex vomitaria Ait. Yaupon. Occasional, base of mound.

Sapindaceae

Exothea paniculata (Juss.) Radlk. Inkwood. Frequent.

Rhamnaceae

Sageretia minutiflora (Michx.) Mohr. Buckthorn. Abundant.

Vitaceae

Cissus trifoliata (L.) L. Possum Grape. Abundant, west side.
Parthenocissus quinquefolia (L.) Planchon. Virginia Creeper. Dominant.
Vitis rotundifolia Michx. Muscadine Grape. Rare, at base of mound.
Vitis shuttleworthii House. Calusa Grape. Rare, at base of mound.

Malvaceae

Malvastrum coromandelianum (L.) Garcke. False Mallow. Abundant along trail.
Pavonia spinifex (L.) Cav. Spur Bur. Frequent along trail.

Passifloraceae

Passiflora suberosa L. Passionflower. Abundant.

Caricaceae

Carica papaya L. Papaya. Rare.

Loasaceae

Mentzelia floridana Nutt. ex Torr & Gray. Poor Man's Patches. Occasional in open areas.

Cactaceae

Cereus eriophorus Pfeiffer var. *fragrans* (Sm.) Benson. Rare.
Opuntia compressa (Salisb.) Macbride var. *amnophila* (Sm.) Benson. Occasional.
Opuntia stricta Haw. var. *stricta*. Occasional.
Opuntia stricta Haw. var. *dillenii* (Ker.) Benson. Frequent.

Rhizophoraceae

Rhizophora mangle L. Red Mangrove. Occasional on river side.

Combretaceae

Laguncularia racemosa (L.) Gaertn. f. White Mangrove. Rare on river side.

Myrtaceae

Eugenia axillaris (Sw.) Willd. White Stopper. Dominant.
Myrcianthes fragrans (Sw.) McVaugh. Nakedwood. Dominant.

Myrsinaceae

Ardisia escallonioides Schlecht. & Cham. Marlberry. Dominant.
Myrsine floridana D.C. Myrsine. Frequent.

Plumbaginaceae

Plumbago scandens L. Leadwort. Frequent.

Sapotaceae

Bumelia tenax (L.) Willd. Tough Buckthorn. Occasional.
Mastichodendron foetidissimum (Jacq.) Cronquist. Rare.

Oleaceae

Forestiera segregata (Jacq.) Krug. & Urban. Florida Privet. Abundant.

ASCLEPIADACEAE

Cynanchum scoparium Nutt. Leafless Cynanchum. Frequent.

CONVOLVULACEAE

Ipomea alba L. Moonflower. Occasional.
Ipomoea acuminata (Vahl) Roem. & Schult. Occasional.

BORAGINACEAE

Heliotropum angiospermum Murray. Dog's Tail. Occasional on river side.

AVICENNIACEAE

Avicennia germinans (L.) L. Black Mangrove. Occasional on river side.

VERBENACEAE

Callicarpa americana L. French Mulberry. Occasional.
Lantana ovalifolia Britt. Shrub Verbena. Rare on north side at base.
Verbena maritima Sm. Seaside Verbena. Rare on river side.

LABIATAE

Salvia coccinea Buc'hoz *ex* Etlinger. Scarlet Salvia. Occasional in exposed areas.

SOLANACEAE

Capsicum frutescens L. Bird Pepper. Frequent.
Lycium carolinianum Walt. Christmas Berry. Rare on river side.
Physalis viscosa L. var. *maritima* (M.A. Curtis) Waterfall. Ground Cherry. Occasional along wall near river.

RUBIACEAE

Chiococca alba (L.) Hitch. Snowberry. Abundant.
Psychotria nervosa Sw. Wild Coffee. Frequent.
Galium hispidulum Michx. Bedstraw. Frequent.

CUCURBITACEAE

Melothria pendula var. *crassifolia* (Sm.) Cogn. Creeping Cucumber. Rare.

COMPOSITAE

Ambrosia artemisiifolia L. Common Ragweed. Occasional along river side.
Baccharis halimifolia L. Groundsel Tree. Occasional on river side.
Bidens pilosa L. Spanish Needle. Abundant along trail.
Borrichia frutescens (L.) D.C. Sea Oxeye. Occasional on river side.
Iva frutescens L. Marsh Elder. Occasional on river side.
Melanthera aspera Jacq. var. *aspera*. Occasional on river side.
Solidago sempervirens L. Goldenrod. Occasional on riverside.
Sonchus oleraceus L. Sow-Thistle. Occasional along trail.
Verbesina laciniata (Poir.) Nutt. Crownbeard. Abundant along trail.
Vernonia gigantea (Walt.) Trel. Ironweed. Abundant along trail.

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Biological Sciences

SIZE TRENDS IN LIVING BENTHONIC FORAMINIFERIDA

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ABSTRACT: *Except for the very largest species of calcareous benthonic Foraminiferida (10 mm or larger), there appears to be only a slight trend toward a higher percentage of large-sized species in warm water. The agglutinated Foraminiferida have a slight trend toward larger size in cold water, and all of the largest species (20 to 40 mm) live in water that is less than 5° C.*

WE RECORDED the size of each species of living benthonic Foraminiferida in ten regional monographs. Previously, little analysis of this type had been done on invertebrates, although Bé (1968, p. 881) noted that tropical and subtropical species of planktonic Foraminiferida were generally larger than those living in cold water, and Nicol (1966, p. 109-113) observed that a higher percentage of large-sized species of marine pelecypods live in warm water.

This type of size analysis was performed by Lindsey on poikilotherm vertebrates (1966, p. 456-465). He recorded the size of each species from regional monographs and arranged them into size classes. Lindsey found a clear trend toward a higher percentage of large-sized species of freshwater fish in the higher latitudes or colder water. He found the same trend occurring, to a somewhat lesser extent, in shallow-water marine fish. Lindsey noted a geographic anomaly; in the Sea of Okhotsk the species of fish were of uncommonly small size, considering the coldness of the water in that region. Surprisingly enough, the trend toward a higher percentage of large-sized species in higher latitudes was even more marked in deep-sea fish than it was in shallow-water marine fish, but Lindsey did not specify what he meant by deep sea. The trend toward a higher percentage of large-sized species in colder climates is also well marked in all amphibians—frogs, toads and salamanders. With the exception of the Boidae, which are largely restricted to the tropics, the snakes show a slight trend toward larger size in the higher latitudes. There is no correlation between size and latitude in either the lizards or non-marine turtles. It is interesting to note the latitudinal differences in size trends in these poikilotherm vertebrate groups from very marked, through slight, to none at all, because these differences also occur in some living invertebrate groups with calcareous shells or tests. It will also be noted that regional anomalies in size distributions can occur in the Foraminiferida.

Calcareous benthonic Foraminiferida show little trend toward larger size in warmer water except for the truly large species of 10 mm or more. There are few extant species of large calcareous Foraminiferida, but one species attains a size of 48 mm at Bikini. Murray (1973) states that all occurrences of larger foraminiferids are encompassed by the 25° C surface-water isotherms for the northern and southern summers.

The agglutinated foraminiferids show a slight trend toward a larger size in cold water, and the true giants (20 to 40 mm in length) are all found in cold water (less than 5° C). The largest agglutinated species we recorded was 40 mm long and lives in the region of South Georgia, but there are undoubtedly species as large or larger living in such cold water.

One regional anomaly can be noted in Figure 1. The San Diego, California, benthonic foraminiferids, both calcareous and agglutinated, have an uncommonly high percentage of small-sized species and an absence of any species of more than moderate size.

Ten foraminiferidal faunas were analyzed by comparing the number of species of calcareous to agglutinated forms in each of four size classes. Table 1 is a summary of the totals of the ten faunas. Most of the smallest species of benthonic Foraminiferida (0.150 mm or less) are calcareous rather than agglutinated, and of all species that are 0.5 mm or less, 88% are calcareous. In Table 1 one sees that in the four size classes from smallest to largest, there is a steadily decreasing percentage of calcareous species. In only the peculiar fauna from San Diego, of the ten analyzed, is the smallest recorded species an agglutinated form. In warm water the largest living species is commonly calcareous; this is true at Bikini, the

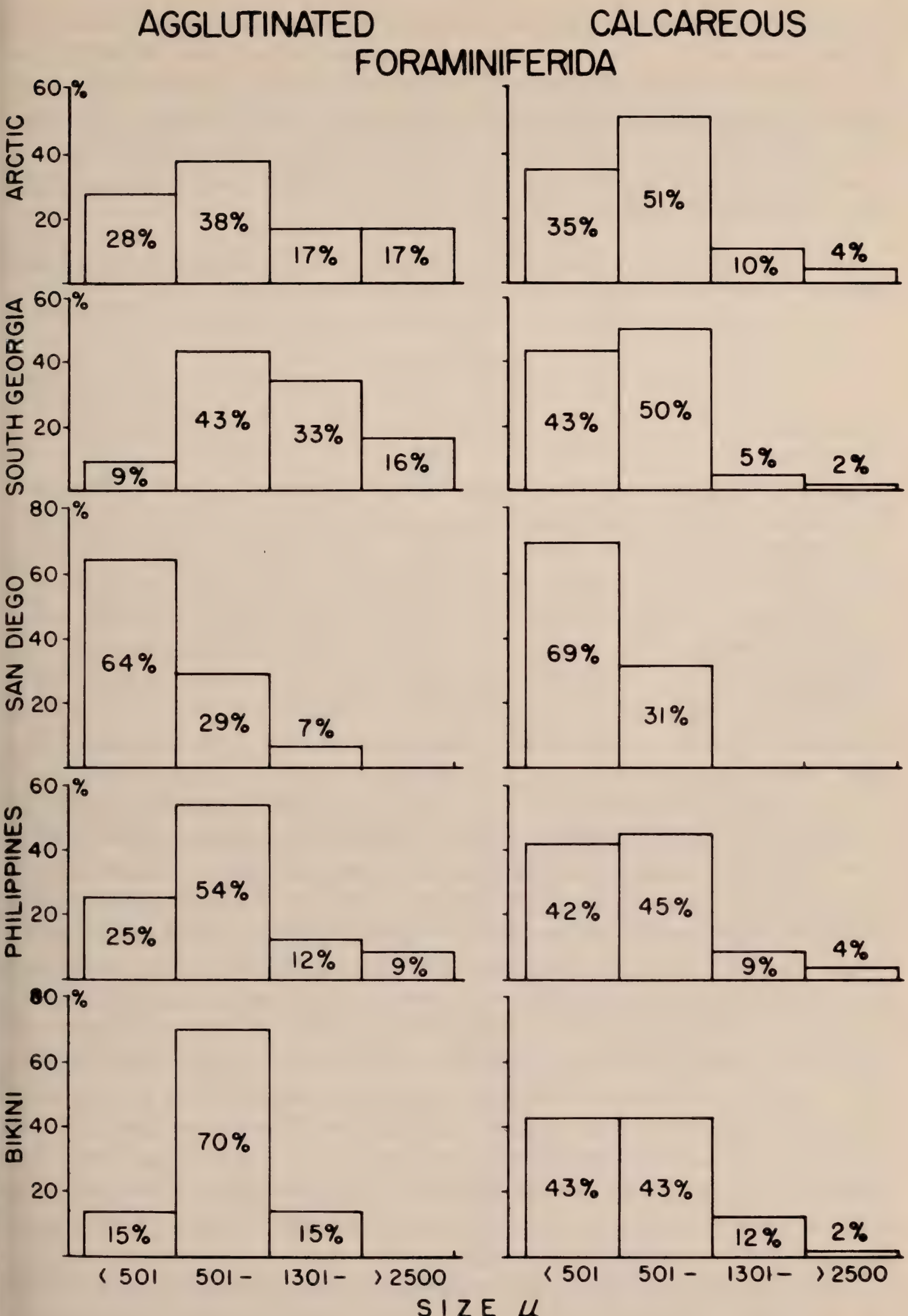

Fig. 1. Histograms which show the percentages of calcareous and agglutinated species of Foraminiferida grouped into four size classes. Data taken from five regional monographs.

Philippines, Greece, and southern Brasil. However, in the Gulf of Alaska the largest living species is also calcareous, and in central Chile one calcareous species is just as large as the largest agglutinated species. On the other hand, the largest living species is agglutinated in the Arctic, South Georgia, San Diego, and, surprisingly, the Gulf of Mexico faunas. This bears out the previous statement that the large calcareous species are mainly found in warm water and the large agglutinated species live mainly in cold water.

TABLE 1. Number of species and percentage of calcareous and agglutinated benthonic Foraminiferida divided into four size classes. Data taken from ten regional faunas.

Size	Number of Species	Per Cent
100-500 micra		
Calcareous	584	88
Agglutinated	80	12
501-900 micra		
Calcareous	336	82
Agglutinated	78	18
901-1300 micra		
Calcareous	118	69
Agglutinated	54	31
1301 micra or greater		
Calcareous	127	60
Agglutinated	85	40
TOTAL OF ALL SPECIES		
Calcareous	1,195	80
Agglutinated	297	20

Tappan and Loeblich (1971, p. 290) state that the smallest species of adult Foraminiferida is 0.020 mm and the largest species is 110 mm, but these extreme sizes probably include extinct as well as extant species. The largest and smallest species of calcareous foraminiferid we recorded was 48 mm and 0.100 mm respectively. The ratio in size between the largest and smallest calcareous species is 480:1. The largest and smallest species of agglutinated foraminiferid we recorded was 40 mm and 0.130 mm respectively. The ratio in size between the largest and smallest agglutinated species is 308:1. These ranges in size are greater than those found in some of the larger-sized living invertebrate groups, as for example the fresh-water gastropods. It is the ratio of the largest species to the smallest species, or absolute size range within a group, that is considered to be an important factor in explaining diversity. It is noted here that the calcareous foraminiferids have a greater size range and are also more diverse, outnumbering the agglutinated species 4:1 in the ten faunas.

Table 2 is a compilation of the ten foraminiferidal faunas from cold, temperate, and warm water. One will note in Table 2 that the cold and temperate faunas all have 75% or less of calcareous species, whereas the more diverse warm-water faunas have 81% to 89% calcareous species. Calcareous species of benthonic Foraminiferida increase in number from cold to warm water, but there appears to be no such change in the number of agglutinated species. The San

TABLE 2. Comparison of species diversity of calcareous and agglutinated Foraminiferida in ten different regions.

Region	% Calcareous	% Agglutinated
South Georgia	61	39
Arctic	73	27
Gulf of Alaska	75	25
San Diego	60	40
Central Chile	74	26
Southern Brasil	86	14
Gulf of Mexico	81	19
Greece	89	11
Philippines	85	15
Bikini	89	11
Species of all faunas	80	20

Diego fauna is again exceptional in the high percentage of agglutinated species, but a high percentage of agglutinated species is not surprising for the very cold water at South Georgia.

We have analyzed one well-known fossil fauna: Puri's (1957) study of the Foraminiferida of the Ocala Group of Florida, which is of Late Eocene age. From the molluscan evidence, as well as the presence of the large Foraminiferida *Lepidocyclina, Asterocyclina,* and some nummulitid species, the water temperature on the Ocala Bank must have been at least 25° C, and it was very likely higher than this. Puri described 115 calcareous species and 21 agglutinated species: i.e., approximately 85% were calcareous and 15% were agglutinated. These percentages fit well to the living warm-water foraminiferidal faunas as seen in Table 2. Whether ratios of calcareous species to agglutinated species can be used as an indicator of water temperature must await further study.

It has been noted that broken echinoid spines are regenerated more rapidly when these animals are placed in warm water (Davies et al., 1972). Calcium carbonate is more readily obtainable in warm water by animals using it for skeletal material, and the metabolism of these animals increases at higher temperature, thus utilizing calcium carbonate more rapidly. This at least partially explains the trend toward larger size at warm temperature as seen in the calcareous Foraminiferida and, more conspicuously, in the marine pelecypods (Nicol, 1966).

RELIABILITY OF THE DATA—Few monographs on Foraminiferida have size data in the text, except for new species that are described. One must get the magnification of each figure and measure the figure with a millimeter ruler. These calculations are tedious and some errors are certain to occur. Even so, size data on the Foraminiferida appear to be reasonably accurate when one compares the few monographs with size data in the text to those that do not have this information.

Besides those publications actually cited in the paper, we have also included under Literature Cited the sources from which basic data on size were taken.

ACKNOWLEDGMENTS—We are indebted to many people who gave us advice and suggestions on size data on the Foraminiferida. Ms. M. Ruth Todd of the

U. S. Geological Survey saved us many days' work by selecting appropriate faunal monographs on living Foraminiferida for analysis. Dr. Richard Cifelli of the National Museum of Natural History also suggested some useful monographs on Foraminiferida for size data. Dr. K. N. Sachs of the U. S. Geological Survey was helpful in discussions on the large living calcareous Foraminiferida. Mr. Lawrence B. Isham of the National Museum of Natural History discussed the accuracy of the size data of Foraminiferida with the senior author. Mr. Paul Laessele, scientific illustrator for the zoology department at the University of Florida, drew the histograms. Dr. Leo Polopolus, chairman of the department of food and resource economics at the University of Florida, gave us some excellent suggestions on statistical treatment of the size data.

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A PYGMY KILLER WHALE FOUND ON THE EAST COAST OF FLORIDA

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Abstract: *A sexually mature male* Feresa attenuata *207 cm long was discovered alive and taken to the Miami Seaquarium for treatment. Measurements and blood test results were recorded from this first specimen recorded for Florida.*

A small whale (fig. 1-4) entered a boat slip on 3 May 1971 at Lake Worth, Florida (26°37′N, 80°02′W) and remained there for several hr in an apparently weakened condition. On our arrival we found that the animal, a male pygmy killer whale (*Feresa attenuata* Gray, 1875), had been tethered to a piling by a small nylon rope around the tail in water approximately 1.2 m deep. The 2m long animal (Table 1) was resting calmly at the surface and offered little resistance when placed in a transport stretcher. The animal remained calm during transport (1 hr) to the Miami Seaquarium.

Following arrival at the Seaquarium, a blood sample was collected from a median vein-artery complex of the flukes (Tables 2 and 3). Body temperature, measured rectally, was 35.9°C. B-complex vitamins were administered intramuscularly. The animal was placed in a 1 m deep concrete holding tank. It swam at the surface slowly, with a definite list to the left, and attempts to dive were feeble. Although Pryor et al. (1965) reported that a specimen of *Feresa* captured in Hawaiian waters was extremely aggressive toward its captors and other cetaceans while in captivity, our specimen swam away from the attendants. When left unattended, the animal swam into the wall of the tank. Its eyes remained open, and sounds not unlike the "whistles" or "clicks" sounds made by *Tursiops truncatus* were detected. Unfortunately, these sounds were not recorded, but the "growling" and "blatting" noises reported by Pryor et al. (1965) were not heard.

Attempts to interest the animal in various species of fishes were unsuccessful; it made no gesture that could be interpreted as an interest in food.

The animal swam slowly at the surface in no particular pattern during the 40 hr that it remained in the holding tank. During the 5 hr prior to its death, it belched large volumes of air from the mouth on four occasions. At the time of death, it passed fresh blood from the mouth.

Although superficially quite similar to the false killer whale (*Pseudorca*), the absence of pigmentation around the mouth and genital region, the relatively larger pectoral flippers and the dentition clearly characterized *Feresa*. Unpigmented lines appearing to be scars of "tooth rakes" were noted over the entire body (see figs).

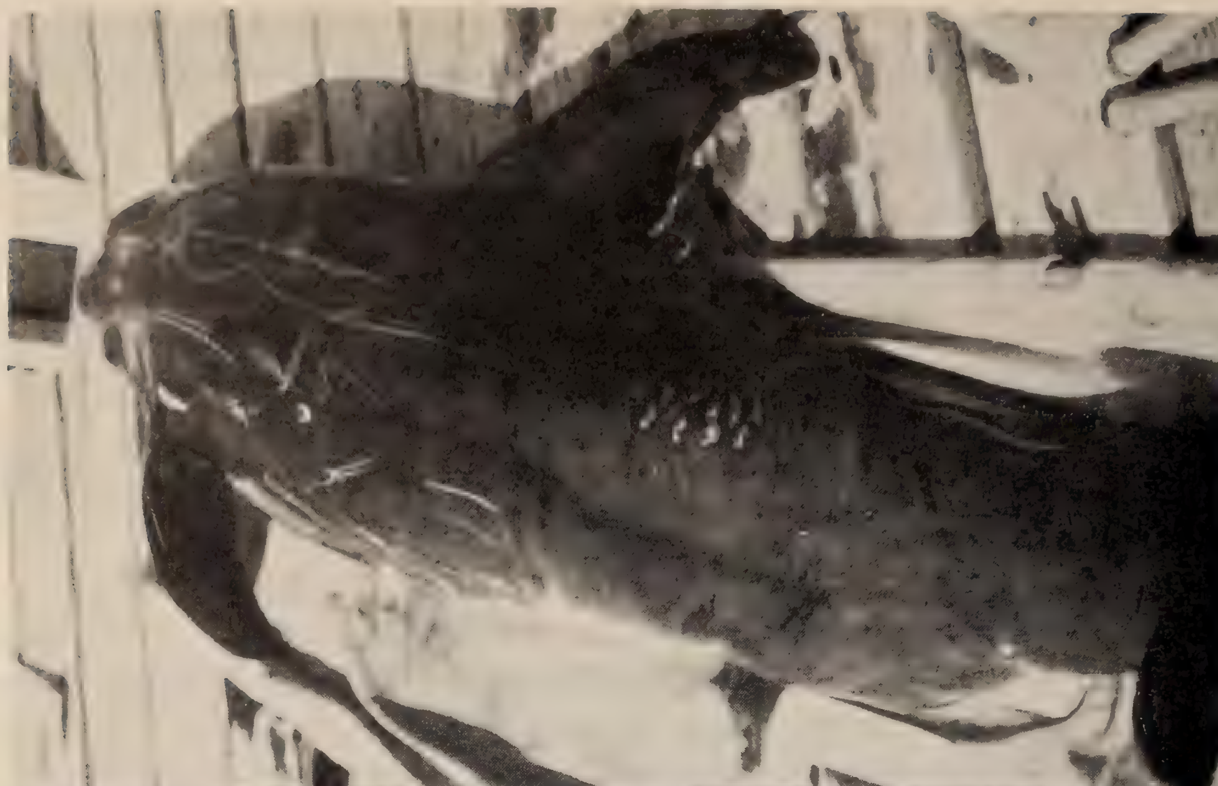

Fig. 1. (upper) *Feresa attenuata,* lateral surface.

Fig. 2. (lower) *Feresa attenuata,* unpigmented area around the buccal cavity.

Two previous records of this species are known from the western Atlantic: the dead specimen described by James et al. (1970) from Padre Island, Texas, and a skull from St. Vincent in the Lesser Antilles reported by Caldwell and Caldwell (1971). Our specimen is the first record from Florida.

Detailed body measurements were made utilizing the standardized system established by Norris (1961) (Table 1). Six freshly-perforated ulcers were found in the mucosa of the fundic region of the stomach. Each ulcer was over 1 cm

TABLE 1. Body measurements and proportions of male *Feresa attenuata* from Lake Worth, Florida (following Norris, 1961).

Measurement	CM	Percent of Total Length
Total length	207	100
Tip of upper jaw to center of eye	22.2	10.7
Tip of upper jaw to angle of gape	15.87	7.66
Tip of upper jaw to external auditory meatus	27.30	13.28
Center of eye to external auditory meatus	3.8	1.83
Center of eye to angle of gape	6.9	3.33
Center of eye to center of blowhole	17.14	8.28
Tip of upper jaw to blowhole	19.05	9.20
Tip of upper jaw to anterior insertion of flipper	40.0	19.32
Tip of upper jaw to tip of dorsal fin	124.4	60.1
Tip of upper jaw to midpoint of umbilicus	99.06	47.8
Tip of upper jaw to midpoint of genital aperture	109	52.6
Tip of upper jaw to center of anus	137.1	66.23
Projection of upper jaw beyond lower	6	2.90
Thickness of blubber:		
Mid-dorsal at anterior insertion of dorsal	2.5	1.21
Mid-lateral at midlength	3.8	1.83
Mid-ventral at midlength	1.9	0.92
Girth—axillary	55.8	26.9
Girth—maximum (90 cm from tip of upper jaw)	60.9	29.4
Girth—anal	36.1	17.4
Dimensions of eye:		
Height	1.27	0.6
Length	3.17	1.53
Length, genital slit	19.05	9.20
Length, anal aperture	5.7	2.75
Dimensions of blowhole:		
Width	3.17	1.53
Length	1.90	0.92
Length, flipper (anterior insertion to tip)	40.0	19.32
Length, flipper (Axilla to tip)	31.7	15.31
Width, flipper (maximum)	13.3	6.42
Height, dorsal fin	26	12.56
Length, dorsal fin base	33.6	16.23
Width, flukes (tip to tip)	51.43	24.8
Depth of notch between flukes	17.1	8.3
Teeth:		
Rt. upper 11 Lt. upper 11		
Rt. lower 11 Lt. lower 10		

diam. with the largest being 3.6 cm. Several hundred nematode and several cestode parasites were found in the first compartment of the stomach. The nematodes were identified as *Filocapsularia* sp., probably *F. marina* (Linnaeus, 1767), while the cestodes have as yet been identified only to family (Tetrabothriidae).

The right lung revealed congestion and areas of red hepatization, indicative of early pneumonia. The remaining systems were unremarkable. Live sperm were found upon microscopic examination of testicular tissue, thereby indicating sexual maturity.

TABLE 2. Hemogram of stranded *Feresa attenuata* from Lake Worth, Florida.

Date	RBC X 10^6/cmm	Hb (Gm/ 100 ml)	PCV (%)	MCV m^3	MCH mmcg	MCHC %
5-3-71	3.9	15.0	42.7	107	37	34.6
5-5-71	4.1	14.8	43.1	105	34	35.1

			Differential				
Date	WBC X 10^3/cmm	Baso-phils	Eosino-phils	Band neutro-phils	Seg-mented neutro-phils	Lympho-cytes	Mono-cytes
5-3-71	7.1	0	2	6	73	17	2
5-5-71	8.4	0	4	6	69	20	1

ACKNOWLEDGEMENTS—The author expresses his appreciation to Dr. Arthur A. Myrberg of Rosenstiel School of Marine and Atmospheric Sciences for reviewing the manuscript, and to the General Manager of Wometco Miami Seaquarium, Burton Clark, Warren Zeiller and the entire Seaquarium staff, for their dedicated cooperation. Parasitological identifications were kindly supplied by Dr. W. Henry Leigh, University of Miami.

TABLE 3. Blood chemistry values: Stranded *Feresa attenuata* from Lake Worth, Florida.

Date	Na + (mEq/ L)	K + (mEq/ L)	Cl− (mEq/ L)	CO_2 (mEq/ L)	Total protein (Gm/ 100 ml)	Ca + + (mg/ 100 ml)
5-3-71	160	4.1	130	18.5	8.3	8.5
5-5-71	155	4.0	120	22.6	8.8	8.0

Date	Alkaline phosphatase activity (King Armstrong units	Total bilirubin (mg/ 100 ml)	BUN (mg/ 100 ml)	Glucose (mg/ 100 ml)	SGOT activity (Karman's units
5-3-71	7.5	0.2	37	130	250
5-5-71	10.1	0.2	44	121	250

Fig. 3. (upper) *Feresa attenuata,* unpigmented area around the genital slit.

Fig. 4. (lower) *Feresa attenuata,* ventral surface.

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NEW RECORDS AND RANGE EXTENSIONS OF BENTHIC ALGAE IN THE GULF OF MEXICO

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Abstract: *Three species of benthic algae are newly reported for the Gulf of Mexico:* Agmenellum quadruplicatum, Rhizoclonium tortuosum, *and* Vaucheria bermudensis. *Range extensions in the Gulf are reported for six other species.*

As a result of a year around study of the benthic algae of the Anclote estuary near Tarpon Springs, Florida Gulf coast (Hamm, 1975), three species appear to be new records for the Gulf of Mexico, and range extensions of six others are noted.

Species New for the Gulf—One bluegreen (Cyanophyta), one green (Chlorophyta), and one yellow-green (Xanthophyta) are here newly reported for the Gulf of Mexico.

Agmenellum quadruplicatum Brebisson was found on intertidal muddy sand just north of the mouth of the Anclote river in the estuary. The area was protected by a salt marsh partially surrounding it and by extensive shallow water. This species is more common in fresh and brackish water, but it occurs in high salinity water in salt marsh and mangrove areas. It has been recorded from New England to the West Indies and South America in the western Atlantic (Drouet and Daily, 1956; Cocke, 1967).

Rhizoclonium tortuosum Kützing was found among the aerial roots of black mangroves around mangrove islands in Anclote estuary the year around. Harvey (1858) first reported this species from North America at Halifax, Nova Scotia; Maine; Massachusetts; and Alaska. Howe (1918) reported it from Bermuda with the comment, " . . . perhaps an untenable name. . ." Taylor (1957, 1960) indicates a North Carolina record but without a substantiating reference. Taylor and Bernatowicz (1969) do not list this species for Bermuda, apparently treating Howe's record under another name. Culture studies are needed to determine the extent of the influence of the environment upon taxonomic characters used in the genus *Rhizoclonium.*

Vaucheria bermudensis Taylor and Bernatowicz formed dense mats that accumulated fine sand and silt over old oyster shells in the lower part of the Anclote River. This species was described from Bermuda by Taylor and Bernatowicz (1952). It was reported in Biscayne Bay, Miami, with some doubt, by Humm (1963). This third report is made with confidence as an abundance of reproductive material was obtained from the Anclote River collections.

Range Extensions—Range extensions in the eastern Gulf of Mexico include three bluegreens, one red, and two greens.

Anacystis marina Drouet and Daily, the smallest-celled species of coccoid bluegreen found in the sea, formed minute colonies on intertidal muddy sand in the same area as *Agmenellum quadruplicatum* (above). Drouet and Daily

(1956) reported *A. marina* from the New England coast. It was found in the marine plankton in North Carolina by Aziz and Humm (1962), and recorded from several fresh and brackish water habitats in North Carolina by Cocke (1967). Apparently the only previous report in the Gulf of Mexico is that of Humm and Caylor (1957) in Mississippi Sound. This species is probably much more widely distributed than records indicate as the colonies are microscopic and the cells only about 0.5 micron in diameter.

Nodularia harveyana (Thwaites) Thuret was found the year around throughout the Anclote estuary and the lower part of the Anclote River in the intertidal zone on muddy sand, on pilings, plastic strips, and concrete blocks. It has been reported in the northern Gulf of Mexico at Bay St. Louis, Mississippi (Humm and Caylor, 1957), and in the western Gulf at Vera Cruz, Mexico (Humm and Hildebrand, 1962). It also occurs in fresh water.

Scytonema hofmannii Agardh was found in the Anclote estuary among the pneumatophores of black mangroves around mangrove islands the year around. This species has been recorded by Drouet (1973) from many localities in Florida but apparently not from the marine environment of the Tampa Bay region.

Acrochaetium sagraeanum (Montagne) Bornet was an epiphyte on larger algae that were loose and drifting in Anclote estuary during the winter months only (1973-1974). It has been reported from Connecticut (Taylor, 1957), Barbados (Vickers, 1905), Bermuda (Collins and Hervey, 1917), Vera Cruz, Mexico (Humm and Hildebrand, 1962), and from Biscayne Bay at Miami (Humm, 1964). That this alga is much more widely distributed than these records indicate has been shown by Aziz (1965) who recorded it from Beaufort, N. C., Alacran Reef, southern Gulf of Mexico, Largo Sound at Key Largo, and off Alligator Point, Franklin County, south of Tallahassee, Florida. Its distribution may be regarded as continuous around the Gulf of Mexico and from the West Indies to the south side of Cape Cod along the Atlantic coast (Distribution group 7 of Humm, 1969, fig. 1, p. 46). Apparently in all collection records except one this species was an epiphyte on larger algae. The exception is a collection in which the plant was growing upon a nylon fishing line caught on a pier piling in Bayboro Harbor, St. Petersburg, Florida, October 31, 1967 (in the herbarium of the Mote Marine Laboratory, Sarasota, Florida). The species is not an obligate epiphyte.

Enteromorpha erecta (Lyngbye) J. G. Agardh was found on natural substrata such as oyster shells and limestone but it also developed in abundance on concrete blocks and plastic strips that were placed in the lower intertidal zone in the Anclote estuary, especially from December to February 1973-1974. This species was reported from Maine to the West Indies by Collins (1909), a species of more or less exposed shores. In the Gulf of Mexico it has been collected at Alacran Reef off Yucatan by Kim (1964) and along the mainland of the coast of Mexico by Huerta and Garza Barrientos (1964) so that the Gulf records seem to be restricted to the southernmost sector. The present report extends its known range to the Tampa Bay area. It is probably a species that occurs around the entire periphery of the Gulf of Mexico.

Cladophora crystallina (Roth) Kützing was common the year around in the

Anclote estuary at many stations. Collins (1901) reported *C. crystallina* from Jamaica and (1909) from New England and the West Indies. There seem to be few reports of it between the two areas. Apparently the only report of this species in the Gulf of Mexico is that of Dawes et al. (1967) off the Ten Thousand Islands at the western boundary of the Everglades National Park. The present report extends the known range northward to the Tampa Bay area. *Cladophora crystallina* is probably an invalid name. In his monograph on European species, van den Hoek (1963) writes, "*C. crystallina* may be conspecific with either *C. glomerata* var. *glomerata* or *C. vagabunda.*" Söderström (1963) in his monograph of European species of *Cladophora* expresses the opinion that *C. crystallina* is a synonym of *C. glomerata* (L.) Kützing. The latter is a fresh water species that penetrates brackish water and does not appear to be the same plant reported here from Anclote. Until there is a better understanding of the marine species of *Cladophora* of the Atlantic coast of North America, it seems best to continue to follow Collins' (1909) treatment.

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Science Teaching

A LABORATORY METHODS COURSE FOR TEACHER CANDIDATES[1]

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ABSTRACT: *Students enrolled for the science methods course at FTU are provided with formal exposure to science laboratory teaching techniques and technology by service in an introductory laboratory under supervision of the faculty member in charge. This individualized, professionally directed, "hands on" experience has proven successful for teacher candidates.*

A PERENNIAL PROBLEM in preparation of secondary teachers in biology and other laboratory sciences has been the manner in which "methods" have been presented. Usually, some type of laboratory course is presented wherein the pre-service teacher is *shown how* to accomplish several class experiments. The student may present the material to his classmates in the course as a demonstration or set up some apparatus for inspection and submit a written report.

Conferences with biology education majors at Florida Technological University and biology teachers in public schools revealed that pre-service teachers usually cannot critique and discuss the rationale associated with specific laboratory situations. Further, we found that the supervising teacher often was unaware of the rationale for laboratory exercises which were done "according to the book" and could not discuss new principles introduced. The student, or pre-service, teacher may enter his supervised classroom service with a minimum of laboratory experience much of which has little relevance to the new situation. Finally, we discovered that the pre-service teacher has limited, if any, direct experience in organizing and preparing materials for the laboratory.

With this feedback in hand, the science methods course being taught in the conventional manner was reviewed. It seemed to lack the flexibility to address itself to some of the problems elucidated in the conferences. This was especially

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so in the area of "hands on" experience in preparation of biological materials and in presenting laboratory experience to students in a primary learning situation. The conventional course could not be directed to meet the highly individualized needs of the pre-service teachers with extremely diverse backgrounds.

The Department of Biological Sciences and the Department of Secondary Education have cooperated in development of the program for the biology education major and interdepartmental communication has remained free and open. As the needs of pre-service teachers and teachers became apparent, Miller suggested that an apprenticeship program similar to one he had initiated at Washington State University between the Program in General Biology and the Department of Education might be of value. Armstrong reviewed curricular needs of the students and developed a mutually acceptable and academically appropriate course which incorporated the strengths inherent in both a conventional course and in Miller's modified apprenticeship program. We have found that our program, as cooperatively developed, has been satisfactory to our respective departments, has proven to be eminently workable, and has been highly regarded by both pre-service and recently graduated teachers.

The course as presented is called BIOLOGY LABORATORY TEACHING and is designed to be taken normally during the senior year. Coordination of student experiences is accomplished by a weekly class meeting by all enrolled in the course with the Education instructor in charge of the course. During this period the selected students report on the activities in the Biological Sciences courses in which they are involved. As five courses are possibilities—BIOLOGICAL PRINCIPLES, BASIC BIOLOGY (for majors only), GENERAL BOTANY, GENERAL MICROBIOLOGY, or GENERAL ZOOLOGY—the diversity of experience within the group is considerable so that both breadth and depth of coverage is possible, either first hand or on a student to student basis. The instructor may elect to assign special reading or special topic reports to individual students to assure that maximum advantage is derived from the weekly sessions.

The heart of BIOLOGY LABORATORY TEACHING resides in the total involvement of the pre-service teacher in one of the five introductory courses available in Biological Sciences. In consultation with the Education instructor, he elects his first and second choice of courses for participation. Then the student confers with the professor with whom he wishes to work. Because the Biology professor is not required to accept the student, *nor to keep him if participation is unsatisfactory*, the student faces some of the same uncertainties that accompany a first position. Equally important, however, is that the faculty member commits himself to give the apprenticing student a meaningful and useful experience. Although some students have indeed been dismissed by their Biology professor (a sobering and highly beneficial, albeit academically expensive, experience in each case), the great majority develop a special rapport with "their" professor and develop an element of self-confidence born of the experience and close association.

Once accepted, the student is required to meet a series of minimum obligations: 1) to work with the students under professional supervision in one laboratory section per wk for 3-4 hr; 2) to attend the weekly staff meetings for those multiple section courses where detailed plans, behavioral objectives and rationale for the week's work are discussed along with any special problems that might arise; 3) to learn how to use routine laboratory apparatus and to be able to demonstrate its use; 4) to become acquainted with planning, ordering, and preparing for laboratory exercises; 5) to demonstrate a knowledge of the necessary content background for the laboratories; 6) to prepare and conduct a presentation discussion for one laboratory exercise; 7) to become acquainted with the evaluation procedures for the laboratory; and 8) to correct one laboratory exercise in cooperation with the supervising laboratory instructor. The nature of these obligations is such that they cannot be met if the student does not actively participate in every aspect of course operation and presentation.

The student is continuously evaluated by the laboratory teacher and the Education supervisor as each of the obligations is fulfilled. This feedback to the student allows correction of minor problems and serves to guide future behavior to more desirable patterns.

At the end of the course, each student is asked to write comments concerning the experience. The spectrum of input is broad, but the majority of the students respond with statements such as these: 1) "exposure to the laboratory was useful"; 2) "we uncovered the small everyday problems one will run into while teaching"; 3) "working with students was enjoyable"; 4) "preparation of laboratory materials showed how much work is needed"; 5) "observation of the organization of the laboratories was beneficial"; 6) "allows you to work with equipment which you were exposed to earlier but didn't have skill"; 7) "gives one a better understanding of the techniques and procedures used in the laboratory".

The final grade for the course is based in part upon the laboratory instructor's rating of the student on five points: 1) attendance and punctuality; 2) preparation for laboratories; 3) initiative; 4) presentation; and 5) communication. Usually the Education supervisor discusses the final grade of the students with weak records with the laboratory instructor to assure the fairest possible final grade evaluation.

Our several years of highly satisfactory experience with this program at Florida Tech has convinced us that the plan has broad applicability in science teacher training. The major condition to be met, seemingly, is to establish an open dialogue between the science education department and the specialized science department—a dialogue, we note with regret, which seems almost unknown in American academic circles. We hope that the success of our program will stimulate others to cross the lines and become involved in training better public school teachers.

Can this approach be utilized for training teachers in areas other than biology? We can report that the Departments of Chemistry and Physics each came forward with a request to become involved in parallel courses at Florida Tech. Both the students and all the departments involved seem happy about the whole thing. We think other students and departments might be, too.

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OCCURRENCE OF A FLORIDA MANATEE AT PENSACOLA BAY

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We observed a solitary manatee (*Trichechus manatus* Harlan) entering Santa Rosa Sound (30°19′08.5″N, 87°17′07″W) at 15:45 CDST on 30 June 1975. The sighting was made from the beach at the extreme western end of Santa Rosa Island, in Fort Pickens State Park. The animal was a little more than 2 m long, gray-brown, and clearly visible for about 2 min in limpid water. It was swimming slowly to the east at a depth of about 1 m over a sand bank 3 m offshore. Water depth was approximately 2 m. The animal surfaced once for a few seconds. No scars or other distinguishing marks were observed, and it appeared to be robust and swimming normally. Air and sea surface temperatures were, respectively, 28.9°C and 28.6°C (National Weather Service data). The weather was fair, the sea was calm (sea state 1) and the tide was on the ebb. High tide occurred at 10:11 and low tide occurred at 22:23 CDST.

Moore (1951) reported that the normal summer distribution of *Trichechus manatus* rarely extends north or west of the Charlotte Harbor area, although they have been seen in the Wacissa and Suwanee River systems. The westernmost substantiated sighting of *T. manatus* was made in 1946 off Beacon Hill, Florida (29°56′N, 85°23′W—off Port St. Joe). True (1844) reported a sighting of *T. manatus* in Santa Rosa Sound (30°22′N, 86°50′W—20 miles east of Pensacola) but his distributional observations of the species have been questioned (Moore, 1951, reviewed the pertinent literature).

A 1972 survey estimated some 800-1200 manatees in Florida waters, an underestimate according to Powell (National Fish and Wildlife Laboratory, Gainesville, personal communication). While the number of manatees may have increased as predicted by Moore (1951) they are seriously endangered at present and their situation is likely to worsen in the future (Manatee Survey, 2820 East University Avenue, Gainesville, Florida 32601, personal communication).

As the health of northern Gulf estuaries and their associated flora improves, the summer excursion range of the manatee may broaden somewhat. Our sighting should not be taken as presumptive evidence of this, however, and we cannot here explain the occurrence of *T. manatus* in the Pensacola area.

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