

BULLETIN

of the



POST-MIOCENE SPECIES OF *LATIRUS*
MONTFORT, 1810 (MOLLUSCA:
FASCIOLARIIDAE) OF SOUTHERN FLORIDA,
WITH A REVIEW OF REGIONAL MARINE
BIOSTRATIGRAPHY

William G. Lyons

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POST-MIOCENE SPECIES OF *LATIRUS* MONTFORT, 1810 (MOLLUSCA: FASCIOLARIIDAE) OF SOUTHERN FLORIDA, WITH A REVIEW OF REGIONAL MARINE BIOSTRATIGRAPHY

William G. Lyons*

ABSTRACT

Pliocene and Pleistocene marine deposits of southern Florida include the Tamiami, Caloosahatchee, Bermont, Ft. Thompson, and Coffee Mill Hammock formations. Eight species of *Latirus* from three of these deposits are described and illustrated. *Latirus (Latirus) nosali* new species and *L. (Polygona) miamiensis* Petuch, 1986, occur in the middle Pliocene Pinecrest facies of the Tamiami Formation; *L. (L.) stephensae* new species, *L. (P.) hypsipettus* Dall, 1890 (synonym: *L. tessellatus seminolensis* M. Smith, 1936), and *L. (P.) caloosahatchiensis* new name for *L. tessellatus* Dall, 1890, non Récluz, 1844, nec Kobelt, 1874, occur in the late Pliocene Caloosahatchee Formation; and *L. (L.) cariniferus* (Lamarck, 1816), *L. (P.) maxwelli* Pilsbry, 1939, and *L. (P.) jucundus* McGinty, 1940, occur in the early Pleistocene Bermont Formation. No species of *Latirus* is known from the late Pleistocene Ft. Thompson or Coffee Mill Hammock formations. The Florida fossils are compared with 9 late Miocene to Pleistocene species from the Caribbean Basin and with 11 species in the Recent fauna of Florida and the Caribbean Sea. Of the four Recent species of *Latirus* that occur in Florida, only one also occurs in Florida Pleistocene deposits, but three, and possibly all four, are known as Pleistocene fossils in the Caribbean Basin.

RESUMEN

Los depósitos marinos del Plioceno y Pleistoceno del sur de Florida incluyen las formaciones Tamiami, Caloosahatchee, Bermont, Ft. Thompson, y Coffee Mill Hammock. Ocho especies de *Latirus* de tres de estos depósitos son descritas e ilustradas. *Latirus (Latirus) nosali* especie nueva y *L. (Polygona) miamiensis* Petuch, 1986, se encuentran en los estratos Pinecrest del Pleistoceno medio de la Formación Tamiami; *L. (L.) stephensae* especie nueva, *L. (P.)*

* Department of Natural Resources, Florida Marine Research Institute, 100 Eighth Avenue S.E., St. Petersburg, Florida 33701-5095.

hypsipettus Dall, 1890 (synonym: *L. tessellatus seminolensis* M. Smith, 1936), y *L. (P.) caloosahatchiensis* nombre nuevo para *L. tessellatus* Dall, 1890, non Récluz, 1844, nec Kobelt, 1874, se encuentran en el Plioceno tardío de la Formación Caloosahatchee; y *L. (L.) cariniferus* (Lamarck, 1816), *L. (P.) maxwelli* Pilsbry, 1939, y *L. (P.) jucundus* McGinty, 1940, se encuentran en el Plioceno temprano de la Formación Bermont. No especie de *Latirus* es conocida del Pleistoceno tardío de las formaciones Ft. Thompson o Coffee Mill Hammock. Los fósiles de Florida son comparados con 9 especies del Mioceno tardío al Pleistoceno de la Región del Caribe y con 11 especies en la fauna del Reciente de Florida y el Mar Caribe. De las cuatro especies de *Latirus* del Reciente que se encuentran en Florida, solo una se encuentra también en depósitos del Pleistoceno de Florida, sin embargo tres, y posiblemente las cuatro todas, son conocidas como fósiles del Pleistoceno en la Región del Caribe.

Key words: Gastropoda, Fascioliariidae, *Latirus*, Pliocene, Pleistocene, Florida, Caribbean Basin.

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INTRODUCTION

A century has passed since the publication of the first part of William Healey Dall's monograph on the Tertiary mollusks of Florida (Dall 1890). The scope of Dall's work, which he began in 1885, was greatly expanded by the discovery during early 1886 of rich deposits of fossil mollusks in the banks of

the Caloosahatchee River (Heilprin 1886-1887; see Petit and Wilson 1987) and by collections that Dall himself made soon thereafter along the Caloosahatchee River and elsewhere in southwestern Florida. Unfortunately, as sometimes happens after the publication of great works, investigations of the fossil mollusks of southern Florida waned after Dall completed his study (Dall 1903). A resurgence of interest occurred several decades later when excavations for flood control, wetland drainage, and highway construction began to reveal an abundance of strata and accompanying new taxa not known to Dall. Pertinent papers on fossil mollusks of southern Florida published during the 1930s and 1940s include those by Mansfield (1931, 1932, 1939), Tucker and Wilson (1932a, 1932b, 1933), Smith (1936), Pilsbry (1939), and McGinty (1940). These revelations led to another major contribution: the review of Pliocene mollusks of southern Florida by Olsson and Harbison (1953). However, excavations that continued during the 1950s and 1960s revealed additional taxa, many undescribed, that limited the usefulness of Olsson and Harbison's monograph. Some of the subsequent contributions useful in identifying and understanding the distributions of Florida fossil mollusks include those by DuBar (1958a, 1958b, 1962a, 1974), Olsson and Petit (1964), Olsson (1967), Perkins (1968), Hoerle (1970), McGinty (1970), and numerous papers by E.H. Vokes, principally on Muricidae and Turbinellidae, published since 1963 and still forthcoming. Most recently, Petuch (1982a, 1982b, 1986a, 1988) has made important contributions to the systematics and stratigraphy of Florida fossil mollusks.

The recent discovery of a species of *Latirus* in excavations at APAC Mine near Sarasota, Florida, prompted this review of previously named taxa in *Latirus* Montfort, 1810, and *Peristernia* Mörch, 1852. Members of the gastropod family Fascioliidae, including the subfamily Peristerniinae, are prominent constituents of the post-Miocene fossil beds of southern Florida. Names proposed for Florida fossil species of *Latirus* during the past century include *L. hypsipettus* Dall, 1890, *L. tessellatus* Dall, 1890, *L. tessellatus seminolensis* M. Smith, 1936, *L. maxwelli* Pilsbry, 1939, *L. jucundus* McGinty, 1940, and *L. miamiensis* Petuch, 1986. Two names originally erected for Recent taxa, *L. mcgintyi* Pilsbry, 1939, and *L. brevicaudatus* (Reeve, 1847), have also appeared on lists of Florida fossils. Another two species, "*Peristernia*" *filicata* (Conrad, 1843) and "*P.*" *insula* Olsson, 1922, have been reported as Florida fossils (Mansfield 1930; Tucker and Wilson 1933; Campbell et al. 1975). Cossmann (1901) reported the first of these species as "*Lathyrus* [= *Latirus*] *filicatus*," and Dall (1903) listed the species as *Latirus filicatus*. However, neither of the species belong to *Peristernia* or *Latirus*, or even to the family Fascioliidae. Instead, those species are members of the family Buccinidae and are not included in this report. Likewise, two Florida Pliocene species of *Dolicholatinus* Bellardi, 1884, a genus usually included in Peristerniinae, were revealed during this study. Because radulae of species of

Dolicholatinus resemble the radulae of species of Turbinellidae (fide Abbott 1958; Vokes 1977) more than they resemble the radulae of species of Fasciolaridae, the species of *Dolicholatinus* are not treated here.

The results of this review indicate the presence of eight species of *Latinus* in Pliocene and Pleistocene deposits of southern Florida, including two species described as new and one for which a replacement name is proposed. No species of *Peristernia* were found. The Florida fossil *Latinus* species are compared with 9 species from late Miocene to Pleistocene deposits of the Caribbean Basin and with 11 species that occur in the Recent fauna of the Caribbean Region.

The Florida fossil species of *Latinus* can be associated with particular depositional units, thereby rendering the species useful as biostratigraphic index taxa. However, the ages, stratigraphic relationships, and formational names of the Florida deposits in which the species of *Latinus* occur have been topics of considerable controversy. Consequently, it was necessary to review the evidence related to age and stratigraphy of the deposits in order to understand the ages and relationships of the species of *Latinus*. The review, as well as a revised chronological sequence for the deposits proposed as a result of that review, is presented as a preface to the systematic work. Most southern Florida localities mentioned in the review are depicted in Figure 1.

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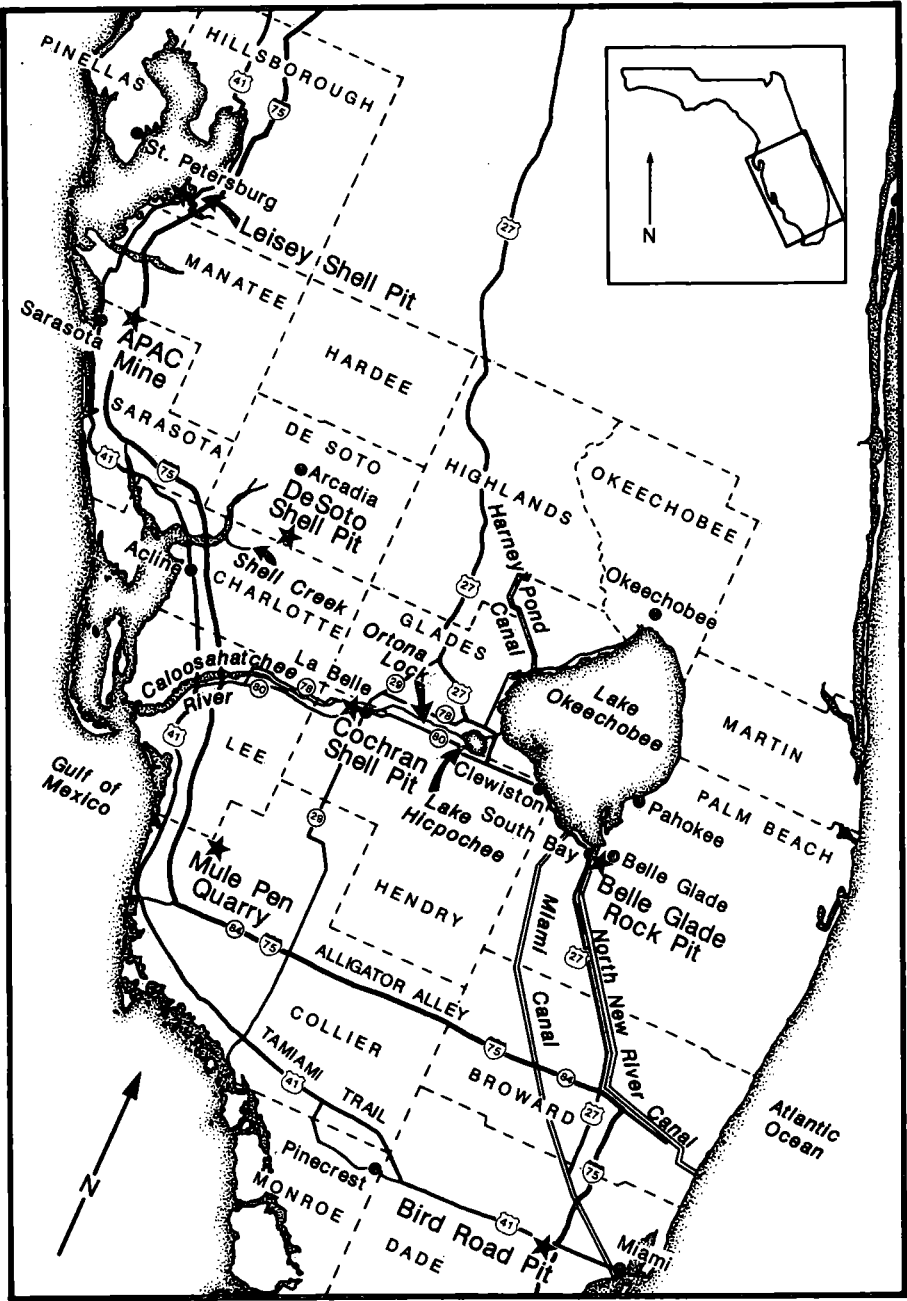


Figure 1.--Florida localities from which post-Miocene specimens of *Latirus* were examined.

manuscript. Sally D. Kaicher of St. Petersburg provided literature and photographed most of the specimens; Lynn French (FMRI) produced Fig. 1 and the overlays for the other figures; and Jeanne Hoyt (FMRI) typed the manuscript.

STRATIGRAPHY AND AGES OF THE MARINE DEPOSITS OF SOUTHERN FLORIDA

As knowledge of the fossil mollusks of Florida has increased, so has understanding of the stratigraphy of the deposits which contain them. The aforementioned excavations have revealed richly fossiliferous deposits both above and below the original Caloosahatchee beds, and several of these deposits have received formational names. Although the stratigraphic code requires lithologic differences for recognition of lithostratigraphic units, there are few lithologic criteria that distinguish most of the named "formations" of southern Florida. Instead, the units are identified by their contained faunas, principally mollusks. The formational names are used here because of their widespread use in the geological and paleontological literature and because they serve, to a limited extent, to identify chronologically discrete biostratigraphic zones. However, as will be shown, the use of lithostratigraphic names has confused as much as clarified understanding of the molluscan biostratigraphic sequence.

Estimates of the boundary ages of the post-Miocene formations of southern Florida are still controversial. Until recently, use of Lyellian percentages (i.e. the fraction of species in a fossil fauna that has survived to the Recent) caused overestimates of their ages because the catastrophic magnitude of molluscan extinctions in the western Atlantic during the Pliocene and Pleistocene epochs had not been recognized (Akers 1972; Stanley 1986). Conversely, underestimates of the age of the Plio-Pleistocene boundary and misinterpretations of mammalian fossil evidence, principally of *Equus* sp. from the banks of the Caloosahatchee River (DuBar 1958a), prompted underestimates of the ages of some of the strata (see Gibson 1983a: 356-357).

Approaches now used to discern the relationships and ages of marine fossil beds include comparisons of faunal similarity; studies of the sequence of planktonic microfossils and correlations with global climatic events; and absolute dating methods. Studies of faunal similarity, although useful in demonstrating the relationships between stratigraphically or geographically disjunct fossil assemblages, reveal little about the ages of those assemblages. Studies of planktonic microfossils (Akers 1972; Gibson 1983a, 1983b; Hazel 1983); helium/uranium (He/U) isotope dates of corals (Bender 1972, 1973); thorium/uranium ($\text{Th}^{230}/\text{U}^{234}$) isotope dates of corals, limestones, and oolites (Broecker and Thurber 1965; Osmond et al. 1965, 1970; Harmon et al. 1979);

amino acid enantiomeric ratios in bivalve shells (Mitterer 1974, 1975; Wehmiller and Belknap 1978); strontium ($\text{Sr}^{87}/\text{Sr}^{86}$) isotope ratios in bivalves (Webb et al. 1989); and magnetostratigraphy (Webb et al. 1989) have prompted re-evaluation of the ages of many deposits. However, the accuracy of results obtained using most of these techniques remains uncertain.

In upward progression, the post-Miocene stratigraphic sequence used here consists of the Tamiami Formation (Mansfield 1939; = Buckingham Formation of Mansfield 1939; = Pinecrest beds of Olsson 1964, Pinecrest "beds or formation" of Olsson 1968); the Caloosahatchee Formation (Dall 1887); the Bermont Formation (DuBar 1974; = "Unit A" of Olsson 1964, 1968; = "Glades Unit" of McGinty 1970); the Ft. Thompson Formation (Sellards 1919); and the Coffee Mill Hammock Formation (Sellards 1919). The principal controversies regarding these units involve the stratigraphic relationships between the Tamiami Formation, the Pinecrest beds, and the Buckingham Formation; the chronologic and stratigraphic limits of the Caloosahatchee Formation, the Bermont Formation, and the Ft. Thompson Formation; and the relationship between the Ft. Thompson and the Coffee Mill Hammock formations.

Tamiami Formation

Considerable controversy exists regarding the relationships of the Buckingham and Tamiami formations and the Pinecrest beds. The Buckingham Formation and the Tamiami Formation were described consecutively by Mansfield (1939: 8) as discrete formational units beneath the Caloosahatchee Formation. Mansfield (1939) designated a quarry "half a mile west of Orange River, Lee County" as the type locality of the Buckingham Formation, and he identified other Buckingham strata along the Caloosahatchee River. The Tamiami Formation was proposed by Mansfield "for a limestone penetrated in digging shallow ditches to form the road bed of the Tamiami Trail over a distance of about 34 miles in Collier and Monroe Counties." Olsson (1964, 1968) implied that the type locality of the Tamiami Formation was near the junction of the Tamiami Trail and Route 29 in Collier County, but Mansfield did not designate a specific locality for the Tamiami Formation. Olsson's claim seems to have been derived from Mansfield's statement that "the character of the matrix and the included fossils were described elsewhere" (i.e. in Mansfield 1932). Mansfield (1932: 43) described fossils from five locations (1/1176-1/1180) "along the Tamiami Trail within a northwest-southeast distance of about 34 miles, in Collier and Monroe Counties." Actually, all five of Mansfield's stations were in Collier County and extended from "9 miles west of Pinecrest" to "about 11 miles east by north of

Marco." His station 1/1180, "Tamiami Trail at Carnestown," at the junction of the Tamiami Trail and Florida State Road 29, is the location cited by Olsson.

The type locality of the Pinecrest beds is in "sand, barren or highly fossiliferous, encountered directly below a surface limestone [Tamiami Formation?] in the general region of 40 Mile Bend [40 miles west of Miami] on the Tamiami Trail and extending into Collier County" (Olsson 1964: 516). Olsson (1964) originally considered the Pinecrest beds to be a lower member of the Caloosahatchee Formation. Later, Olsson (1968) treated the Pinecrest beds as a separate formation that he considered to be younger than the Tamiami Formation but older than the Caloosahatchee Formation.

The typical Tamiami Formation is now considered by most workers to be a stratum, principally of consolidated limestone, said to underlie the Pinecrest beds. In that stratum, the aragonitic fossils have been dissolved, and the most useful faunal indicators consist of calcitic remains, principally of pectens, oysters, barnacles, and echinoids. In reference to his 1932 report, Mansfield (1939) mentioned that the Tamiami fauna includes six genera of gastropods. Mansfield (1932) listed *Terebra dislocata* (Say, 1822), *Fasciolaria* sp., *Strombus* sp., *Turritella* n. sp.? aff. *T. perattenuata* Heilprin, 1886, *Calyptraea* sp., and *Crucibulum* sp. from his Tamiami collections, but those names are too ambiguous to be of value as index taxa. The only other gastropod that has been mentioned as an indicator of the lithified Tamiami deposits is *Ecphora quadricostata umbilicata* "Wagner" (Hunter 1968; Brooks 1974), but that name has also been rendered ambiguous due to the recent revisions by Wilson (1987), Ward and Gilinsky (1988), and Petuch (1989). Consequently, Olsson (1964, 1968), Brooks (1974), Vokes (1988), and others have emphasized the calcitic bivalves, barnacles, and echinoids as typical Tamiami index taxa. Adherents to this restricted definition of the Tamiami Formation are generally those who combine the Buckingham and the Tamiami formations and recognize the Pinecrest as a separate unit.

Petuch (1986a, 1988, 1989) has maintained that the Buckingham and Pinecrest units constitute a single formation that, as Mansfield contended, is older than the Tamiami Formation. Petuch (1986a) also pointed out that the name "Pinecrest Formation" of Olsson (1964, 1968) is a stratigraphic junior homonym of the Triassic Pinecrest Formation of Utah, and the earlier name "Buckingham Formation" of Mansfield should be used for the Florida deposits. Vokes (1988: 2) responded to Petuch's remarks with the observations that Mansfield's Buckingham Formation is simply the non-indurated phase of the typically indurated limestone of the Tamiami Formation, that both are facies distinct from the Pinecrest beds facies, and that in any event Mansfield's name is preoccupied by the Precambrian Buckingham Gneiss of Quebec and thus is equally inappropriate for the Florida deposits.

Despite Vokes' assertion, Petuch's argument that the Florida Buckingham Formation and Pinecrest beds are equivalent has merit. Mansfield (1939)

obviously believed that the Buckingham Formation was older than the Tamiami Formation. He reported Tamiami limestone overlying Buckingham strata at a site about 6 km from the type locality of the Buckingham Formation, and he proposed three stratigraphic units along the Caloosahatchee River: "the Buckingham limestone (upper Miocene), the Tamiami limestone (lower Pliocene), and the Caloosahatchee marl (Pliocene)." Mansfield noted that several characteristic species of the Buckingham Formation had been reported from pit excavations west of Acline (Charlotte County) by Tucker and Wilson (1932a), and he remarked on the similarity between the Buckingham fauna and the fauna in sands from an excavation along the Tamiami Trail 42 miles west of Miami (i.e. near Pinecrest). Mansfield (1931) had previously stated that the limestone at his Tamiami Trail station 1/1179 was younger than the sands near Pinecrest, which he associated with the Buckingham Formation. Mansfield (1931) reported 55 species of mollusks from the latter locality, including 11 which he described as new; his new species included *Turritella pontoni* and *Cypraea carolinensis floridana*.

Among the gastropods that Mansfield (1939) stated to be indicative of the Buckingham Formation were "*Turritella* cf. *T. pontoni* Mansfield [1931]; *Cancellaria* cf. *C. tabulata* Gardner and Aldrich [1919]; *Cancellaria* aff. *C. venusta* Tuomey and Holmes [1856]; *Dorsanum*? cf. *D. plicatulum* (Böse [1906]); and *Cypraea carolinensis floridana* Mansfield [1931]." Mansfield noted that his specimen of "*Cancellaria* aff. *C. venusta*," an external mold, was larger than typical *C. venusta* and in that feature resembled *C. propevenusta* Mansfield, 1930, a species then known only from supposed upper Miocene (actually middle Pliocene) deposits of north Florida and the Carolinas (see Mansfield 1930: 47,48).

Several of Mansfield's Buckingham index species, including *Turritella pontoni*, *Cancellaria propevenusta*, *Dorsanum plicatile*, and *Siphocypraea floridana*, were also designated as characteristic species of the Pinecrest beds by Olsson (1964, 1968). Olsson noted that Mansfield (1931) had described a collection of fossils from near the type locality of the Pinecrest beds, and he stated further that the Acline fauna described by Tucker and Wilson "belongs to the same [i.e. Pinecrest] unit."

Despite Olsson's statement (1964: 515) that "the Buckingham marl is a light or cream-colored facies of the Tamiami," it is difficult to avoid the conclusion that both Mansfield and Olsson had the same fauna in mind when they named the Buckingham and Pinecrest units. This conclusion is supported by the facts that 1) the units share identical index taxa; 2) both authors considered the Acline fauna as belonging to their units; and 3) the type deposits of the Pinecrest beds on the Tamiami Trail seem to be the same sands from which Mansfield originally described some of his Buckingham index species, sands which Mansfield (1939) later associated with the Buckingham Formation.

Parker and Cooke (1944) included Mansfield's sands near Pinecrest and some subsurface deposits near Miami within their concept of the Tamiami Formation, and they considered the Buckingham limestone to be a facies of the Tamiami limestone. They considered all of these strata to be of Pliocene age. Schroeder (1954) also included the Buckingham limestone in the Tamiami Formation, but he considered the units to be of late Miocene age. Parker (1951) redefined the Tamiami Formation to include all "late Miocene" strata in southern Florida, thereby including the Tamiami and Buckingham formations and, according to Brooks (1968), even including the upper part of the Hawthorn Formation, a stratum still acknowledged as Miocene (Scott 1988).

Drawing upon these expanded concepts of the Tamiami Formation, Hunter (1968) defined three biostratigraphic range zones within the Tamiami, naming each zone for a prominent and supposedly characteristic species of *Pecten* (sensu lato), i.e. in downward sequence the "*Pecten tamiamiensis* [Mansfield, 1932] zone," the "*Pecten* [= *Chesapecten*] *jeffersonius* [Say, 1824] zone," and the "*Pecten* [= *Chesapecten*] *santamaria middlesexensis* [Mansfield, 1936] zone."

Hunter included Mansfield's Tamiami and Buckingham units, as well as Olsson's Pinecrest beds, within her *Pecten tamiamiensis* concurrent range zone. She named a hard, sandy limestone within the type area of Mansfield's Tamiami Formation as the Ochopee Limestone Member, and she contended that most species represented as molds of aragonitic fossils in the Ochopee limestone are present as shells in "Mansfield's sand at Pinecrest." Hunter also contended that the shell-bearing sands mentioned by Mansfield (1939) were the same sands that Olsson (1964) designated as the Pinecrest beds. Thus, Hunter considered the Pinecrest sands, the Buckingham limestone, and the Ochopee limestone to be sand, soft limestone, and hard limestone facies of a single depositional unit. Hunter listed 17 gastropods and 26 bivalves as representative of the *P. tamiamiensis* zone; included among the gastropods were *Cancellaria tabulata*, *C. propevenusta*, *Dorsanum plicatile*, *Sconsia hodgei* (Conrad, 1841), "*Cypraea carolinensis* Conrad [1841] and subspecies" (i.e. *Siphocypraea floridana*), and *Ecphora quadricostata umbilicata* (Dall, 1898).

Hunter defined the *Pecten jeffersonius* zone from strata at Murdock Station in Charlotte County, and she described both an upper and a lower unit for her Murdock Station Member of the Tamiami Formation. The units were distinguished principally by differences in their faunas of oysters, pectens, and echinoderms, and by the gastropod *Ecphora quadricostata* (Say, 1824). *Chesapecten jeffersonius* is common in lower Pliocene Yorktown deposits of Virginia and North Carolina (Ward and Blackwelder 1975; Gibson 1987).

Hunter defined her *Pecten santamaria middlesexensis* biostratigraphic zone based upon fauna in her Bayshore Clay Member of the Tamiami Formation. Like the *P. jeffersonius* zone above it, the *P. santamaria middlesexensis* zone was characterized by various pectens, oysters, and the

gastropod *E. quadricostata*. According to Gibson (1983b, 1987), *Chesapecten santamaria* (Tucker, 1934) is characteristic of the middle to late Miocene St. Marys Formation of Maryland, and *Chesapecten middlesexensis* occurs in the younger "Virginia St. Marys" beds, which Gibson (1983b) considered to be the late Miocene part of the Yorktown Formation. A transitional form of *Chesapecten middlesexensis* - *C. jeffersonius* also occurs in the uppermost part of the "Virginia St. Marys" beds (Ward and Blackwelder 1975; Gibson 1983b). Ward and Blackwelder (1980) gave the name Eastover Formation to the "Virginia St. Marys" beds, which they assigned to the upper Miocene. Thus, Hunter's Bayshore Clay Member seems to be of late Miocene age.

DuBar (1974) concurred with Brooks (1968) and Hunter (1968) in considering the Buckingham Formation and the Pinecrest beds to be facies of the Tamiami Formation. DuBar (1974: 211) recognized a "medial to late Pliocene" upper Tamiami Formation, containing the Ochopee Limestone, Pinecrest Sand, and Buckingham Limestone members, and a "medial Miocene to medial Pliocene" lower Tamiami Formation, containing the Murdock Station and Bayshore Clay members. DuBar listed 44 gastropod species, virtually all of which actually occur in the Pinecrest sands, as characteristic Tamiami macrofossils. DuBar's list includes Mansfield's Buckingham taxa, most of the Acline species described by Tucker and Wilson (1932a, 1933), and most of the species associated with the Pinecrest beds by Olsson and Petit (1964), Olsson (1967, 1968), and Hunter (1968).

Finally, in a curious reversal of opinion, Brooks (1974) decided that the Pinecrest beds were not contemporaneous with the Tamiami Formation but were, instead, a facies of the lower unit of the Caloosahatchee Formation. Olsson (1964) had originally proposed a Caloosahatchee-Pinecrest equivalence, but he later (Olsson 1968) favored association of the Pinecrest beds with the Tamiami Formation. No subsequent evidence has been presented to support Brooks' (1974) opinion.

Blackwelder (1981a) used molluscan data to distinguish six biostratigraphic interval-zones (M1 to M6 in downward sequence) for post-Miocene deposits of the middle Atlantic Coastal Plain (Virginia to Georgia), and he identified numerous taxa that he used to define the zones. Soon thereafter, Petuch (1982b) described 11 biostratigraphic units (1 to 11 in downward sequence) at APAC Mine in Sarasota. Petuch assigned Units 2-9 to the Pliocene Pinecrest beds and Units 10 and 11 to the Tamiami Formation, which he related to the Chesapeake Miocene. (Actually, Petuch was equivocal regarding Unit 10; on pp. 12 and 19, he assigned that unit to the Miocene, but on pp. 20 and 21 he assigned it to the Pinecrest beds.) The presence of species common to both regions allows correlations of several of Petuch's lower units with Blackwelder's interval-zones. For example, Stanley (1986) listed several species of bivalves from APAC Mine (e.g. *Chesapecten jeffersonius*; *Ostrea compressirostra* (Say, 1824)) that occur in Petuch's basal Unit 11. Blackwelder

(1981a) cited those species as indicators of interval-zone M6, which corresponds to his Wiltonian Stage, the narrow and short-lived basal Pliocene stage of southeastern North America. According to Blackwelder, only about 5% of the molluscan species in Wiltonian assemblages are extant.

Blackwelder (1981a) estimated the age of interval-zone M6 to be approximately 4.8-4.7 million years (m.y.), which he considered equivalent to the base of planktonic foraminiferal zone N19. Later, in collaboration with others (Cronin et al. 1984), Blackwelder revised his estimate of the age of interval-zone M6 to approximately 4.0-3.8 m.y., i.e. upper zone N19. The ages of some of Blackwelder's younger interval zones M5-M1 were also revised by Cronin et al. (1984) to bring them into compliance with evidence derived from calcareous nannofossils, planktonic foraminiferans, ostracodes, and paleomagnetism. Both Blackwelder's original estimates and his revised estimates in Cronin et al. are presented here.

It must be noted here that Petuch (1989) redesignated Unit 11 as the stratotype of his newly named Sarasota Member, which he defined as the uppermost member of the Hawthorn Formation. Based on several index taxa, Petuch declared the Sarasota Member to be late Tortonian-early Messinian Miocene in age. However, it is not clear how Petuch's Sarasota Member differs faunistically from Hunter's (1968) Murdock Station Member of the Tamiami Formation, nor why, on the basis of the species Petuch (1982b) listed in Unit 11, the member should not be assigned to the early Pliocene.

Blackwelder considered interval-zone M5, his Burwellian Stage, to be contemporaneous with the upper Tamiami and the Jackson Bluff formations in Florida, with the Raysor Formation in South Carolina, and with the Yorktown Formation in North Carolina and Virginia. Approximately 5% of the Burwellian mollusk species are extant (Blackwelder 1981a). Some of Blackwelder's M5 index taxa (e.g. *Panopea reflexa* Say, 1824; *Mercenaria tridacnoides* [Lamarck, 1818]; *Sconsia hodgeii*) occur at APAC Mine, and Petuch identified *P. reflexa* and *M. tridacnoides* in his Unit 10. Petuch's narrow Unit 9 was defined only by species that also occur in other units, and his Units 8 and 5 are simply shallow-water beds of *Vermicularia recta* Olsson and Harbison, 1953, that bracket the deeper-water Units 7 and 6. Unit 7, his thickest section, reportedly contains more than 250 species of caenogastropods, including *Sconsia hodgeii*, and his Unit 6 contains *Buccinofusus sparrowsi* (Emmons, 1858), a species typically associated with upper Yorktown deposits in the Carolinas. Units 7 and 6 also contain *Cancellaria tabulata*, *C. propevenusta*, *Dorsanum plicatile*, and *Siphocypraea floridana*, index taxa for the Pinecrest facies of the Tamiami Formation. Thus, Petuch's Units 10-6 at Sarasota correlate with the lower and upper Yorktown units of Virginia and North Carolina. Blackwelder (1981a: 7-9, text-fig. 1) reviewed dating studies whose results suggest that these strata were deposited between 4.6 and 3.0 m.y. ago, but he depicted the Yorktown Formation as no younger than about 3.7

m.y., i.e. uppermost zone N19. Based on He/U dates of 3.9 and 3.5 m.y. for two coral samples, Bender (1972, 1973) assigned an approximate age of 3.7 m.y. to the Pinecrest beds, but he did not specify the source of his corals. On the basis of planktonic foraminiferal assemblages, Akers (1972) placed the Yorktown and Jackson Bluff formations, as well as the Agueguexquite Formation of eastern Mexico, in late zone N18 and zone N19, i.e. early and middle Pliocene. However, Cronin et al. (1984) placed the age of the Yorktown Formation at 4.0-2.8 m.y., with an upper limit near the middle of zone N21. Most recently, Dowsett and Cronin (1990) used planktonic foraminiferans, calcareous nannofossils, and marine ostracodes to estimate an age of 3.5-3.0 m.y. (uppermost zone N19 and part of zone N20) for the Duplin (i.e. upper Yorktown) and Raysor formations of North and South Carolina.

The lower and upper boundaries of the Pliocene Epoch are considered to be approximately 5 m.y. and 1.8-1.6 m.y. ago, respectively (Haq et al. 1977). Some workers designate Pliocene deposits as either early or late (lower or upper), without a middle (e.g. Cronin et al. 1984). However, Blackwelder (1981a) discerned three molluscan faunal stages (M6-M4: the Wiltonian, the Burwellian, and the lower part of the Colerainian) in Pliocene strata of the middle Atlantic Coastal Plain, and deposits that are contemporaneous with each of those stages occur in southern Florida. Akers (1972) recognized two complete planktonic foraminiferal zones (N20, N19) and parts of two others (N18, N21) within the Pliocene Epoch, and Cronin et al. (1984) recognized zones N19 and N21 as Pliocene. This and other evidence has prompted other workers (e.g. Brooks 1974; Saunders et al. 1986; Vokes 1988) to distinguish between early, middle, and late Pliocene tropical marine deposits in the New World. Brooks (1974) declared that "the Tamiami Formation is Late Middle to Late Pliocene in age," whereas the lower unit of the Caloosahatchee Formation (and, by Brooks' equivalence, the Pinecrest beds) was "Late Pleistocene (sic) and preglacial Pleistocene"; Brooks evidently meant late Pliocene, not late Pleistocene. Vokes (1988) referred the Florida Pinecrest beds to the middle Pliocene, which, considering the age of dated corals, seems to be the most appropriate designation.

The Yorktown Formation of Virginia and North Carolina, the Raysor Formation of South Carolina, the Jackson Bluff Formation of northwestern Florida, and the Pinecrest sands of the Tamiami Formation of southern Florida are now generally acknowledged to have contained contemporaneous faunas that lived when sea level rose during a period of global warming that followed the end of the Messinian Miocene approximately 5 m.y. ago (Akers 1972; Blackwelder 1981a; Stanley 1986; Petuch 1988). All of the early to middle Pliocene formations of the southeastern United States, together with the late Pliocene formations above them, have been placed in the Caloosahatchian Province (Petuch 1982a). The Caloosahatchian Province differs faunistically and geographically from the more southern Gatunian

Province, which contains, among others, the Gatun Formation of Panama and Costa Rica, the Pliocene beds of the Dominican Republic, and the Agueguexquite Formation of eastern Mexico. Petuch (1988) assigned subprovincial status (Yorktownian, Buckinghamian, Jacksonbluffian, Agueguexitean (sic), etc.) to the faunas at many of these locations. The faunal assemblages that existed simultaneously at different locations in southeastern North America were climatically and ecologically controlled, and the differences among them were as different as those that occur at various locations between Cape Hatteras and Key West today. Thus, Petuch's (1986a) tropical-reef fauna at Miami seems to have occurred concurrently with the tropical-estuarine to intermediate-depth shelf fauna of the Pinecrest beds at Sarasota and with the shallow-water, warm-temperate upper Yorktown fauna of southeastern Virginia and the Carolinas.

In the simplest scenario, the various faunas of the early to middle Pliocene began with relatively few cool-water species and then became the diverse, warm-water assemblages that flourished for almost 2 m.y. until the sea again retreated. However, the actual sequence was not that simple. A slight sea-level retreat about 4.2 m.y. ago was followed almost immediately by a significant regression about 3.9-3.8 m.y. ago (Vail and Hardenbol 1979; Haq et al. 1988) that, although less severe than those that followed, must have caused considerable changes in local molluscan communities. After that brief regression, sea level rose again to 30-35 m above its present height (Brooks 1973, 1974; Dowsett and Cronin 1990) before plummeting during a major global cooling event 3 m.y. ago. The fluctuations between shallower and deeper assemblages among fauna in the deposits at APAC Mine may reflect these events.

In an alternative explanation, Cronin et al. (1984: 42-43) proposed that, in the Atlantic Coastal Plain, cool climates (relative to today's) prevailed between about 4.0 and 3.2 m.y. ago, followed by a short-duration warming event 3.2 to 2.8 m.y. ago, which terminated in a major regression 2.8-2.4 m.y. ago. Cronin et al. acknowledged several sources of evidence that, in contradiction to their explanation, signified the beginning of a major cooling event 3.0 m.y. ago. However, they invoked the diversion of Gulf Stream water to the Atlantic Coastal Plain at the closing of the Isthmus of Panama 3.1 m.y. ago to explain this discrepancy. This explanation does not allow for the deposition of marine beds along the Atlantic Coastal Plain (and southern Florida) during the early Pliocene Epoch 5.0 m.y. to 4.0 m.y. ago.

More work is needed to delineate the relationships among the Buckingham, Tamiami, and Pinecrest units. The relationships of Hunter's lower units, the Murdock Station and Bayshore Clay members, and Petuch's Sarasota Member to the Tamiami and Hawthorn formations are also unclear. Because of these uncertainties, Vokes (1988) recommended that, until a definitive study resolves the relationships among the various units, the name

"Pinecrest beds" be retained for the highly fossiliferous, unlithified sandy beds underlying the Caloosahatchee Formation. Instead, I follow the more conservative approach of Hunter (1968) and DuBar (1974) by using the name "Tamiami Formation," but with the stipulation that species of *Latirus* reported from that formation were collected from the unlithified middle Pliocene Pinecrest facies, which the most recent study has dated at 3.5-3.0 m.y. If Hunter is correct in her contention that the species represented by molds in the Ochopee limestone are the same species as those represented by intact shells in the Pinecrest sands, then I concur with her interpretation that the Pinecrest beds and the Buckingham limestone are, indeed, facies of the uppermost beds of the Tamiami Formation.

Caloosahatchee Formation

Various interpretations of stratigraphy have produced different estimates of the temporal extent of the Caloosahatchee Formation. According to Richards (1969: 607): "The age of the Caloosahatchee Formation of Florida remains in doubt...the lower part is definitely Pliocene, while the upper part could be Pliocene or early Pleistocene. The same is true of the Waccamaw and Croatan [i.e. Chowan River, Bear Bluff, James City, and restricted Waccamaw] formations of the Carolinas." Summaries of earlier age estimates for the Caloosahatchee Formation were presented by Puri (1968) and Puri and Vanstrum (1969).

Dall (1887) used "Caloosahatchie marl" as a general term for the fossiliferous beds exposed in the banks of the Caloosahatchee River. Matson and Clapp (1909) first used the name Caloosahatchee Formation for those deposits. Sellards (1919) restricted the name to the lower strata by describing two overlying shell-bearing units as the Ft. Thompson Formation and the Coffee Mill Hammock Formation. Olsson (1964: 519) fixed the type locality of the Caloosahatchee Formation as "an outcrop seen on the south bank of the river about a mile east of La Belle" (i.e. TU 536 of this report).

DuBar (1958a, 1958b) included three upwardly successive units, the Ft. Denaud Member, the Bee Branch Member, and the Ayers Landing Member, within his concept of the Caloosahatchee Formation and later (DuBar 1974: Table 5) listed 75 species of "characteristic macrofossils of the type Caloosahatchee Formation," including 66 species of mollusks. Among the mollusks, DuBar listed 21 species in the Ft. Denaud Member, 20 species in the Bee Branch Member, and 46 species in the Ayers Landing Member. According to that list, the Ayers Landing Member contains such characteristic Caloosahatchee gastropods as *Siphocypraea problematica* (Heilprin, 1886), *Liochlamys bulbosa* (Heilprin, 1886), *Typhis floridanus* Dall, 1890, and

Hystriwasum horridum (Heilprin, 1886). However, Brooks (1968: 32) recognized only the Ft. Denaud and Bee Branch units as members of the Caloosahatchee Formation. Brooks contended that the Ayers Landing Member was equivalent to DuBar's Okaloakoochee Member, the lower unit of the later Pleistocene Ft. Thompson Formation. According to Brooks (1968: 18), the Ayers Landing Member "does not contain nearly all of the extinct species attributed to it by DuBar [and] it is not a 'Caloosahatchee assemblage.'" The only extinct species that Brooks (1968) mentioned from the Ayers Landing unit was *Pyrazisinus scalatus* (Heilprin, 1887), a species that he and Hunter (1968) associated with the Ft. Thompson Formation and that DuBar (1974) listed as characteristic of the Bermont Formation. However, Waller (1969) recognized the Ayers Landing Member as a unit containing Caloosahatchee-age pectens, and he placed it below Olsson's (1964) Unit A, now known as the Bermont Formation. Brooks (1974: 263) later seemed to reverse his earlier opinion of the Ayers Landing Member by stating that "the biozones of several species of the tropical Caloosahatchee assemblages extend into the upper two units of the classical Ft. Thompson Formation [in which he included Unit A]."

Brooks (1974) finally despaired at sorting out the post-Tamiami stratigraphy of southern Florida. Instead, he proposed that, except for the uppermost Coffee Mill Hammock Formation, "the best purposes of stratigraphy will be served by including these heterochronic and heterogeneous marine and fresh water deposits of Plio-Pleistocene age into a single formation" that he called the Caloosahatchee-Fort Thompson Formation. No subsequent worker has supported that proposal.

Coral He/U dates place the age of the Caloosahatchee Formation between 2.5 and 1.8 m.y. (Bender 1972, 1973). The oldest date (2.53 m.y.) is for corals from North St. Petersburg, and the youngest dates (1.78-1.89 m.y.) are for corals taken "from the top of the Caloosahatchee" along the Caloosahatchee River (Bender 1973). Blackwelder (1981a) designated interval-zone M4, the late Pliocene Gouldian Substage of his biostratigraphic Colerainian Stage, for molluscan assemblages that occurred from 2.5 to 1.8 m.y. ago (Blackwelder 1981a; Cronin et al. 1984). The age of the Pliocene-Pleistocene boundary is 1.8-1.6 m.y. (Haq et al. 1977). Because the youngest dates for corals from the uppermost Caloosahatchee deposits coincide with the Plio-Pleistocene boundary date (approximately 1.8 m.y.) used by Blackwelder (1981a: 9), all taxa assigned to the Caloosahatchee Formation in this report are considered to be of late Pliocene age and are considered to have occurred within interval-zone M4.

The Caloosahatchee Formation has been reported to be contemporaneous with the Chowan River and James City formations (formerly, in part, the "upper Yorktown," Duplin, and Croatan formations) of southeastern Virginia and North Carolina and with the Bear Bluff and Waccamaw formations of North and South Carolina. According to

Blackwelder (1981a, 1981b), Bender (unpubl. data) obtained He/U dates of 2.4-1.9 m.y. (late Pliocene) for corals from the Chowan River Formation and 1.6-1.1 m.y. (early Pleistocene) for corals from the James City and Waccamaw formations. Collection sites for the Chowan River corals were given by Blackwelder (1981b: B10) and Hazel (1983: 97), but the sources of Bender's James City and Waccamaw corals were not reported.

Blackwelder (1981a) included the Chowan River and Bear Bluff formations in interval-zone M4. Correlation of the Chowan River Formation with the Caloosahatchee Formation seems fixed by the He/U dates of the Chowan River corals. Blackwelder estimated that Colerainian Stage molluscan assemblages contain approximately 35-40% extant species. However, instead of providing individual estimates for percentages of extant taxa in each of zones M4 (late Pliocene) and M3 (early Pleistocene), Blackwelder hedged by providing a collective estimate (35-40%) for both zones, because their faunas were very similar and shared many index taxa.

Interval-zone M3, the Windyan Pleistocene Substage of the Colerainian Stage, was estimated by Blackwelder to have occurred from 1.8 to 0.5 m.y. ago; Cronin et al. (1984) revised the estimate to 1.7 to 0.73 m.y. ago. Blackwelder used Bender's unpublished coral He/U dates of 1.6-1.1 m.y. to include the James City and Waccamaw formations in interval-zone M3, and he used Bender's (1973) He/U dates of 1.89-1.78 m.y. to also include the Caloosahatchee Formation at its type area in zone M3. Thus, the Caloosahatchee Formation of southern Florida has been considered to span both the late Pliocene and the early Pleistocene (Blackwelder 1981a; Ward and Blackwelder 1987). Hazel (1977, 1983) also depicted a lower (late Pliocene) Caloosahatchee unit at St. Petersburg and an upper (early Pleistocene) Caloosahatchee unit at the type locality, with an interval of about 0.4 m.y. between the two units. However, Hazel in both instances placed the Plio-Pleistocene boundary at 2.0 m.y.

Blackwelder's concept of interval-zones M4 and M3 seems to be derived, in part, from his experience with the Chowan River and James City formations at Lee Creek Mine, North Carolina. The manuscript of Ward and Blackwelder's (1987) study of that fauna was submitted for publication in 1975, six years before Blackwelder (1981a) defined his molluscan interval-zones. Ward and Blackwelder reported 194 molluscan species, of which only 35% were collectively reported to be extant, from four units (B-E in upward sequence) at Lee Creek Mine. They assigned Unit B to the Chowan River Formation and Units C-E to the James City Formation. Ward and Blackwelder compiled a presence-absence table of species occurrences in each unit. I used data from that table to generate Jaccard similarity coefficients with which to compare the molluscan assemblages of the four units. Similarities among the units were generally low (Table 1). As might be expected, those between contiguous units were slightly higher than were those between noncontiguous units.

Table 1. Numbers of species and Jaccard similarity co-efficients among Ward and Blackwelder's Units B, C, D, and E at Lee Creek Mine, North Carolina.

Number of Species	105	115	136	119
UNIT	B	C	D	E
Jaccard Similarity				
B		0.60	0.51	0.52
C			0.59	0.54
D				0.63

However, the coefficients do not support a contention of significant faunal change between Unit B and the overlying units. Instead, they suggest a rather diverse fauna in which further sampling of individual units would probably produce additional species records that would strengthen the similarity coefficients among all units.

Several of Ward and Blackwelder's records of gastropods support a contention of late Pliocene age for Units C, D, and E at Lee Creek Mine. *Diodora nucula* (Dall, 1892), *Contraconus adversarius* (Conrad, 1840), *Cymatosyrinx lunata* (Lea, 1843), and *Pterorhytis conradi* (Dall, 1890) represent species--and in the last three instances, genera--that do not occur in Florida deposits above the uppermost Caloosahatchee, which has been dated at 1.8 m.y. All of these taxa became extinct in Florida at the end of the Pliocene Epoch (i.e. after Unit B by Ward and Blackwelder's classification). However, Ward and Blackwelder reported *C. lunata* and *P. conradi* in Unit D and *D. nucula* and *C. adversarius* in Units D and E. Those records suggest either that Units C-E are actually of late Pliocene age or that the taxa became extinct at the end of the Pliocene in Florida but survived into the early Pleistocene in North Carolina. The second option seems less likely. Instead, individual species records, as well as the similarity coefficients, indicate that Units B-E at Lee Creek Mine all represent Caloosahatchee-equivalent late Pliocene deposits.

Like the James City Formation, the Waccamaw Formation has been reported to share many molluscan taxa with the Caloosahatchee Formation. Support for a hypothesis that at least part of the Waccamaw Formation is of late Pliocene age is found among its gastropod fauna, as reported by DuBar

(1962b) and Olsson and Petit (1964). Species that they associated with the Waccamaw and that I consider to be not younger than late Pliocene age include the following: *Diodora caloosaensis* (Dall, 1892); *D. floridana* Gardner, 1948; *D. nucula*; *Calliostoma willcoxianum* Dall, 1892; *Pterorhytis conradi*; *P. fluviana* Dall, 1903; *Trossulasalpinx trossula* (Conrad, 1832); *Typhis floridanus*; *Vokesinotus lepidotus* (Dall, 1890); *Heilprinia caloosaensis* (Heilprin, 1886); *Cancellaria venusta* Tuomey and Holmes, 1856; *Contraconus adversarius*; *Crassispira perugata* (Dall, 1890); and *Cymatosyrinx lunata*. Unfortunately, it is no longer certain that any of those species actually occur in the Waccamaw Formation because the original Waccamaw beds of Dall (1892), like the original Caloosahatchee beds, have been subdivided by subsequent workers. DuBar (1969) recognized both late Pliocene and early Pleistocene deposits within the Waccamaw Formation, and later (DuBar et al. 1974) renamed the lower (Pliocene) deposits as the Bear Bluff Formation, an action validated by Blackwelder and Ward (1979). Blackwelder (1979) redescribed the upper (Pleistocene) beds as the restricted Waccamaw Formation, and he designated a formational lectostratotype on the Waccamaw River near Tilly Lake, South Carolina. However, Blackwelder mentioned only three mollusks, all bivalves, as being biostratigraphically distinctive within the restricted formation.

Akers (1972) was unable to find useful foraminiferal index taxa in sediments from the Caloosahatchee Formation and consequently could not correlate the Caloosahatchee with other formations, but he did find index taxa in the Waccamaw Formation. Species composition of the planktonic foraminiferans prompted Akers to place the Waccamaw Formation in late zone N21 and early zone N22, i.e. the early Pleistocene, but that placement may not be correct for deposits containing the "classic" Waccamaw (now Bear Bluff?) molluscan fauna. Akers obtained foraminiferans from three Waccamaw sites, including two pits in South and North Carolina and a third site (TU 875) at Walker's Bluff on the Cape Fear River near Elizabethtown, North Carolina. Akers did not state whether his pit samples were collected in situ or from spoil, but no significant index foraminiferans were found at either pit. The most important of Akers' sites was at Walker's Bluff, where he collected approximately 400 specimens in 15 species. Despite the fact that 13 of the 15 species at TU 875 are known to occur in deposits that date from Pliocene (or earlier) to Holocene age, Akers relied upon a single, sinistrally coiled specimen of *Globorotalia cultrata menardii* (Parker, Jones, and Brady, 1865) and two specimens of *G. truncatulinoides* (d'Orbigny, 1839) to place the Waccamaw Formation in the early Pleistocene because those two species occur only above the Plio-Pleistocene boundary.

Akers was hesitant about assigning the Waccamaw Formation to the early Pleistocene. According to Akers (1972: 40), the Walker's Bluff material was "a composite sample from an interval of ten feet. The association of [two species]

suggests that both a warm and a cool stage are represented in this interval." Akers went on to note that "the beds at TU 875 are not necessarily the same age as sediments at other localities which have been assigned to the Waccamaw. It is possible, too, that the Caloosahatchee Formation is older than this material."

Despite Akers' tentative conclusion regarding the Pleistocene age of the Walker's Bluff deposits, Blackwelder (1979, 1981a) unequivocally accepted the Walker's Bluff deposits and all other Waccamaw deposits as early Pleistocene. However, although Cronin et al. (1984: 40) maintained the South Carolina Waccamaw sites as early Pleistocene, they reclassified the Walker's Bluff deposits and those at several other North Carolina Waccamaw sites as late Pliocene. Thus, even deposits assigned to the recently restricted Waccamaw Formation seem to contain both late Pliocene and early Pleistocene components.

In southern Florida, marine beds that were deposited during the early Pleistocene Epoch constitute the Bermont Formation (see following text), a unit that lacks all of the taxa designated herein as being of Caloosahatchee age. Relatively few species of the Caloosahatchee fauna persisted into the Bermont fauna. Instead, the Bermont fauna is characterized by several species that are unique to those deposits, and those species are accompanied by many others that first appeared in the Bermont and that survive today. Consequently, it is difficult to accept the Bermont fauna as having been wholly contemporaneous with the faunas of the James City and Waccamaw formations because, as previously noted, many species, and even genera, shared by the James City, Waccamaw, and Caloosahatchee faunas became regionally or absolutely extinct at the ends of the periods when those deposits were formed. The demise of those taxa in Florida, in the last great extinction of marine mollusks, occurred at the Plio-Pleistocene boundary, i.e. at the end of the interglacial stage that preceded the Nebraskan Glacial Stage. It is doubtful that the thermophilic taxa that characterized the Caloosahatchee fauna could have survived in the Carolinas an event that caused their extinction and replacement in south Florida. It is far more likely that units bearing typical Caloosahatchee-age molluscan taxa in the Waccamaw and James City formations were formed concurrently with the Caloosahatchee Formation, i.e. during the late Pliocene, and those units belong in interval-zone M4. Certainly, there is no evidence that the Caloosahatchee taxa belonged to a fauna that persisted until 0.7 or 0.5 m.y. ago, which Blackwelder (1981a) and Cronin et al. (1984) defined as the younger boundary of interval-zone M3.

The Caloosahatchee Fauna at APAC Mine

The presence of a Caloosahatchee-age fauna at APAC Mine in Sarasota County has been uncertain. Based on specimens of *Conus waccamawensis* B. Smith, 1930, Petuch (1982b) proposed that his Unit 1 might belong to the "Plio-Pleistocene" Caloosahatchee Formation. However, Stanley (1986) relegated the entire bivalve fauna at APAC Mine to the Pinecrest beds, which he assigned to the early Pliocene. A search for two Caloosahatchee-age species of *Latirus* rare at APAC Mine revealed an extensive Caloosahatchee fauna there.

Petuch's Unit 4, the "black layer" at APAC Mine, was formed during a major sea-level regression near the boundary between the middle and the late Pliocene and has an earliest age of approximately 2.5 m.y. (Jones 1990). Unit 4 contains bones of terrestrial vertebrates and shells of estuarine, marine-marsh (*Pyraxisinus* spp., *Cerithidea* sp.), terrestrial (*Euglandina* sp., *Polygyra* sp.), and freshwater mollusks. Freshwater gastropods (*Planorbella conanti* (Dall, 1890); *P. disstoni* (Dall, 1890); *Physa meigsii* Dall, 1890) that Petuch reported from Unit 4 have been considered characteristic of the Caloosahatchee Formation (Pilsbry 1934; DuBar 1958a, 1974). However, prominent marine gastropods of Unit 4 include *Olivella tamiamiensis* Mansfield, 1931, and *Echinofulgur helenae* (Olsson, 1967), both considered index taxa for the Tamiami Formation (Olsson 1964; DuBar 1974).

Above Unit 4, the APAC deposits progress through Unit 3, a bed of marine (or estuarine?) mussels, *Perna conradiana* (d'Orbigny, 1852), and Unit 2, a marine shelf assemblage characterized by oysters, *Hyotissa haitensis* (Sowerby, 1850). Although Units 3 and 2 contain some mollusks (e.g. *Hystrivassum locklini* (Olsson and Harbison, 1953)) that still seem indicative of the Tamiami fauna, those units also contain the first appearances of other species (e.g. *Diodora caloosaensis*; *D. carditella* (Dall, 1892); *Hemitoma retiporosa* (Dall, 1903); *Lucapinella talanteia* Olsson and Harbison, 1953; *Lithopoma precursor* (Dall, 1892); *Trivia floridana* Olsson and Harbison, 1953; *Dermomurex engonatus* (Dall, 1892); *Pisania maxwelli* (Olsson and Harbison, 1953); *Engina floridana* Olsson and Harbison, 1953; *Conus waccamawensis*) that bring a distinct "Caloosahatchee" aspect to the fauna. Unit 2 is usually capped by a shelly limestone in which such gastropods as *D. caloosaensis* and *H. retiporosa* are embedded.

Petuch described Unit 1, which he measured on the eastern side of APAC Mine, as a 0.9-m thick zone of quartz sand with abundant shell fragments. In addition to *Conus waccamawensis*, Petuch reported *Macrocallista nimbosa* (Lightfoot, 1786), *Chione cancellata* (Linnaeus, 1767), and mytilids to be common in Unit 1. The uppermost unit on the western side of APAC Mine is as much as 2.5 m thick and is more complex. That unit consists of several

zones of molluscan beds in which *M. nimbosa*, *C. cancellata*, and many other species of bivalves and gastropods occur. However, *Conus waccamawensis* and mytilids are rare there, and the beds may not be equivalent to Petuch's Unit 1.

The uppermost molluscan zone of the unit on the western side of APAC Mine is a bed of densely packed shells, most prominently of *Macrocallista nimbosa*, *Dinocardium robustum* (Lightfoot, 1786), *Raeta plicatella* (Lamarck, 1818), and *Melongenella subcoronata* Heilprin, 1886. Approximately 0.7-1.0 m from the top of that bed is a discontinuous layer of consolidated clumps of sabellariid polychaete tubes, within which boring bivalves, *Petricola pholadiformis* Lamarck, 1818, are abundant. The sabellariid layer overlies another shell bed (~0.4 m thick) in which the species composition resembles that of the uppermost zone except that shells of *Mulinia sapotilla* Dall, 1898, are abundant. Shells of *Carditamera arata* (Conrad, 1832) become common at the base of the zone, and large specimens of *Melongenella subcoronata* and *Anomalocardia caloosana* (Dall, 1900), the latter paired and in life position, are abundant there. That zone is underlain by a thin (~3-10 cm) black layer of wood and other plant material in which occur shells of *Planorbella disstoni*, a freshwater gastropod. The organic layer is sometimes accompanied by (or replaced by) a thin (~15 cm), discontinuous layer of hard, compacted quartz sand that usually is devoid of shells but rarely is packed with crushed shell fragments. Beneath the organic layer is another zone (~0.5 m thick) of densely packed shells. That zone (the *Carditamera* zone) is characterized principally by *Carditamera arata*, *Chione cancellata*, and *Argopecten anteamplicostatus* (Mansfield, 1936) but also contains shells of many other marine mollusks. The base of the *Carditamera* zone is a thin bed of oysters, *Crassostrea virginica* (Gmelin, 1791). Paired valves of *Pinna* sp. cf. *P. caloosensis* Dall, 1898, in life orientation often extend downward through the base of the zone. Beneath the oysters, a zone of quartz sand (~1.2 m thick) contains scattered but frequently paired shells of *Dinocardium robustum*, *Raeta plicatella*, *Tagelus divisus* (Spengler, 1794), *T. plebeius* (Lightfoot, 1786), *Ensis* sp. cf. *E. minor* Dall, 1900, *Macrocallista nimbosa*, and *Mercenaria campechiensis*. *Cyrtopleura costata* (Linnaeus, 1758) and *Mercenaria campechiensis*, both in paired, up-right position, and *Melongenella subcoronata* characterize the base of the sand-shell zone. Other gastropods within the sand-shell zone include *Epitonium rupicolum* (Kurtz, 1860), *Neverita* sp., *Ficus* sp., *Busycotypus floridanus* (Olsson and Harbison, 1953), *Fasciolaria apicina* Dall, 1890, *Pleuroploca gigantea* (Kiener, 1840), *Siphocypraea problematica*, and *Pleioptygma lineolata* (Heilprin, 1886), although all of these are much less common than *M. subcoronata*.

All of the above zones (collectively the uppermost APAC unit) lie unconformably on a thin layer (~10-15 cm thick) of black wood that is arrayed horizontally atop two zones of black and brown quartz sands. Together, these sand zones are approximately 1 m thick. The black zone of muddy sand is not

always evident but, when present, it overlies the more prevalent, sandier brown zone. Both zones seem devoid of marine or freshwater macrofossils and, in fact, both may have terrestrial origins. This is particularly evident of the brown zone, in which roots and tree trunks in up-right position are common. The brown zone lies unconformably upon the indurated top of Unit 2.

The molluscan fauna of the uppermost APAC unit is most diverse in the *Carditamera* zone. Within that zone, many of the bivalve shells are articulated, indicating little disturbance after death. Gastropods dispersed among the bivalves include *Turbo rectorammicus* Dall, 1892, *Cerithioclava caloosaensis* (Dall, 1887), *Siphocypraea problematica*, *Typhis floridanus*, *Pyruella planulata* (Dall, 1890), *Triplofusus scalarinus* (Heilprin, 1886), *Hysirivasmus horridum*, and *Contraconus tryoni* (Heilprin, 1886). These gastropods are index taxa for the Caloosahatchee Formation (Olsson 1964, 1968; Vokes 1966a; Gertman 1969; DuBar 1974; Petuch 1982b). Species with distinctive features in the *Carditamera* zone include a large (to 29 mm) slender form of *Typhis floridanus*, a small (50-65 mm) form of *Siphocypraea problematica* typical of the beds along the Caloosahatchee River, and an afrondose, shallow-water form of *Chicoreus floridanus* that differs markedly from the frondose forms of lower units.

Other Caloosahatchee index gastropods that have been collected rarely from mixed spoil, principally of the uppermost unit, but that have not been obtained in situ at APAC Mine include *Diodora carolinensis* (Conrad, 1875), *Calliostoma euconulum* Olsson and Harbison, 1953, and *Trigonostoma sericeum petranum* Olsson and Harbison, 1953. *Haustellum rubidum* (Baker, 1897), a late Pliocene to Recent species common in most Caloosahatchee deposits, has also been collected rarely in that spoil by Mrs. Evelyn Bradley.

Most gastropods that occur in the uppermost APAC unit are restricted to that unit or are much more common there than in underlying Units 2 and 3; very few of them occur elsewhere in the pit. All of those species also occur in the Caloosahatchee beds at North St. Petersburg and at the DeSoto Shell Pit south of Arcadia, and most of them also occur in the Caloosahatchee beds at the Cochran Shell Pit near La Belle. Significantly, no index taxa of the Tamiami or Bermont formations have been found in the uppermost APAC unit.

The biochronologic affiliations of species in the higher beds of the uppermost APAC unit are uncertain because the Caloosahatchee index taxa thin out rapidly above the *Carditamera* zone. However, *Trigonostoma* cf. *T. tenerum* (Philippi, 1848) and at least two species of *Trivia* (one large, one or more small) that are common in the *Carditamera* zone also occur with *Mulinia sapotilla* in the zone above the organic layer, and *Fasciolaria apicina* occurs upward to at least the sabellariid layer. Virtually all of the other mollusks that occur in the higher beds are ubiquitous species that occur not only in the Caloosahatchee Formation but also in the early Pleistocene Bermont

Formation, in the late Pleistocene Ft. Thompson Formation, and in the Recent fauna.

The evidently terrigenous sands that separate Unit 2 from the uppermost unit represent a significant hiatus in the marine depositional sequence at APAC Mine. The uppermost unit probably began as an estuary of fluctuating salinity, as indicated by species of *Tagelus*, *Crassostrea*, *Cyrtopleura*, and *Melongena*. The *Carditamera* zone, densely packed with shells of *Carditamera arata* and *Chione cancellata*, indicates a shallow, warm-water, high-salinity estuary, and the occurrence of *Argopecten anteamplicostatus* suggests that sea grasses were present. That assemblage was succeeded first by a freshwater assemblage containing *Planorbella disstoni* and then by a high-salinity estuary and a coastal marine system.

The uppermost APAC unit may reflect several stages of fluctuating sea level. Certainly, the organic layer with freshwater gastropods suggests one such event. In fact, sharp contacts occur between the lowest sand-shell zone and the *Carditamera* zone, between the *Carditamera* zone and the organic layer, and between the organic layer and the *Mulinia* shell bed. However, the small-scale dynamics of coastal environments can strongly influence the local composition of molluscan assemblages. Even in the absence of significant sea-level fluctuations, marine waters can be constricted from coastal estuaries by relatively transient features such as shifting barrier islands. When such events occur, they can cause faunal fluctuations such as those evident in the uppermost APAC unit.

The presence of *Cyrtopleura costata* in life orientation at the base and the bed of *Crassostrea virginica* at the top of the lowest zone of the uppermost APAC unit might indicate concurrence with the Ft. Denaud Member of the Caloosahatchee Formation. That member is characterized by *Cyrtopleura costata* at its base and by *Crassostrea virginica* at its top (DuBar 1958a, 1958b, 1974; Brooks 1968). However, that similarity might be coincidental; beds of *C. costata* and *C. virginica* sometimes occur in close proximity in Florida estuaries today, and succession of one by the other might have occurred frequently in response to environmental fluctuations during the past 2 m.y.

Other molluscan associations in the uppermost APAC unit are not particularly similar to any of the associations described by DuBar (1958a, 1962a) or by Brooks (1968) for deposits in the Ft. Denaud, Bee Branch, or Ayers Landing members or the Shell Creek units of the Caloosahatchee Formation. The inordinate abundances of species of *Trivia* and *Trigonostoma* in and above the *Carditamera* zone are remarkable--I know of no shallow-water assemblage, fossil or Recent, in which species of these genera are so common. Furthermore, many index gastropods (e.g. *Diodora floridana*; *Calliostoma jujuanulum* Olsson and Harbison, 1953; *C. permagnum* Dall, 1892; *C. sincerum* Olsson and Harbison, 1953; *Strombus leidy* Heilprin, 1886; *Fasciolaria monocingulata* Dall, 1890; *Liochlamys bulbosa*; *Turbinella*

scolymoides Dall, 1890; *Comus spurioides* Olsson and Harbison, 1953; *Crassispira perrugata* (Dall, 1890); *Syntomodrillia scissurata* (Dall, 1890)) that typify Caloosahatchee faunas at La Belle, North St. Petersburg, and other sites have not been found at Sarasota. Consequently, it is not yet possible to relate the uppermost APAC unit directly to any of the named Caloosahatchee members.

Bermont Formation

Restriction of the Caloosahatchee Formation to the late Pliocene leaves a formational gap in the sequence of Florida marine units because, according to Blackwelder's (1981a) supposed correlations, there is now no Florida unit to correspond to the early Pleistocene portion of interval-zone M3. That "missing unit" is contained in deposits of the Bermont Formation, a unit whose age has been underestimated by several recent workers.

The existence of a distinctive biostratigraphic unit between the Caloosahatchee and Ft. Thompson biostratigraphic units was well known during the 1960s. Vokes (1963) informally referred to that unit as the "Glades formation," and Olsson (1964) referred to it as Unit A. Those names were used frequently in the many discussions of Florida stratigraphy published during the next decade. Waller (1969), commenting on the relative ages of his pecten samples, observed that Olsson's Unit A is younger than DuBar's Ayers Landing Member of the Caloosahatchee Marl, and that DuBar's (1962a) Unit F on Shell Creek is Olsson's Unit A.

Despite Brooks' (1974: 263) admonition against "introducing another formational name based solely upon paleontological grounds, e.g. the Unit A of Olsson (1968)," Dubar (1974) named the Bermont Formation for the uppermost fossiliferous marine sands exposed along Shell Creek (i.e. Unit F of DuBar 1962a) in the Bermont Quadrangle of Charlotte County. The molluscan fauna of the type locality was described by DuBar (1962a). DuBar (1974) reported Bermont strata from Charlotte County northward to Levy County, eastward through southern DeSoto and Highlands counties, through the Lake Okeechobee region into Martin and Palm Beach counties, and along the Caloosahatchee River in Hendry and Glades counties. DuBar differentiated Bermont strata from Caloosahatchee strata "primarily in the absence from the former of most of the typical Caloosahatchee species, and in the occurrence in the Bermont Formation of a few species rare or absent in Caloosahatchee strata" (DuBar 1974: 221). Gastropods that DuBar listed as restricted to the Bermont Formation are *Fasciolaria okeechobensis* Tucker and Wilson, 1932, *Fusinus watermani* (M. Smith, 1936), *Melongena bispinosa* Philippi, 1844, *Strombus mayacensis* Tucker and Wilson, 1933, and *Vasum*

floridanum McGinty, 1940. None of those species was reported by DuBar (1962a) from the type locality of the Bermont Formation, but *Vasum floridanum* is now known from the uppermost marine deposits at Shell Creek (E.H. Vokes pers. comm.). Instead, all of the index taxa cited by DuBar (1974) were from other supposed Bermont sites, including Ortona Lock (McGinty 1970), Belle Glade Rock Pit (Hoerle 1970; McGinty 1970; Brooks 1974), and other excavations along the margin of Lake Okeechobee that DuBar uncertainly noted as "an apparent facies of the Bermont Formation." Hoerle (1970) listed more than 430 species of mollusks, of which about 15% were extinct, from Belle Glade Rock Pit, but all were collected from excavated spoil. Consequently, it is not known how many of Hoerle's species may have occurred only in overlying deposits of the Ft. Thompson and Coffee Mill Hammock formations.

McGinty (1970) included all of DuBar's Bermont-restricted taxa in his list of index fossils for what was then called the "Glades Unit." Additionally, McGinty included *Haustellum anniae* (M. Smith, 1940), *Murexiella gracieae* (McGinty, 1940), *Monostiolium thomasi* Olsson, 1967, *Latirus jucundus* McGinty, 1940, and *L. maxwelli* Pilsbry, 1939, as indicators of the "Glades Unit." Of this total of 10 gastropod species, all except *M. gracieae* were reported to occur at Ortona Lock and all except *H. anniae*, *L. maxwelli*, and *V. floridanum* were reported from Belle Glade. McGinty (1970) believed that the common presence of *Vermicularia recta* in spoil at Belle Glade Rock Pit indicated that excavations there had reached the lowest level of the Glades Unit and had touched the top of the Caloosahatchee Formation, despite Olsson's (1964: 521) statement that the *Vermicularia erecta* (sic) zone at Ortona Lock "lies a foot or two above the base of [Unit A]." Olsson's (1964) list of characteristic mollusks of Unit A is very similar to that later used by DuBar (1974) for the Bermont Formation. Vokes (1966b) also declared *Turbinella hoerlei* Vokes, 1966, to be restricted to Unit A, and Petuch (1988) added his *Lindoliva* species complex to the list of Bermont index taxa.

Vokes (1963) and Hoerle (1970) considered the deposits at Belle Glade Rock Pit to be early Pleistocene in age, and Skinner (1972) tentatively suggested that they should be considered Plio-Pleistocene. On the basis of the non-marine mollusks, Taylor (1966) considered Unit A to be late Pliocene or early Pleistocene. Waller (1969) concluded from evolutionary evidence of the *Argopecten gibbus* stock that Unit A was "early Pleistocene or possibly late Pliocene-early Pleistocene in age." Waller noted that shells from Unit A "are beyond the range of existing methods of radiometric dating." He cited evidence of samples from Belle Glade Rock Pit that, "based on the $\text{Th}^{230}/\text{U}^{234}$ ratios, are greater than 250,000 years in age, and, based on the $\text{U}^{234}/\text{U}^{238}$ ratios, are greater than 750,000 years" (W.S. Broecker, unpubl. data, in Waller 1969: 92). Nevertheless, DuBar (1974) placed the Bermont Formation in the "medial" Pleistocene Yarmouth Interglacial Stage.

Perhaps influenced by DuBar's assessment of the Bermont Formation as middle Pleistocene, as well as by his own belief in the early Pleistocene age of the upper Caloosahatchee deposits, Blackwelder (1981a) designated a very young age for Bermont deposits. Blackwelder associated the Bermont Formation with Unit III of Mitterer's (1974, 1975) and Wehmiller and Belknap's (1978) studies of amino acid (isoleucine) kinetics in the bivalve *Mercenaria*, and he stated that Wehmiller and Belknap's data indicated an age of 0.4-0.5 m.y. for Unit III. That age for Bermont deposits is suspect for several reasons.

Estimates of age derived from kinetic models of isoleucine enantiomeric ratios in mollusks are controversial, and several problems are evident in the studies cited here. Mitterer (1974, 1975) analyzed samples of *Mercenaria* from seven units (I to VII in upward sequence) from northern, central, and southern Florida. The specimens were supplied to him by H.K. Brooks and others. Unit VII was designated as Holocene, with *Mercenaria* shells dated by radiocarbon (C^{14}) at 1.2-4.5 thousand years. Unit VI was designated as a Pleistocene stratum in central and northern Florida, from which *Mercenaria* shells had been dated by C^{14} at 34 thousand years. Mitterer identified Unit V as the Coffee Mill Hammock Formation, which is generally acknowledged to be time-equivalent to the Miami and Key Largo Limestone formations of southern Florida and a unit at Cape Canaveral whose ages have been dated by Th^{230}/U^{234} at ~0.13-0.14 m.y. and ~0.11 m.y., respectively (Osmond et al. 1965, 1970; Broecker and Thurber 1965; Harmon et al. 1979). Based on those known ages, Mitterer applied a linear kinetics model to calculate the ages of the underlying units, which he identified as two units of the Ft. Thompson Formation (Units IV, III) and two units of the Caloosahatchee Formation (Units II, I). In concurrence with then-popular opinions (e.g. DuBar 1958a, 1958b) regarding the ages of mammalian fossils, Mitterer considered the upper unit of the Caloosahatchee Formation (his Unit II) to be mid-Pleistocene, with an age he calculated to be 324,000 years. Mitterer reached that conclusion despite Broecker's U^{234}/U^{238} evidence (in Waller 1969) of an age greater than 750,000 years for Bermont mollusks at Belle Glade Rock Pit and despite Brooks' (1974: 264) statement that "both units of the classical Caloosahatchee are too old to date by [Th^{230}/U^{234} ratios], i.e., over 400,000 years old." Mitterer calculated ages for his younger units as follows: Unit III--236,000 years; Unit IV--180,000 years; Unit V--134,000 years.

Wehmiller and Belknap (1978) considered Mitterer's linear model to be inappropriate, and they recalculated Mitterer's data using a nonlinear model. Their recalculated ages for the units are as follows: Unit II--800,000 \pm 200,000 years; Unit III--475,000 \pm 175,000 years; Unit IV--250,000 \pm 50,000 years.

According to Wehmiller and Belknap (1978: 339), "The time equivalence of Unit V throughout the Florida peninsula appears to be both a working assumption and a stated conclusion of Mitterer's work." Mitterer did not

disclose how he identified or correlated unit samples from northern, central, and southern Florida sites (or even the locations of those sites), so his assumptions of equivalence cannot be tested. Furthermore, Mitterer seems to have reported on different units in his two papers. In 1974, he reported samples from Units IV to VII of northern and central Florida and from Units I to V and VII (but not VI) of southern Florida. However, in 1975, he reported samples from Units II to V of northern Florida and from Units III to V (but not II) of central and southern Florida. No explanation was provided for that inconsistency, which probably contributed to Wehmiller and Belknap's (1978: 344) confusing conclusion: "The 'medial Pleistocene' Bermont Formation of DuBar (1974) which overlies the Caloosahatchee Formation in northern [?] Florida is a possible equivalent of the $800,000 \pm 200,000$ -year (nonlinear model age) Unit II in northern [?] Florida."

Because Mitterer obtained his samples from Brooks, it might be assumed that he used Brooks' system to identify the sequence of units from which the samples were obtained, but that may not be true. Brooks (1968, 1974) identified six upwardly sequential Plio-Pleistocene marine depositional units, beginning with the basal unit of the Caloosahatchee Formation. Units I and II are the Ft. Denaud and Bee Branch members of the Caloosahatchee Formation. Units III, IV, and V were stated by Brooks to belong to the Ft. Thompson Formation, but at least Unit III, and perhaps Unit IV, is now believed to represent the Bermont Formation. Brooks' Unit V is the true Ft. Thompson Formation, which Brooks (1974) estimated to be "probably 220,000 or more years old," and his Unit VI is the Coffee Mill Hammock Formation, which he and others have considered to be contemporaneous with the Miami Limestone. A seventh marine unit, which Brooks (1968) mentioned but did not number, is the mid-Wisconsin Princess Anne Formation. Mitterer likewise recognized seven (Pliocene and) Pleistocene to Holocene units in Florida, but he designated Unit V, not Unit VI, as the Coffee Mill Hammock unit. Consequently, he considered Unit V to be contemporaneous with the Miami Limestone. In fact, Mitterer reported no Unit VI samples from southern Florida, so he may not have sampled the Coffee Mill Hammock unit at all. Wehmiller and Belknap (1978) strongly questioned Mitterer's correlation of Unit V between northern and southern Florida. Because of the uncertainty regarding the origins and correlations of Mitterer's units and because of the apparent contradictions with other dating techniques (e.g. Bender 1972, 1973; Hulbert and Morgan 1989; Webb et al. 1989), it seems best to give little credence to the results of these studies, especially those relating to estimates of the ages of the Bermont and Caloosahatchee formations.

The most recent evidence of age for the Bermont Formation is provided by Hulbert and Morgan (1989) and Webb et al. (1989), who described several beds of vertebrate fossils at the Leisey Shell Pit in southwestern Hillsborough County, Florida. According to Hulbert and Morgan, two of the richest beds

are separated by a marine depositional unit of the Bermont Formation, as indicated by the presence of *Fasciolaria okeechobensis* and *Strombus mayacensis*. The terrestrial mammalian fauna of the layer overlying the Bermont deposits indicates a late early Irvingtonian age of about 1.5 to 1.0 m.y., and the underlying layer, also early Irvingtonian, indicates an age of less than 1.7 m.y. Thus, the Bermont index gastropods are bracketed by terrestrial vertebrate fossils of ages less than 1.7 m.y. and greater than 1.0 m.y.

Webb et al. (1989) combined magnetostratigraphy, strontium isotope ($\text{Sr}^{87}/\text{Sr}^{86}$ of bivalves, *Chione cancellata*) chronology, and mammalian biochronology to derive ages of 1.8 and 1.6 m.y. for the two richest vertebrate fossil beds. The older bed is underlain by marine deposits of the Bermont Formation and is overlain by an indurated stratum of calcareous marl. The younger bed is overlain and underlain by marine deposits of the Bermont Formation. Strontium isotope analyses for the marine deposits range from 1.8 to 1.1 m.y. Magnetostratigraphy indicates that the entire Bermont portion of the section is reversed and presumably accumulated in the post-Olduvai part of the Matuyama Magnetochron (i.e. 1.66 m.y. or younger).

The dates of Bermont deposits from Leisey Shell Pit correlate well with the 1.6-1.1 m.y. age estimate for the early Pleistocene portion of Blackwelder's interval-zone M3. Consequently, it seems likely that the Bermont Formation, not the uppermost unit of the Caloosahatchee Formation, was contemporaneous with the early Pleistocene portion of the Waccamaw Formation of the Carolinas. Compositions of their planktonic foraminiferal assemblages also place the Moín Formation of Costa Rica and the Bowden Formation of Jamaica in late zone N21 and zone N22, the early Pleistocene (Akers 1972; Lamb and Beard 1972).

Petuch (1988) stated that the Bermont Formation consists of two members, i.e. beds deposited during the Aftonian and Yarmouth Interglacial Stages and separated by the Kansan Glacial Stage. The possibility of more than one member needs to be confirmed, and the relationship of the Ortona Lock and Belle Glade faunas to the fauna at the type locality at Shell Creek needs to be assessed to better understand the extent of the Bermont Formation.

Ft. Thompson Formation

Sellards (1919) assigned the name Ft. Thompson Formation to beds of fresh-water, brackish-water, and marine marls and limestones along the Caloosahatchee River. The type locality is at Ft. Thompson, about 1.5 miles upstream (eastward) from La Belle in Hendry County (DuBar 1974). Nearly all molluscan species in the Ft. Thompson Formation are extant. However, the

deposits do contain a few extinct marine gastropods, including *Pyrazisinus scalatus* (fide Brooks 1968; Hunter 1968) and *Turritella subannulata* Heilprin, 1886 (fide DuBar 1974).

The Myrtleian Substage (interval-zone M2) of Blackwelder's Pleistocene Longian Stage was designated for the Canepatch Formation of South Carolina, which contains about 94-96% extant species (Blackwelder 1981a). Szabo (1985) obtained a uranium-series date of $460,000 \pm 100,000$ years from corals of the Canepatch Formation. The Canepatch Formation has been correlated with the Bermont Formation on the basis of the contained mollusks (Oaks and DuBar 1974; Blackwelder 1981a; Ward and Blackwelder 1987), but that correlation should be re-examined. The Ft. Thompson Formation (exclusive of the Coffee Mill Hammock unit) seems to be the only Florida marine depositional unit now available for correlation with the Canepatch Formation.

In addition to Wehmiller and Belknap's (1978) age estimate for Unit III ($475,000 \pm 175,000$ years), Blackwelder (1981a) cited a significant warming interval in the subantarctic (Kennett 1969) and North Pacific (Kent et al. 1971) and evidence of sea-level transgressions 0.5 to 0.4 m.y. ago as indications of the age of interval-zone M2. However, Wehmiller and Belknap's age estimate for Unit IV ($250,000 \pm 50,000$ years) is very similar to Brooks' (1974) estimated age for the Ft. Thompson Formation (220,000 or more years). Webb et al. (1989) reported $\text{Sr}^{87}/\text{Sr}^{86}$ isotope dates of 0.95 to 0.55 m.y. for Ft. Thompson marine deposits that overlie the Bermont deposits at Leisey Shell Pit. An anomalous date of 1.6 m.y. for one sample in that study was reanalyzed after publication and found to be erroneous (D.S. Jones, pers. comm.). All of these ages (0.22 to 0.95 m.y.) seem reasonable for the Ft. Thompson Formation, given the several transgressive and regressive events reported to have occurred during the creation of that unit (Brooks 1968, 1974; Perkins 1977).

DuBar's (1974) naming of the Bermont Formation and Brooks' (1968, 1974) reinstatement of Sellard's (1919) Coffee Mill Hammock unit to full formational status reduced the stratigraphic extent of the Ft. Thompson Formation. DuBar (1958b, 1974) recognized two members in the Ft. Thompson, the upper Coffee Mill Hammock Member and the lower Okaloakoochee Member. As shown in a comparison of stratigraphic classifications (Perkins 1977: fig. 4), other authors (Parker and Cooke 1944; Brooks 1968; Conklin 1968) have recognized two discrete members in the Ft. Thompson Formation exclusive of the Coffee Mill Hammock unit. Those two units were numbered 4 and 5 in each of the three studies. At this time, it is not at all clear whether the underlying Unit 3 (shown to correlate with the Ayers Landing Member of the Caloosahatchee Formation) includes the Bermont fauna, or whether that fauna occurs in Unit 4. If Unit 4 is the Bermont Formation and if the Coffee Mill Hammock unit has separate formational status, then DuBar's Okaloakoochee Member would be the only remaining major unit in the Ft. Thompson Formation, and the names would be

synonymous. Further clarification is needed to define the age and stratigraphic extent of the Ft. Thompson Formation.

Coffee Mill Hammock Formation

Sellards (1919) assigned the name Coffee Mill Hammock Marl to exposures along the Caloosahatchee River near Ortona Lock. Brooks (1968, 1974) has argued to maintain the Coffee Mill Hammock Marl as a formational unit separate from the underlying Ft. Thompson Formation, whereas Cooke and Mossom (1929), DuBar (1958a, 1958b, 1974), and others have combined the two as a single formation. On the basis of their faunas, there seems little reason to separate the two units. However, the age of the Coffee Mill Hammock unit has been ascertained with some confidence (0.13 to 0.11 m.y.), whereas the ages of all older Pleistocene marine deposits of southern Florida are less certain. Consequently, it seems prudent to retain the Coffee Mill Hammock unit as a separate formation until its relationship with the Ft. Thompson Formation is better understood.

The uppermost of Blackwelder's interval-zones, the Yongesian Substage of his Longian Stage, has been assigned to late Pleistocene deposits of the Carolinas, Virginia, and Maryland, and contains no extinct species. Interval-zone M1 reportedly includes the Socastee Formation, the Pamlico Formation (in part), the Norfolk Formation, the Sandbridge Formation, the Princess Anne Formation, the Silver Bluff Formation, and the Anastasia Formation. The age of interval-zone M1, derived from several studies (Blackwelder 1981a: 30), has been estimated to range from 0.220 to 0.062 m.y. Ward and Blackwelder (1987) considered the Ft. Thompson Formation of Florida (including the Coffee Mill Hammock Member) to be contemporaneous with the Socastee Formation. However, as previously discussed, probably only the Coffee Mill Hammock Formation and the younger Princess Anne Formation are contained in zone M1.

Summary

The ages and stratigraphic relationships of the Plio-Pleistocene marine deposits of south Florida are still poorly understood, as are the correlations of those units with other deposits. Some confusion has arisen because workers have used lithostratigraphic names for biostratigraphic units, a necessary error given the lack of a suitable biostratigraphic nomenclature. Most papers cited in this review were concerned principally with molluscan assemblages, not with

geological formations, but the mollusks were reported in lithostratigraphic context. When molluscan assemblages are correlated within that context, the results can be misleading, especially if a formation contains more than one depositional unit and a single age determination has been applied to the entire formation.

Exposures along the Caloosahatchee River and elsewhere in southern Florida range in age from middle Pliocene to late Pleistocene, and five formational names have been applied to the various units. Despite the fact that groups of index taxa define distinctive molluscan assemblages for several of the "formations," there is little agreement on the stratigraphic boundaries and ages of any of the units. Brooks (1974) suggested that deposits previously assigned to the Caloosahatchee (and Bermont) and Ft. Thompson formations should simply be combined as a single formation created by an unknown number of glacial and interglacial events. That suggestion is not biostratigraphically useful because important evidence of climatic fluctuation, evolutionary change, and extinction is contained within the various assemblages.

Another source of confusion involves the fact that virtually no formational age determination based on coral $^{14}\text{C}/^{12}\text{C}$ dates, index foraminiferans, or ostracodes has been accompanied by information on the species composition of molluscan assemblages in the strata from which the samples were obtained. As an example, Akers (1972) used planktonic foraminiferans and Blackwelder (1981a) used unpublished data from Bender's coral dating to assign an early Pleistocene age for the Waccamaw Formation. Because of the marked similarity between the classic Waccamaw and Caloosahatchee molluscan faunas, some authors have cited those assignments as support for an early Pleistocene age for some or all of the Caloosahatchee mollusks. It is now contended that both late Pliocene and early Pleistocene strata occur in the Waccamaw Formation (Cronin et al. 1984), but it is no longer evident whether the Waccamaw mollusks that correlate with the Caloosahatchee fauna occur in the late Pliocene strata, the early Pleistocene strata, or both.

If lithostratigraphic nomenclature is not appropriate for the identification and correlation of these biological assemblages, then a system of age-related molluscan biostratigraphy is needed to identify the units. Blackwelder's (1981a) attempt to construct such a system for the middle Atlantic Coastal Plain is a step in that direction, but his system seems flawed by incorrect correlations, at least in the upper half of the sequence. The best evidence now available for Florida indicates that the classic Caloosahatchee fauna became extinct at the end of the Pliocene Epoch and was replaced by the Bermont fauna in the early Pleistocene. The Bermont fauna lacks many genera (e.g. *Pterorhynchus*, *Contraconus*, *Cymatosyrinx*) that became regionally extinct at the end of the Caloosahatchee era. The fact that those genera occurred in the faunas of the now-restricted Waccamaw and James City formations casts

further doubt on the supposed early Pleistocene ages of those formations. If those formations are partially of Pliocene age, Blackwelder's interval-zones M3, M2, and M1 must be recalibrated.

The molluscan faunas of the Florida units are much more diverse than are those of corresponding units in the middle Atlantic Coastal Plain, but the actual stratigraphic situations of many Florida taxa are still based principally upon conjecture. Only DuBar (1958a, 1962a) has thoroughly documented southern Florida marine assemblages in situ. Much has been made of the low topography and paucity of stratigraphic exposures in southern Florida, and of the consequent necessity to collect from excavation spoil. However, those excuses may disguise the fact that it is far easier to collect from spoil than from in situ deposits. For example, the APAC Mine, a dry excavation, has been accessible for in situ study for more than 20 years, but relatively little comprehensive effort has been made to document the species compositions of the various units. Petuch's (1982b) biostratigraphic outline of APAC Mine only begins to reveal the information that could be forthcoming from more intensive study.

As dry-excavation sites occasionally become available, every opportunity should be used to document faunal assemblages in situ. The results of such studies, when correlated with global climatic events, will reveal information necessary to better understand the evolution of the marine mollusks of southern Florida.

Until a suitable biostratigraphic lexicon becomes available for the Florida marine deposits, it will be necessary to relate the molluscan assemblages by their less precise stratigraphic formational names, as I do here. Species of *Latirus* treated in this report are from the Pinecrest beds facies of the Tamiami Formation (middle Pliocene; estimated age 3.5-3.0 m.y.); the Caloosahatchee Formation (restricted; late Pliocene; age 2.5-1.8 m.y.); and the Ortona Lock and Belle Glade facies of the Bermont Formation (revised; early Pleistocene; <1.7>1.0 m.y.). The Bermont Formation may actually consist of two members and, if so, the age of the upper member may be considerably younger. No species of *Latirus* is known from early Pliocene (Wiltonian Stage equivalent) or late Pleistocene (Ft. Thompson and Coffee Mill Hammock) deposits of Florida.

METHODS

Many of the specimens of *Latirus* that were examined for this study were collected by the author. Other specimens were loaned or donated by amateur collectors, and additional records were obtained from specimens in the palontological collections of the Florida Museum of Natural History, the Department of Geology of Tulane University, and the Academy of Natural Sciences of Philadelphia.

Nearly all of the specimens of *Latirus* were collected from spoil of pit or canal excavations, so their biostratigraphic affinities could not be precisely ascertained. However, the acknowledged biostratigraphic affinities of other index taxa that accompanied the specimens of *Latirus* allow considerable confidence in the affinities assigned to the latter specimens. Locations of most collecting sites are shown in Figure 1. Locality data and stratigraphic information for south Florida sites that produced most of the specimens are as follows:

APAC Mine -- Excavation spoil at pit 3.2 km east of Sarasota, 0.3 km west of Interstate Highway I-75 (Sec. 12, T36S, R18E, Bee Ridge Quadrangle), Sarasota County; Latitude 27°21'N, Longitude 82°27'W. Principally middle Pliocene Tamiami Formation, with scattered lenses of late Pliocene Caloosahatchee Formation. Other names: Newbern Road Pit; Warren Bros. Pit; MacAsphalt Pit.

Belle Glade Rock Pit -- Excavation spoil approximately 1.6 km south of Belle Glade, just south of State Road 80 (W1/2 NE1/4 Sec. 7, T44S, R37E, Belle Glade Quadrangle), Palm Beach County; Latitude 26°39'30"N, Longitude 80°40'40"W. Early Pleistocene Bermont Formation.

Cochran Shell Pit -- Excavation spoil approximately 6.5 km southwest of La Belle, 0.2 km north of State Road 80 (NE1/4 Sec. 23, T43S, R28E, Sears Quadrangle), Hendry County; Latitude 26°43'45"N, Longitude 81°29'15"W. Principally late Pliocene Caloosahatchee Formation.

DeSoto Shell Pit -- Excavation spoil 16 km south of Arcadia, on east side of Hog Bay Road (SW1/4 SW1/4 Sec. 28, T39S, R25E, Arcadia SE Quadrangle), DeSoto County; Latitude 27°03'00"N, Longitude 81°49'30"W. Late Pliocene Caloosahatchee Formation, overlain by early Pleistocene Bermont Formation.

Miami Canal -- Excavation spoil 24.4 km west of U.S. Highway 27, 3.6 to 9.1 km north of pumping station, east side of Miami Canal (Sec. 2, 11, 14, and 24, T47S, R35E, Everglades 2 NE Quadrangle), Palm Beach County. Late Pliocene Caloosahatchee Formation overlain sometimes by early Pleistocene Bermont Formation.

Mule Pen Quarry -- Excavation spoil 6.2 km east of Interstate Highway I-75, north side of County Road 846, Naples Park (SE1/4 Sec. 24, T48S, R26E, Corkscrew SW Quadrangle), Collier County; Latitude 26°16'48"N, Longitude 81°40'42"W. Middle Pliocene Tamiami Formation overlain by late Pliocene Caloosahatchee Formation. Other name: Florida Rock Industries, Inc., Naples Quarry.

North New River Canal -- Excavation spoil on west side of canal along east side of U.S. Highway 27, 32.3 km southeast of South Bay, Palm Beach County; Latitude 26°23'28"N, Longitude 80°34'29"W. Early Pleistocene Bermont Formation.

North St. Petersburg -- Excavation spoil at southeast corner of 9th Street and 70th Avenue North, St. Petersburg (NW1/4 Sec. 31, T30S, R17E, St. Petersburg Quadrangle), Pinellas County; Latitude 27°50'19"N, Longitude 82°37'56"W. Late Pliocene Caloosahatchee Formation.

Ortona Lock -- Excavation spoil 2.4 km north-northeast of Goodno, along south bank of Caloosahatchee River (Sec. 26 and 27, T42S, R30E, Goodno Quadrangle), Glades County; Latitude 26°47'20"N, Longitude 81°18'20"W. Early Pleistocene Bermont Formation.

South Bay (2) -- Excavation spoil at pit 1.2 km north of South Bay, approximately 0.4 km east of U.S. Highway 27 (Sec. 2, T43S, R36E, Belle Glade Quadrangle), Palm Beach County; Latitude 26°41'00"N, Longitude 80°43'35"W. Early Pleistocene Bermont Formation.

South Bay (3) -- Excavation spoil at pit 2.4 km northeast of South Bay, on south side of waterworks (Sec. 2, T43S, R36E, Belle Glade Quadrangle), Palm Beach County; Latitude 26°41'00"N, Longitude 80°42'02"W. Early Pleistocene Bermont Formation.

Prefixes of catalogue numbers for specimens that were examined from or deposited in various institutional collections are as follows: Academy of Natural Sciences of Philadelphia (ANSP); Marine Invertebrate Collection, Florida Marine Research Institute (FSBC F and FSBC I); Museum of Comparative Zoology, Harvard University (MCZ); Florida Museum of Natural History, University of Florida (UF); United States National Museum of Natural History, Smithsonian Institution (USNM); and Zoologisch Museum, Universiteit van Amsterdam (ZMA). Specimens in the collection at Tulane University are identified by the prefix TU and appropriate field station numbers (e.g. TU 536).

Specimens were examined using a Zeiss model IV-B binocular dissecting microscope and were measured to the nearest 0.1 mm using vernier calipers. Shell length, measured from the apex to the anterior tip of the siphonal canal, is reported for all specimens; only the range of lengths (minimum-maximum) is reported for lots containing more than two specimens. Greatest

width is also reported for the largest specimen of each species and for all holotypes and lectotypes. Unless otherwise stated, reported measurements are for intact specimens.

SYSTEMATICS

Family Fascioliariidae Gray, 1853
Subfamily Peristerniinae Tryon, 1881
Genus *Latirus* Montfort, 1810
Subgenus *Latirus* Montfort, 1810

Type species.--*Latirus aurantiacus* Montfort, 1810 (= *Murex gibbulus* Gmelin, 1791), by monotypy.

Diagnosis.--Shells moderately large (to >70 mm), solid, fusiform, narrowly to widely umbilicate, with rapidly expanding whorls, well-developed axial ribs or folds, moderate to strong spiral cords and finer threads, short siphonal canal, and prominent columellar plicae; sutural ramps without thin axial lamellae; parietal tooth, if present, formed by continuation into aperture of spiral cord from body whorl.

Remarks.--Bullock (1974) called attention to the fact that the shell of the Indo-Pacific species *Latirus gibbulus* (Gmelin, 1791), the type species of *Latirus*, has features that suggest affinity with species now classified in *Leucozonia* Gray, 1847, rather than with other species now classified in *Latirus*. The radulae of species of *Latirus* have a small node or cusp on the medial end of the lateral tooth, but that node is greatly reduced or absent in species of *Leucozonia* (Bullock 1974). The radula of *L. gibbulus* has not been described. If *L. gibbulus* proves to be allied with species now placed in *Leucozonia*, *Leucozonia* will become a junior synonym of *Latirus* and many species now classified in *Latirus* must adopt another generic designation, probably *Polygona* Schumacher, 1817.

The species of *Latirus* examined during this study can be separated morphologically into two groups. The first group contains species with large, heavy, relatively broad shells that lack axial lamellae on their sutural ramps. The shells may have a tooth-like swelling on the parietal shield, formed externally by continuation into the aperture of a spiral cord of the body whorl. This group, containing the Recent species *Latirus cariniferus* (Lamarck, 1816) of the western Atlantic and *L. armatus* (A. Adams, 1855) of the eastern Atlantic, as well as the fossil species *L. taurus* Olsson, 1922, and two new species described herein, is usually classified in *Latirus* s.s. If the generic names *Latirus* and *Polygona* prove inappropriate for this group, the name

Hemipolygona Rovereto, 1899, is available. *Hemipolygona* was proposed as a replacement name for *Chascax* Watson, 1873 (type species *Chascax maderensis* Watson, 1873 [= *Latirus armatus* A. Adams, 1855] by monotypy; non *Chascax* Ritgen, 1828 [Reptilia]).

A second group within *Latirus* contains species with small to large shells that have distinct axial lamellae on their sutural ramps. This group contains species with or without a prominent tooth near the anal sinus. Unlike the parietal swelling of the previous group, this tooth is the terminus of a ridge that originates within the aperture and emerges to form the anal sinus. The emergent ridge, although always present, may be weak or strong and, if weak, will not form a prominent tooth. Presence or absence of the tooth seems to be a species-level character. All species with axial lamellae, with or without the tooth at the anal sinus, are classified in the subgenus *Polygona* and are treated following those classified in *Latirus* s.s.

Other genera of Peristerniinae that might be confused with *Latirus* include *Peristernia* and *Leucozonia*. As noted by Tryon (1881) and Bullock (1974), no fully satisfactory suite of characters has been identified that will allow confident assignments of all of the species among these genera. The character most useful in distinguishing the genera seems to be the radula (Tryon 1881; Cernohorsky 1972; Bullock 1974), but radulae are not available for the identification of fossils. Most shells assigned to *Peristernia* are relatively small, lack an umbilicus, have a recurved siphonal canal, and have 2-3 columellar plicae that are less developed than are the 3-6 columellar plicae of *Latirus*. No Recent species of *Peristernia* occur in the New World (except, perhaps, in the Galapagos Islands, fide Shasky 1988), and the few New World fossil records of the genus are demonstrably incorrect. At least five Recent species of *Leucozonia* occur in the New World, and Weisbord (1962) reported fossil specimens from northern Venezuela. Shells of some *Leucozonia* species lack the pronounced spiral cords of species of *Latirus*, and all *Leucozonia* have a more open siphonal canal that merges imperceptibly with the anterior portion of the aperture. Moreover, shells of *Leucozonia* often have a single tooth or tubercle on the outer lip at the terminus of a spiral cord situated between the body whorl and the siphonal canal.

Three species of *Latirus* s.s., including two described here, are recorded as post-Miocene fossils of south Florida.

Latirus (Latirus) nosali, new species
(Figs. 2-11)

Description.--Shell solid, broadly fusiform, umbilicate, to approximately 65 mm long, 31.5 mm wide, with about 11 whorls. Protoconchs of all

specimens eroded or absent; eroded remnants small, of no more than 2 whorls. Teleoconch whorls 8-9, with nearly straight sides, slightly constricted at sutures. Whorls of spire with 10-12 low, broad, slightly rounded axial ribs crossed by 2-3 spiral cords, cords separated by 1-2 spiral threads; swollen spiral band separating axial ribs from posterior suture of each whorl. Body whorl with 14-16 axial ribs crossed by 7 spiral cords, cords separated by 1-3 spiral threads; swollen spiral band at posterior suture overlain by 4-5 faint spiral threads. Siphonal canal short, broad, anteriorly truncate, with 4 oblique cords on dorsum, bordered ventrally along inner edge by thin, elevated lip; umbilicus deep, moderately to very wide. Aperture subovate, slightly constricted at anal sinus; outer lip crenulated by terminations of external spiral band and cords, with 8-9 strong lirae within; inner lip thin, elevated; columella straight, smooth, with 4 plicae emerging antero-obliquely from interior, posterior 2 plicae largest.

Type material.--Holotype 57.0 mm long, 26.7 mm wide; APAC Mine, Sarasota County; UF 31500.--3 paratypes, 38.3-57.0 mm; APAC Mine; UF 9697.--1 paratype, 42.3 mm; APAC Mine; ANSP 75403.--1 paratype, 50.1 mm (spire broken); APAC Mine; USNM 451145.--2 paratypes, 42.9, 47.1 mm; APAC Mine; FSBC F 37461.--9 paratypes, 30.8-56.6 mm; APAC Mine; FSBC F 37460.--5 paratypes, 32.3-63.1 mm; APAC Mine; FSBC F 39512.

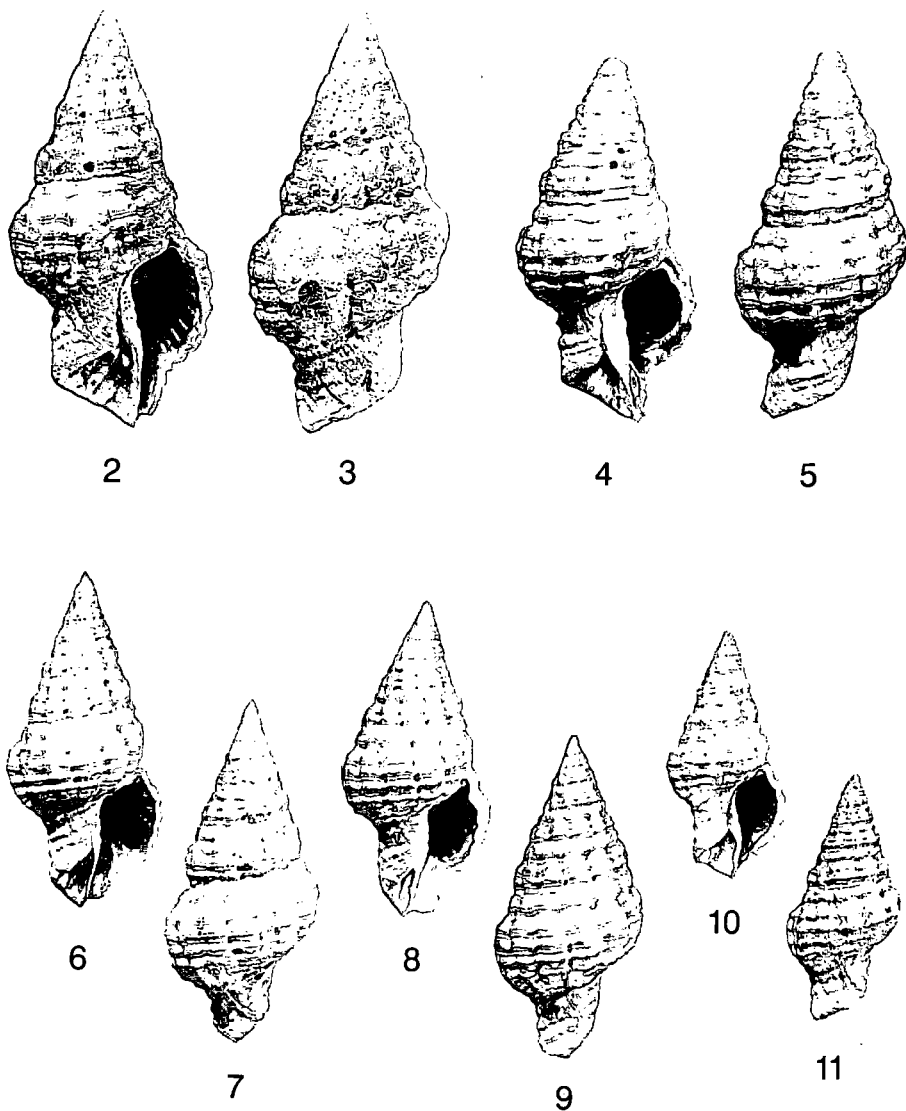
Type locality.--APAC Mine, Sarasota County, Florida.

Other material.--2 specimens, 34.1, 36.0 mm; APAC Mine; collection of Mrs. Meta Jones.--2 specimens, 43.0, 60.6 mm; APAC Mine; collection of Mrs. Yvonne Bequet.

Distribution.--Middle Pliocene; Tamiami Formation; known only from the type locality.

Remarks.--*Latinus nosali* is the first species of *Latinus* s.s. that is known from middle Pliocene deposits of Florida. Although most specimens have been collected from spoil, several of the specimens were collected in situ from Petuch's (1982b) Unit 7, indicating the material to be from the Pinecrest beds of the Tamiami Formation.

The 14-16 axial ribs on the body whorl of *L. nosali* are smaller, more closely spaced, and more numerous than are the 8-9 more prominent ribs of the late Pliocene species *L. stephensae* (described hereafter) and the Pleistocene to Recent species *L. cariniferus* (Lamarck). The swollen band near the posterior suture of *L. nosali* is absent in *L. stephensae* and *L. cariniferus*, which have, instead, relatively flat sutural ramps (Bullock 1974) overlain by faint spiral threads. The 7 spiral cords on the body whorl and the absence of a



Figures 2-11.--*Latirus nosali* new species. Figs. 2, 3.-HOLOTYPE (UF 31500). Figs. 4, 5.-PARATYPE (USNM 451145). Figs. 6, 7.- PARATYPE (FSBC F 37460). Figs. 8, 9.-PARATYPE (ANSP 75403). Figs. 10, 11.- PARATYPE (FSBC F 37460). All from APAC Mine. Figs. 2-11 x 1.

parietal tooth distinguish *L. nosali* from the large Pleistocene species *L. (Polygona) maxwelli* Pilsbry, which has 9-10 spiral cords and a prominent parietal tooth.

The projected maximum length of 65 mm is an approximation extrapolated from the largest specimen (FSBC F 39512), which has a broken spire tip. The width of the umbilicus is more pronounced in some specimens than in others. The umbilicus of each of the larger (> 50 mm) specimens is very wide, but the umbilicus of the 32.1 mm specimen is relatively wider than are those of other specimens 36.0-47.1 mm in length.

Etymology.--The species is named for Adam Nosal, who has facilitated access to the APAC Mine for countless fossil collectors.

Latirus (Latirus) stephensae, new species
(Figs. 12-19)

Latirus (Polygona) brevicaudatus: Olsson and Harbison 1953: 20. (Non *Turbinella brevicaudata* Reeve, 1847 [= *Latirus (Polygona) angulatus* (Röding, 1798) fide Bullock 1974]).

Description.--Shell moderately solid, fusiform, umbilicate, to 72.8 mm long, 31.5 mm wide, with about 11 whorls. Protoconchs of all specimens eroded, that of best-preserved specimen with 1-3/4 whorls, evidently smooth. Teleoconch whorls about 9. Whorls of spire with 9-10 low, rounded axial ribs crossed by 2 strong, carina-like cords, ribs bounded anteriorly and posteriorly by single weaker cords, with a fifth cord on sutural ramp; 3-4 threads in spaces between cords. Body whorl shouldered, with 8-9 broad, weak to moderately developed axial ribs crossed by 6 spiral cords, each separated by 4-6 spiral threads; sutural ramp with 2 spiral cords interspaced with 4-8 spiral threads. Siphonal canal short, relatively narrow, anteriorly truncate, with 3 oblique cords on dorsum, bordered ventrally along inner edge by thin, elevated lip; umbilicus deep, narrow to wide. Aperture subovate, slightly constricted at anal sinus; outer lip crenulated by terminations of external spiral cords, with 7-10 weak lirae within; inner lip thin, scarcely distinguished from body whorl; columella straight, smooth, with 4 plicae emerging antero-obliquely from interior, posterior 2 plicae largest.

Type material.--Holotype 72.8 mm long, 31.5 mm wide; south of State Road 78 along north bank of Caloosahatchee River (SE 1/4 Sec. 11, SW 1/4 Sec. 12, T43S, R28E, Sears Quadrangle), Hendry County; UF 24664.--1 paratype, 55.8 mm; Cochran Shell Pit, Hendry County; USNM 451146.--4 paratypes, 34.0-60.8 mm; Cochran Shell Pit; FSBC F 37463.--1 paratype, 47.8

mm; Cochran Shell Pit; ANSP 75404.--1 paratype, 30.0 mm; DeSoto Shell Pit, DeSoto County; FSBC F 37465.--2 paratypes, 59.5, 68.6 mm; Mule Pen Quarry, Collier County; UF 24658.--4 paratypes, 23.5-66.5 mm; Mule Pen Quarry; UF 24660.--1 paratype, 51.1 mm; Mule Pen Quarry; UF 14641.--4 paratypes, 47.4-56.5 mm; Mule Pen Quarry; TU 1175.--4 paratypes, 38.0-60.5 mm; Mule Pen Quarry; FSBC F 37466.--1 paratype, 45.8 mm; Mule Pen Quarry; FSBC F 37467.--1 paratype, 49.3 mm; 25.9 km WNW of Terrytown, Broward County; ANSP 55440.--2 paratypes, 40.0, 40.1 mm; spoil on east bank of Miami Canal, Palm Beach County; FSBC F 37468.--1 paratype, 35.7 mm (spire broken); Miami Canal, 3 km north of pumping station at Broward County line, Palm Beach County; TU 541.--1 paratype, 51.0 mm; North St. Petersburg, Pinellas County; FSBC F 37469.--1 paratype, 29.6 mm; North St. Petersburg; ANSP 18030.

Type locality.--North bank of Caloosahatchee River, Hendry County, Florida (see **Type material**).

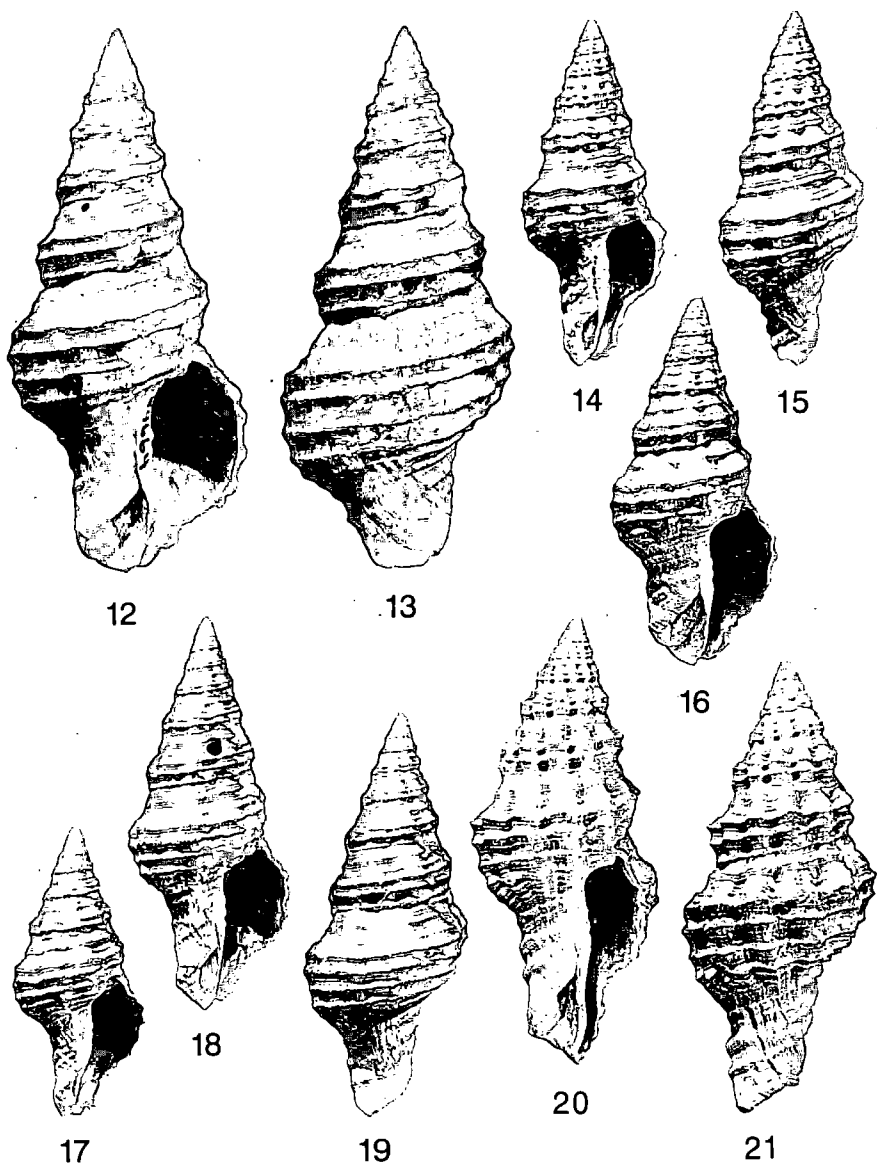
Other material.--1 specimen, 28.1 mm (tip of spire and anterior canal missing); State Road 84 (Alligator Alley), 20.7 km east of State Road 29 (T49S, R32E), Collier County; TU 796.--3 specimens, 31.5-36.4 mm (last with protoconch missing); State Road 84, 21.5 km east of State Road 29 (T49S, R32E), Collier County; TU 797.--2 specimens, both large but badly broken; State Road 84, 34.8 km east of State Road 29, Collier County; TU 933.

Distribution.--Late Pliocene; Caloosahatchee Formation; Hendry, DeSoto, Collier, Broward, Palm Beach, and Pinellas counties, Florida.

Remarks.--The holotype of *Latirus stephensae* (Figs. 12, 13), which is the largest specimen examined, has a relatively shorter siphonal canal than do all smaller specimens. The umbilicus of *L. stephensae* is narrow on all but two of the specimens examined, being wide only on the holotype (Fig. 12) and on one paratype from North St. Petersburg (Fig. 16; FSBC F 37469).

Latirus stephensae, a species of the Caloosahatchee Formation, is the late Pliocene representative of a lineage that includes *Latirus taurus* Olsson, 1922, of the Gatun Formation of Panama, *L. nosali* of the middle Pliocene Tamiami Formation, and *L. cariniferus* of the Pleistocene and Recent fauna. *Latirus taurus* (Figs. 20, 21) has a more widely angled spire and stronger and more numerous axial ribs on the body whorl (11 versus 8-9) than does *L. stephensae*.

Axial ribs and spiral cords of juvenile specimens of *L. stephensae* are very similar to those of *L. nosali*, but juveniles of *L. stephensae* lack the swollen subsutural band of *L. nosali*. Large specimens of *L. stephensae* are considerably more slender, have fewer axial ribs (8-9 versus 14-16), and have stronger spiral cords on the body whorl than do specimens of *L. nosali*. *Latirus*



Figures 12-21.--Figs. 12-19.- *Latirus stephensae* new species. Figs. 12, 13.- HOLOTYPE, north bank of Caloosahatchee River (UF 24664). Figs. 14, 15.- PARATYPE, Mule Pen Quarry (FSBC F 37466). Fig. 16.- PARATYPE, North St. Petersburg (FSBC F 37469). Fig. 17.- PARATYPE, Miami Canal (FSBC F 37468). Figs. 18, 19.- PARATYPE, Cochran Shell Pit (USNM 451146). Figs. 20, 21.- *Latirus taurus* Olsson, HOLOTYPE, Toro Cays, Panama (PRI 21010). Figs. 12-21 x 1.

stephensae has six cords on the body whorl and three on the anterior canal, whereas *L. nosali* has seven and four, respectively.

Shells of *L. stephensae* are relatively more slender than are those of *L. cariniferus*. *Latirus stephensae* resembles *L. cariniferus* principally in that rib counts on whorls of the spire overlap (9-10 for the former, 8-9 for the latter); both species have 8-9 ribs on the body whorl and two strong spiral cords that cross the axial ribs, producing a tabulate appearance on whorls of the spire of each species. However, *L. stephensae* has six cords on the body whorl, including three contiguous cords at the base, whereas *L. cariniferus* has five cords, including two contiguous at the base. In addition, one or both of the cords on the sutural ramp of *L. stephensae* are more prominent than are the one or two stronger threads that are sometimes present on the sutural ramp of *L. cariniferus*.

The species reported from North St. Petersburg by Olsson and Harbison (1953) as *Latirus (Polygona) brevicaudatus* (Reeve) is *L. stephensae*, as revealed by examination of their voucher specimen (ANSP 18030).

The specimens reported as *L. stephensae* from spoil along Alligator Alley (TU 796, TU 797, TU 933) are all juveniles or are badly broken, and those identifications are tentative. Most of the species that accompany them in the collections indicate affinity with the Pinecrest beds of the Tamiami Formation, and no other unequivocal indicator species of the Caloosahatchee Formation were found in those collections. If these specimens are actually of *L. stephensae*, it seems likely that scattered lenses of Caloosahatchee deposits may have overlain the Tamiami material along Alligator Alley.

Etymology.-- The species is named for Susan B. Stephens, Sanibel Island, Florida, a devoted collector of south Florida fossil mollusks, in recognition of the many specimens she provided for this study.

Latirus (Latirus) cariniferus (Lamarck, 1816)
(Figs. 22-31)

Fusus cariniferus Lamarck, 1816: pl. 423, fig. 3.

Turbinella carinifera: Reeve 1847: pl. 3, fig. 14.

Latirus distinctus A. Adams, 1855: 314.

Plicatella trochlearis Kobelt, 1874: pl. 19, figs. 1, 2.

Latirus trochlearis: Pilsbry 1939: 85, 86, pl. 5, fig. 7.

Latirus mcgintyi Pilsbry, 1939: 84, 85, pl. 5, fig. 8; Hoerle 1970: 64 [list].

Latirus (Latirus) cariniferus: Bullock 1974: 71-74, figs. 2-6, 9, 11, 18, 22; Abbott 1974: 226, 227, pl. 11, fig. 2489.

Latirus cariniferus: Petuch 1982c: 775, 777; Vokes and Vokes 1983: 56, pl. 16, fig. 14.

Latirus cariniferus mcgintyi: Vokes and Vokes 1983: 56, pl. 16, fig. 15.

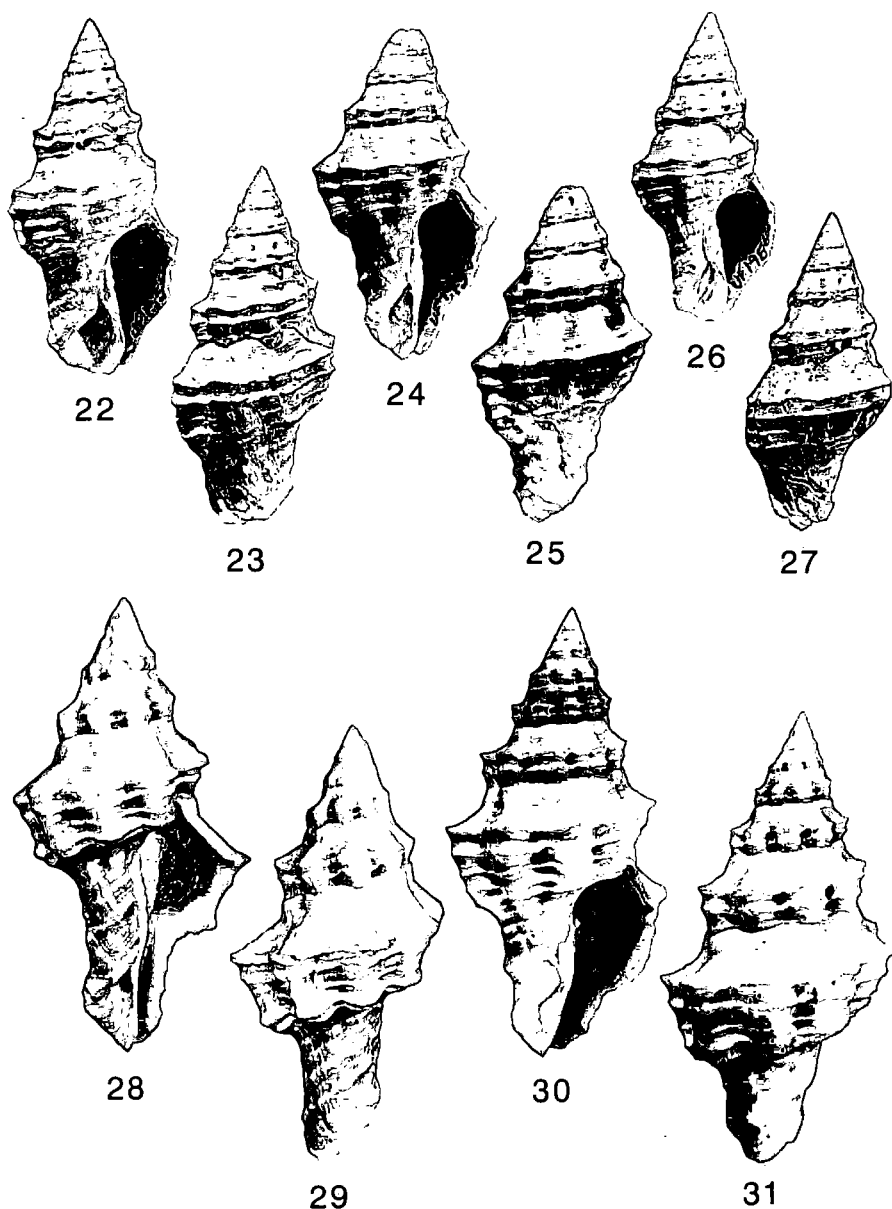
Description.--Shell solid, broadly fusiform, umbilicate, to 73.0 mm long, 36.8 mm wide (Bullock 1974), with about 11 whorls. Protoconch with 1-1/2 whorls. Teleoconch of 8-9 whorls. Whorls of spire with 8-9 moderate to strong axial ribs crossed by 2-3 spiral cords; if 3 cords present, cord nearest anterior suture weaker than others; 5-6 spiral threads usually present between cords. Body whorl with 8-9 axial ribs crossed by 5 strong cords, each separated by as many as 7 faint spiral threads; anteriormost 2 cords at base contiguous; sutural ramp with as many as 16 faint spiral threads, of which 1 or 2 sometimes stronger than others. Siphonal canal short, broad, anteriorly truncate, with 3 oblique cords on dorsum, bordered ventrally along inner edge by thin, elevated lip; umbilicus usually deep, narrow to very wide. Aperture subovate, somewhat compressed along outer edge, slightly constricted at anal sinus; outer lip crenulated by terminations of external spiral cords, with about 7 weak lirae within; inner lip thin, elevated; columella straight, smooth, with 4 plicae emerging antero-obliquely from interior, posterior 2 plicae largest.

Material examined.--3 specimens, 42.0-48.4 mm; South Bay (2), Palm Beach County; UF 19566.--1 specimen, 52.3 mm; South Bay (3); UF 14654.

Distribution.--Early Pleistocene; Bermont Formation; Palm Beach County, Florida. Recent: Florida and the Caribbean Sea to the northern coast of South America (Bullock 1974).

Remarks.--Bullock (1974) did not mention Hoerle's (1970) record of *Latirus mcgintyi* (= *L. cariniferus*) in the "Glades Unit" (= Bermont Formation) at Belle Glade, and he seemed to be unaware of any fossil record for the species. Although I did not see Hoerle's material, the specimens from Bermont deposits at South Bay, only 5 km from Belle Glade, seem to confirm her record. Except for maximum dimensions, the description presented here is based entirely on the South Bay fossils (Figs. 22-27), whose features agree with those Bullock (1974) described for Recent specimens.

Latirus cariniferus is preceded in the fossil record by *L. stephensae* of the late Pliocene Caloosahatchee Formation, by *L. nosali* of the middle Pliocene Tamiami Formation, and by *L. taurus* of the late Miocene to early Pliocene Gatun Formation of Panama. Characters that distinguish *L. cariniferus* from those species are discussed in previous species accounts. Whether all of the forms now assigned to *L. cariniferus* by Bullock (1974) actually represent a single species is uncertain. The typical, strongly carinate, usually unicolored form of *L. cariniferus* described by Lamarck occurs in Cuba (Bullock 1974: figs. 5, 11, 18, 22) and is common in Hispaniola (Figs. 28, 29) and in the Pleistocene Moín Formation of Costa Rica (David G. Robinson, pers. comm.) but is not known in fossil or Recent assemblages of Florida. As noted by Bullock (1974), shells of typical *L. cariniferus* resemble those of *L. armatus*, a species of the



Figures 22-31.--*Latirus cariniferus* (Lamarck). Figs. 22- 27.- South Bay (Pleistocene) (UF 19566). Figs. 28, 29.- typical carinate form, Port au Prince, Haiti (Recent) (FSBC I 37458). Figs. 30, 31. - "mcgintyi" form, Looe Key Reef, Florida (Recent) (FSBC I 37457). Figs. 22-31 x 1.

eastern Atlantic Ocean, but shells of *L. armatus* have only three strong carina-like cords on the body whorl. The stockier, less carinate, and usually bicolored form of *L. cariniferus* (Figs. 30, 31), named *L. distinctus* A. Adams, 1855, and *L. mcgintyi* Pilsbry, 1939, occurs in Recent assemblages of Florida, the Gulf of Mexico, and the western Caribbean Sea. Vokes and Vokes (1983) reported both *L. cariniferus* and *L. cariniferus mcgintyi* from the Yucatán Peninsula. Additional study may reveal these forms to be separate at the species level. Until then, it is sufficient to note that the Florida Pleistocene fossils most resemble the *distinctus* form.

Bullock (1974) stated that *L. cariniferus* lives in depths "from shallow water to over 100 fathoms [= 183 m]"; however, most living specimens in Florida are collected from depths less than 40 m.

Subgenus *Polygona* Schumacher, 1817

Type species.--*Polygona fusiformis* Schumacher, 1817 (= *Murex infundibulum* Gmelin, 1791), by monotypy.

Diagnosis.--Shells small to large, moderately broad to slender, often with pronounced brown spiral cords, with thin axial lamellae on sutural ramp; siphonal canal short or long, with obsolete to well-developed umbilicus; parietal tooth, if present, formed by ridge emerging from within aperture.

Remarks.--Most classifications of the Peristerniinae have either ignored *Polygona* (e.g. Tryon 1881) or considered it a junior synonym of *Latirus* (e.g. Melvill 1891; Thiele 1929; Wenz 1943). Nevertheless, Woodring (1928) and Bullock (1974) argued to maintain *Polygona* as a subgenus of *Latirus*. According to Bullock (1974), species classified in *Polygona* differ from those in *Latirus* s.s. by having smaller, relatively more slender shells with well-developed siphonal canals and, usually, with pronounced brown rather than white spiral cords. However, as acknowledged by Bullock (1974), the subgeneric distinction may be principally for convenience of classification. Specimens of *Latirus infundibulum*, the type species of *Polygona*, attain lengths > 70 mm, as do those of the fossil species *L. maxwelli* from Florida. Characters that do distinguish many species of *Polygona* from those classified in *Latirus* s.s. include the axial lamellae on the sutural ramps and, when present, the tooth at the terminus of the ridge that emerges from within the aperture to form the anal sinus (see **Remarks** for *Latirus* s.s.).

Five species in the subgenus *Polygona* are recorded as post-Miocene fossils of southern Florida. Three of the species have a strong parietal tooth at the anal sinus and two of the species lack such a tooth. The group includes no previously undescribed species, but the name of one of them is a junior homonym, for which a replacement name is proposed.

Latirus (Polygonia) miamiensis Petuch, 1986
(Figs. 32-35)

Latirus miamiensis Petuch, 1986a: 406, pl. 3, figs. 1, 2; 1988: pl. 16, figs. 3, 4.

Description.--Shell slender, fusiform, to approximately 43 mm long, 16 mm wide, with about 9 whorls. Protoconch unknown. Teleoconch whorls about 7, slightly rounded at sides, constricted at sutures. Whorls of spire with 9-10 low, rounded axial ribs crossed by 5 strong spiral cords; cords usually smooth between, but sometimes with single faint cord or thread; sutural ramp slightly inflated, overlain by 2-4 spiral cords and thin, axial lamellae. Body whorl with about 10 low, relatively long axial ribs crossed by 10 spiral cords, occasionally with single threads between cords; sutural ramp overlain by 2 somewhat weaker, undulating cords and numerous thin, axial lamellae that may continue between ribs of body whorl. Siphonal canal slender, elongate; dorsum with 7 strong, oblique spiral cords; thin, elevated inner lip attached ventrally along entire length of canal; umbilicus very small, shallow, chink-like. Aperture subovate; outer lip rounded, with 7 very thin lirae within; low swelling but no tooth on parietal shield near anal sinus; columella straight, with 3 weak pliae emerging antero-obliquely from interior.

Type material.--Holotype 35 mm long, 16 mm wide (spire and siphonal canal broken); MCZ 29226.

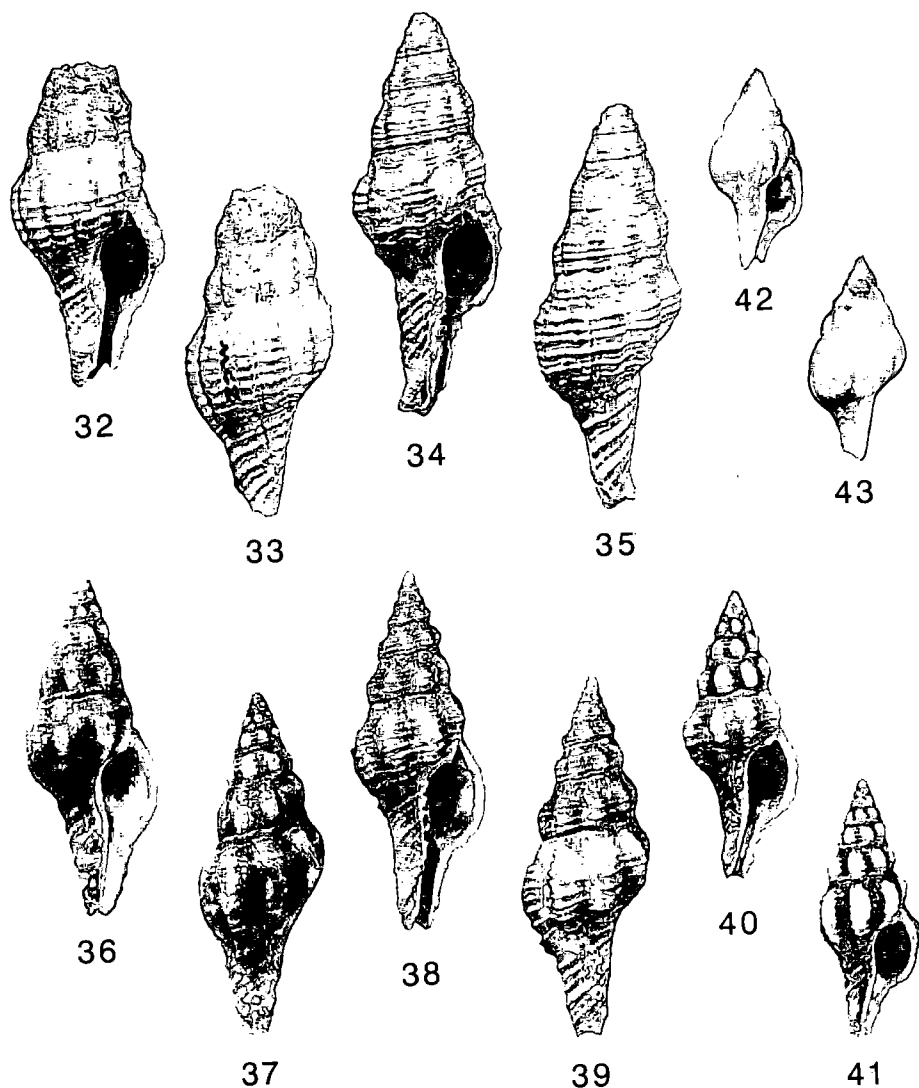
Type locality.--Excavation near SW 146th Avenue and Bird Road, Miami, Dade County, Florida; by original designation (Petuch 1986a).

Other material.--1 specimen, 41.0 mm (apex broken); Mule Pen Quarry, Collier County; FSBC F 37482.

Distribution.--Middle Pliocene; Tamiami Formation; Dade and Collier counties, Florida.

Remarks.--The material of *Latirus miamiensis* examined during this study includes only the damaged holotype and one additional damaged specimen. Nevertheless, the two specimens are sufficiently intact to confirm that *L. miamiensis* is distinct from other slender species of *Latirus (Polygonia)* treated here.

Latirus miamiensis is a member of a group that, in the Caribbean Region, extends from the Miocene to the Recent fauna. Other species in this complex include *Latirus elongatus* Gabb, 1873, from the early to middle Miocene Baitoa Formation of the Dominican Republic and *L. tessellatus* Dall, 1890 (non Récluz, 1844; nec Kobelt, 1874), from the Caloosahatchee Formation. In the



Figures 32-43.--Figs. 32-35.- *Latirus miamiensis* Petuch. Figs. 32, 33.- HOLOTYPE, Bird Road, Miami (MCZ 29226). Figs. 34, 35.- Mule Pen Quarry (FSBC F 37482). Figs. 36-41.- *Latirus virginensis* Abbott (Recent). Figs. 36, 37.- HOLOTYPE, St. Thomas, Virgin Islands (ANSP 196459). Figs. 38, 39.- PARATYPE, St. Thomas (ANSP 34968). Fig. 40.- PARATYPE, St. Thomas (ANSP 34975). Fig. 41.- PARATYPE, West Indies (ANSP 34969). Figs. 42, 43.- *Latirus eppi* Melvill and Schepman, Curaçao (Recent) (ZMA). Figs. 32-43 x 1.3.

Recent fauna, the group is represented by *L. virginensis* Abbott, 1958 (= *Latinus karinae* Üsticke, 1967, fide Faber 1988) (Figs. 36-41) and *L. eppi* Melvill and Schepman in Melvill, 1891 (Figs. 42, 43) of the Caribbean Region and by *L. hemphilli* Hertlein and Strong, 1951, and *L. mediamericanus* Hertlein and Strong, 1951, of the tropical Eastern Pacific Region.

Petuch (1986a) stated that *L. miamiensis* most resembles *L. angustatus* Gabb, 1873, from the late Miocene to early Pliocene Gurabo Formation (actually early to middle Miocene Baitoa Formation) of the Dominican Republic. However, Pilsbry (1922) noted the resemblance of the holotype of *L. angustatus* (ANSP 2950) to the holotype of *L. elongatus* (ANSP 2955), also described by Gabb from the Dominican Republic. I examined both specimens. The type of *L. angustatus* is a small shell (27.0 mm) with breaks on the tip of the spire, outer lip, and siphonal canal. The type of *L. elongatus* is a relatively large fragment (49.5 mm) that consists of the body whorl and siphonal canal plus two whorls of the spire; most of the spire is missing. Because the number and shape of the ribs and spiral sculpture on the posteriormost remaining whorl of *L. elongatus* much resemble those same features on the body whorl of *L. angustatus*, I concur with Pilsbry that the type of *L. angustatus* is a juvenile shell of *L. elongatus*. Together, the two shells indicate a large species, perhaps to 70 mm long, with more slender whorls and a relatively longer siphonal canal than that of *L. miamiensis*.

Latinus (Polygonia) caloosahatchiensis, new name
(Figs. 44-55)

Latinus tessellatus Dall, 1890: 108, pl. 10, fig. 8a; Tucker and Wilson 1932b: 356 [list]; M. Smith 1936: 22; Olsson and Harbison 1953: 215; Petuch 1982c: 777. (Non *Turbinella tessellata* Récluz, 1844a, 1844b [= *Latinus tessellatus* (Récluz) fide Tapparone-Canefri 1879]; nec *Plicatella polygonia* var. *tessellata* Kobelt, 1874 [= *Latinus polygonus* (Gmelin, 1791) fide Melvill 1891]).

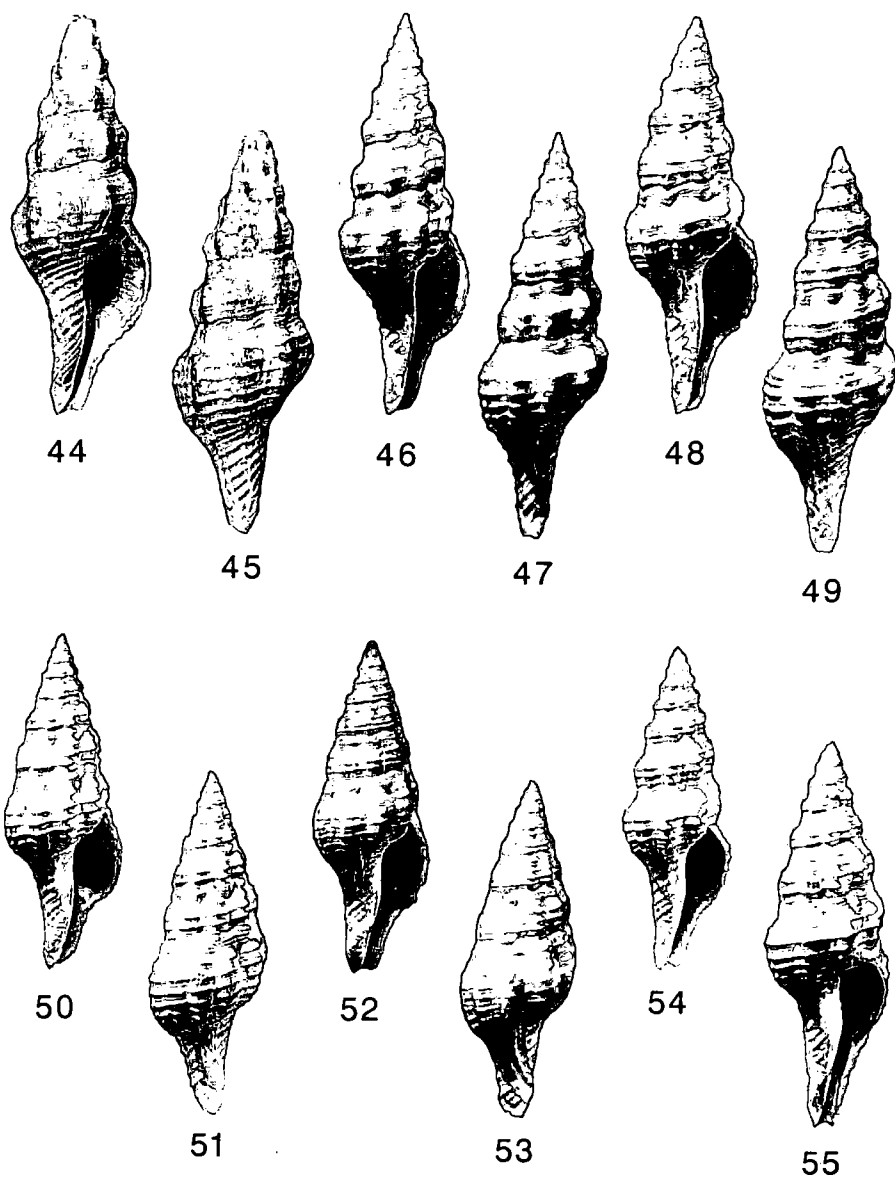
Description.--Shell slender, fusiform, to 47 mm long, 15.2 mm wide, with about 11 whorls. Protoconch of 2 smooth whorls, with 0-6 indistinct axial riblets on anteriormost 1/2 whorl. Teleoconch whorls about 9, with slightly convex, moderately shouldered sides, slightly to moderately constricted at sutures. Whorls of spire with 8-9 low but well-developed axial ribs crossed by 4 weak, subequal spiral cords, with 3 weak spiral threads between cords; sutural ramp inflated, overlain by about 7 undulating spiral threads crossed by thin, irregularly spaced, axial lamellae. Body whorl with 9 relatively slender axial ribs crossed by 9 large spiral cords, with single small cords or threads between posterior 5 large cords; sutural ramp with 7 undulating spiral threads. Siphonal canal elongate, slender; dorsum with about 7 strong, oblique spiral cords, usually with single threads in spaces between; lip attached along ventral inner edge of canal, hardly developed; umbilicus rudimentary, slit-like. Aperture

ovo-elongate; outer lip well-rounded, with 8-10 thin, faint lirae within; distinct but weak ridge emerging from interior onto parietal shield, forming constriction at anal sinus; columella straight, smooth, with 3 weak plicae emerging from interior, anteriormost plication smallest.

Type material.--Holotype 35.3 mm long, 12.2 mm wide, with broken spire; USNM 97496.

Type locality.--Caloosahatchee River, Florida; by original designation (Dall 1890).

Other material.--2 specimens, 28.5, 29.5 mm; north side of Caloosahatchee River, 8.9 km west of Ortona Lock (NW 1/4 Sec. 35, T42S, R29E), Glades County; TU 768.--8 specimens, 19.0-29.0 mm; south bank of Caloosahatchee River, 1.6 km east of La Belle (Sec. 3 and 4, T43S, R29E), Hendry County; TU 536.--1 specimen, 25.5 mm; La Belle, Hendry County; ANSP 55091.--1 specimen, 19.8 mm; north bank of Caloosahatchee River, 3 km west of La Belle (SE 1/4 Sec. 12, T43S, R28E), Hendry County; TU 529.--2 specimens, 25.5, 29.0 mm; 3 km west of La Belle on Caloosahatchee River, Hendry County; UF 2882.--82 specimens, 13.5-40.3 mm; Cochran Shell Pit, 6.5 km west of La Belle, Hendry County; FSBC F 37474.--3 specimens, 24.2-38.6 mm; Cochran Shell Pit; FSBC F 37475.--2 specimens, 28.7, 28.8 mm; Cochran Shell Pit; UF 14175.--1 specimen, 24.8 mm; Cochran Shell Pit; UF 23551.--15 specimens, 20.7-40.2 mm; Cochran Shell Pit; UF 24663.--2 specimens, 37.3, 27.9 mm (broken); Cochran Shell Pit; UF 25090.--1 specimen, 30.4 mm; Cochran Shell Pit; UF 25091.--1 specimen, 30.5 mm (spire broken); Hendry County Rock Pit, 0.8 km north of State Road 80, 4.8 km west of La Belle (SE 1/4 Sec. 14, T43S, R28E), Hendry County; TU 726.--1 specimen, 33.0 mm; north bank of Caloosahatchee River south of State Road 78 (Sec. 11S to Sec. 12SW, T43S, R28E), Hendry County; ANSP 61345.--1 specimen, 32.4 mm; north bank of Caloosahatchee River, 3.2 km east of Ft. Denaud (SW 1/4 Sec. 11, T43S, R28E), Hendry County; TU 203.--1 specimen, 28.9 mm; Caloosahatchee marls, Caloosahatchee River; USNM 97496.--2 specimens, 27.7, 36.9 mm; spoil along Okeechobee Waterway, Clewiston, Hendry County; UF 23195.--1 specimen, 39.3 mm; Clewiston; UF 25902.--1 specimen, 26.4 mm; Miami Canal, 6.4 km north of pumping station at Broward County line, Palm Beach County; TU 579.--1 specimen, 22.2 mm; Harney Pond Canal, Glades County; ANSP 70638.--3 specimens, 35.5-37.0 mm; Mule Pen Quarry, Collier County; UF 24659.--7 specimens, 23.1-38.8 mm; DeSoto Shell Pit, DeSoto County; FSBC F 37476.--1 specimen, 32.3 mm; APAC Mine, Sarasota County; collection of Mrs. Meta Jones.--1 specimen, 47.1 mm; APAC Mine; collection of Mrs. Yvonne Bequet.



Figures 44-55.--*Latirus caloosahatchiensis* new name. Figs. 44, 45.- HOLOTYPE, *L. tessellatus* Dall, Caloosahatchee River (USNM 97496). Figs. 46-49.- rugose form, Cochran Shell Pit (FSBC F 37474). Figs. 50-53.- smoother form, Cochran Shell Pit (FSBC F 37474). Fig. 54.- APAC.Mine (Meta Jones collection). Fig. 55.- DeSoto Shell Pit (FSBC F 37476). Figs. 44-55 x 1.3.

Distribution.--Late Pliocene; Caloosahatchee Formation; Hendry, Glades, DeSoto, Palm Beach, Collier, and Sarasota counties, Florida.

Remarks.--*Latirus caloosahatchiensis* is proposed as a replacement name for *Latirus tessellatus* Dall, 1890, which is preoccupied by *L. tessellatus* (Récluz, 1844) and by *L. tessellatus* (Kobelt, 1874). The name appeared in several important revisions published prior to Dall's work (e.g. Kobelt 1874, 1876; Tapparone-Canefri 1879; Tryon 1881; Paetel 1887).

The collection of types at the National Museum of Natural History contains two lots, each numbered USNM 97496 and each containing a single specimen of *L. tessellatus* Dall. The 35.3-mm specimen with the broken spire is the specimen that Dall figured and was the only specimen known to him when he described the species. That specimen (Figs. 44, 45) is the holotype. The second specimen is 28.9 mm long, has about 9 whorls including a protoconch broken only at the tip, and has an intact siphonal canal and outer lip. A note on the label states that the specimen is a later addition to lot USNM 97496. That specimen has no status as a type.

Shells of *Latirus caloosahatchiensis* vary from a relatively rugose form with pronounced axial ribs, constricted sutures, and prominent spiral cords (Figs. 46-49) to a smoother form with lower ribs, less compressed sutures, and subdued spiral cords (Figs. 50-53). A continuum exists between the rugose and smooth forms, and the rugose form is more common among specimens I examined.

Latirus caloosahatchiensis occurs in most well-known exposures of the Caloosahatchee Formation and seems to be a useful index species for that formation. However, nearly all specimens have been obtained from spoil of excavations that may also have included older or younger deposits. The two specimens of *L. caloosahatchiensis* from the APAC Mine at Sarasota were probably excavated from the Caloosahatchee material that overlies the Tamiami Pinecrest beds in some areas of the pit.

Latirus caloosahatchiensis somewhat resembles *L. miamiensis*, which occurs in the Tamiami Formation. However, shells of *L. miamiensis* have relatively broader whorls, rounder apertures, and more rugose spiral cords than do shells of *L. caloosahatchiensis*. Both species occur in spoil at Mule Pen Quarry, where excavations sometimes intrude through the Caloosahatchee strata into beds of Tamiami age.

Latirus (Polygona) fusiformis Gabb, 1873 (non *Polygona fusiformis* Schumacher, 1817), from the late Miocene to early Pliocene Cercado and Gurabo formations of the Dominican Republic, is superficially similar to *L. caloosahatchiensis*. However, the holotype of *L. fusiformis* Gabb (ANSP 2949) is a small shell (31.5 mm) that has relatively broader whorls and a wider aperture than those of *L. caloosahatchiensis*.

Latirus caloosahatchiensis is probably ancestral to the Recent *Latirus virginensis*. However, shells of *L. virginensis* (Figs. 36-41) are relatively wider and have relatively shorter spires than do shells of *L. caloosahatchiensis*. The only other Recent Caribbean species of *Latirus* that is at all similar to *L. caloosahatchiensis* is *L. eppi* from Curaçao, but the squat, relatively smooth shells of that species (Figs. 42, 43) easily distinguish it from the other two species.

Etymology.--Named for the Caloosahatchee River, whose banks yielded the first specimens of this species. A century ago, the spelling of the name of the river ended in -ie, and both Heilprin (1886-1887) and Dall (1890) used that spelling; in present usage, the name ends in -ee.

Latirus (Polygona) hypsipettus Dall, 1890
(Figs. 56-65)

Latirus hypsipettus Dall, 1890: 108, pl. 10, fig. 5; Petuch 1988: pl. 18, figs. 11, 12.

Latirus hypsipethus (sic): Tucker and Wilson 1932b: 356 [list].

Latirus tessellatus seminolensis M. Smith, 1936: 22, pl. 9, fig. 2.

Latirus (Polygona) hypsipettus: Olsson and Harbison 1953: 20, 214.

Latirus (Polygona) seminolensis: Olsson and Harbison 1953: 20, 214, 215.

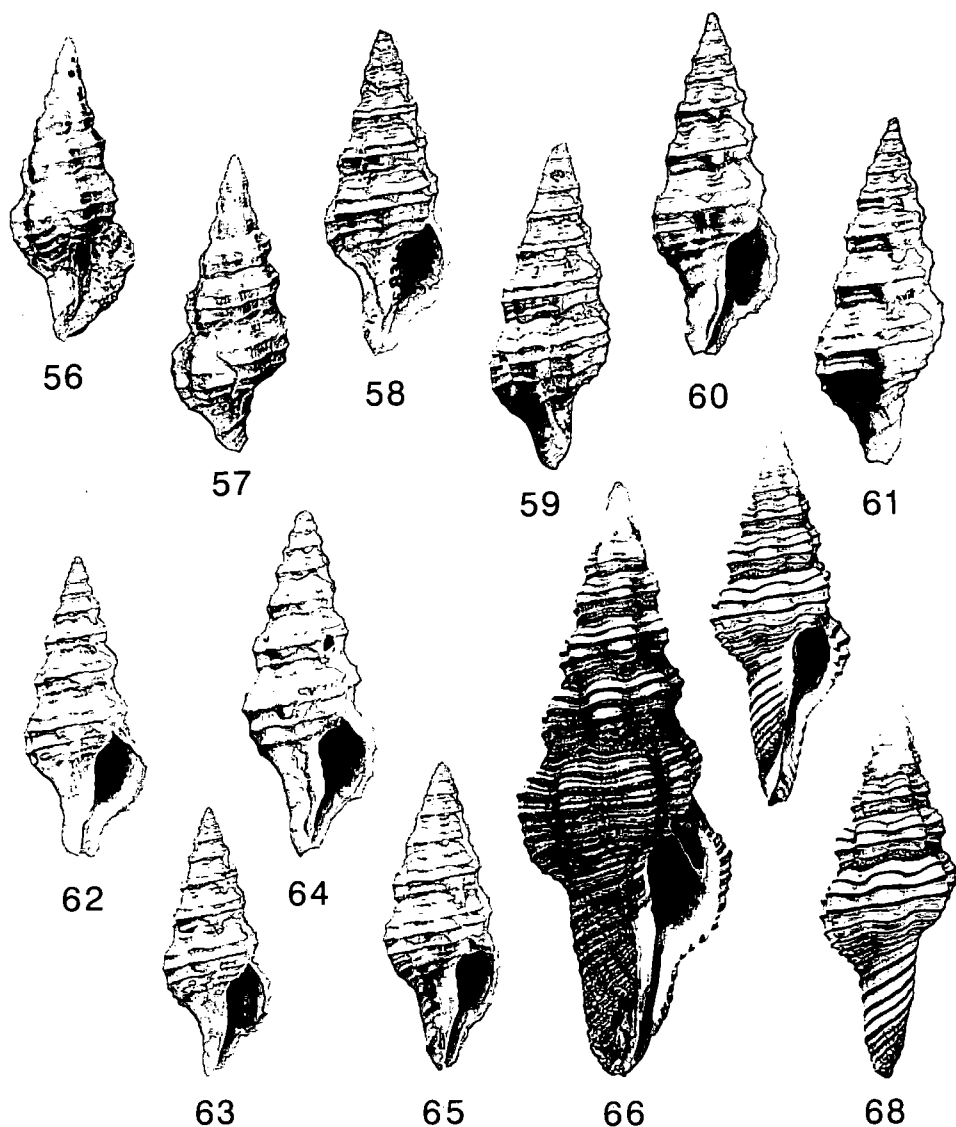
Description.--Shell slender, fusiform, to approximately 35 mm long, 13 mm wide, with about 9-1/2 whorls. Protoconch whorls 1-3/4, with 1-6 axial riblets on last 1/2 whorl. Teleoconch whorls about 8, rounded at sides, moderately to strongly constricted at sutures. Whorls of spire with 6-7 swollen, rounded axial ribs crossed by 3-4 spiral cords, central 2 cords strongest, anterior cord sometimes absent; single spiral threads between cords; sutural ramp overlain by 2-4 weak cords crossed by thin axial lamellae. Body whorl with 7-9 swollen axial ribs extending nearly to suture, crossed by 6-7 strong spiral cords with single spiral threads between; wide band with 0-4 weak cords or threads between anteriormost 2 strong cords; sutural ramp narrow, with 2-4 weak spiral cords or threads and numerous thin axial lamellae. Siphonal canal short, tapered, anteriorly truncate; dorsum with 5-6 oblique, strong to weak cords, 1-5 threads between cords; lip thin, usually appressed to inner edge of canal ventrally, seldom distinctly elevated; umbilicus shallow, chink-like. Aperture subovate, constricted posteriorly; outer lip broadly rounded, with 6-7 thin lirae within; lirae weak to obsolete on some shells; low interior ridge emerging onto parietal shield, sometimes terminating in blunt tooth near anal sinus; inner lip seldom separated from body whorl; columella straight, with 3 weak plicae emerging antero-obliquely from interior.

Type material.--*Latirus hypsipettus*: Lectotype (here designated) 25.4 mm long, 10.1 mm wide, with 9 whorls including intact protoconch; USNM 97497.

Latirus tessellatus seminolensis: Holotype 29.8 mm long, 11.3 mm wide, with 7-1/2 whorls (protoconch missing); UF 8360.

Type locality.--*Latirus hypsipettus*: Caloosahatchee River, Florida; by original designation (Dall 1890). *Latirus tessellatus seminolensis*: spoil along Okeechobee Waterway, Clewiston, Florida; by original designation (M. Smith 1936).

Other material.--18 specimens, 15.5-28.3 mm; south bank of Caloosahatchee River, 1.6 km east of La Belle (Sec. 3 and 4, T43S, R29E), Hendry County; TU 536.--3 specimens, 15.7-29.3 mm; north bank of Caloosahatchee River, 3 km west of La Belle (SE 1/4 Sec. 12, T43S, R28E), Hendry County; TU 529.--2 specimens, 22.0, 26.8 mm; 3 km west of La Belle on Caloosahatchee River, Hendry County; UF 2881.--44 specimens, 11.5-34.9 mm; Cochran Shell Pit; Hendry County; FSBC F 37470.--2 specimens, 25.7, 26.6 mm; Cochran Shell Pit; FSBC F 37462.--3 specimens, 20.2-26.8 mm; Cochran Shell Pit; UF 24662.--3 specimens, 16.8-27.4 mm; Cochran Shell Pit; UF 14167.--2 specimens, 20.3, 23.6 mm; Cochran Shell Pit; UF 14187.--3 specimens, 17.9-28.0 mm; Cochran Shell Pit; UF 25092.--1 specimen, 23.9 mm; Hendry County Rock Pit, 0.8 km north of State Road 80, 4.8 km west of La Belle (SE 1/4 Sec. 14, T43S, R28E); TU 726.--1 specimen, 31.0 mm; Three-Way Rock Pit, La Belle, Hendry County; UF 15095.--4 specimens, 20.0-22.0 mm; Sears/Alva/La Belle Quadrangles, Caloosahatchee River; UF 9515.--1 specimen, 32.6 mm; north bank of Caloosahatchee River, 3.2 km east of Ft. Denaud (SW 1/4 Sec. 11, T43S, R28E), Hendry County; TU 203.--1 specimen, 25.3 mm; Ft. Denaud Rock Pit, Hendry County; UF 15670.--4 specimens, 23.7-27.8 mm; Clewiston, Hendry County; UF 25889.--4 specimens, 20.6-24.8 mm; north side of Caloosahatchee River, 0 to 0.8 km west of center of Lake Hicpochee (now drained) (T42S, R32E), Glades County; TU 975.--8 specimens, 18.1-25.7 mm; Harney Pond Canal at State Road 78, northwest side of Lake Okeechobee (NW 1/4 Sec. 18, T40S, R33E), Glades County; TU 519.--2 specimens, 16.1, 18.6 mm; Harney Pond Canal, Glades County; ANSP 70934.--1 specimen, 14.8 mm; Harney Pond Canal; ANSP 70636.--1 specimen, 24.4 mm; DeSoto Shell Pit, DeSoto County; FSBC F 37464.--1 specimen, 31.6 mm; spoil on east bank of Miami Canal, Palm Beach County; FSBC F 37472.--2 specimens, 23.0 (spire broken), 29.3 mm; Mule Pen Quarry, Collier County; TU 1177.--4 specimens, 20.9-28.0 mm; Mule Pen Quarry; FSBC F 37471.--1 specimen, 33.3 mm; Mule Pen Quarry; FSBC F 37473.--1 specimen, 33.2 mm; APAC Mine, Sarasota County; collection of Mrs. Yvonne Bequet--2 specimens, 25.0, 27.5 mm; North St. Petersburg, Pinellas County; ANSP 18106.--1 specimen, 25.2 mm; North St. Petersburg(?); ANSP 18083.



Figures 56-68.--Figs. 56-65.- *Latirus hypsipetus* Dall. Figs. 56, 57.- LECTOTYPE, Caloosahatchee River (USNM 97497). Figs. 58, 59.- HOLOTYPE, *Latirus tessellatus seminolensis* M. Smith, Clewiston (UF 8360). Figs. 60-62.- Cochran Shell Pit (FSBC F 37470). Fig. 63.- DeSoto Shell Pit (FSBC F 37464). Fig. 64.- Miami Canal (FSBC F 37472). Fig. 65.- Mule Pen Quarry (FSBC F 37473). Figs. 66-68.- *Latirus infundibulum* (Gmelin) (Recent). Fig. 66.- Bani, Dominican Republic (FSBC I 37451). Figs. 67, 68.- Tobago (FSBC I 37452). Figs. 56-65 x 1.3; Figs. 66-68 x 1.

Distribution.--Late Pliocene; Caloosahatchee Formation; Pinellas, Sarasota, DeSoto, Hendry, Glades, Palm Beach, and Collier counties, Florida.

Remarks.--The type lot of *Latirus hypsipettus* (USNM 97497) contains four specimens, of which the 25.4-mm specimen figured by Dall is designated the lectotype (Figs. 56, 57). Of the three remaining specimens (now paralectotypes), one 12.4 mm long is a juvenile *L. hypsipettus*, one 6.2 mm long is a juvenile *L. caloosahatchiensis*, and one 5.1 mm long is a juvenile buccinid.

Latirus hypsipettus Dall and *Latirus tessellatus seminolensis* Smith unquestionably constitute a single species, for which Dall's name has priority. *Latirus hypsipettus* has seldom been mentioned since Dall's (1890) original description, perhaps because the damaged siphonal canal of Dall's illustrated specimen made the species difficult to recognize. Smith (1936) did not mention *L. hypsipettus* when he described *L. tessellatus seminolensis*, even though Dall (1890) described *L. hypsipettus* and *L. tessellatus* on the same page and illustrated them on the same plate. Specimens of *L. hypsipettus* in the collection of the Florida Museum of Natural History were labeled as *L. seminolensis*, *L. tessellatus*, or *Latirus* cf. *brevicaudatus* (= *Latirus* (*Polygona*) *angulatus* (Röding, 1798) fide Bullock 1974).

Although they illustrated neither shell, Olsson and Harbison (1953) reported single specimens of both *Latirus hypsipettus* and *L. seminolensis* from Pliocene deposits of North St. Petersburg. They correctly declared that *L. seminolensis* was a species distinct from *L. tessellatus* (= *L. caloosahatchiensis*), as indicated by the shorter siphonal canal of the former, but they also described a very short siphonal canal on the specimen they called *L. hypsipettus*. The paleontological collection at the Academy of Natural Sciences of Philadelphia includes one lot identified as *L. seminolensis* (ANSP 18106); the lot consists of two vials, each containing one specimen. One vial, originally from the Charles Locklin collection, bears the label "*Latirus tessellatus seminolensis* Maxwell Smith. Pliocene. North St. Petersburg." The other vial is unlabeled, but a label in the box states "Figured, Olsson and Harbison," although Olsson and Harbison did not figure any species of *Latirus*. The two specimens are probably the specimens that Olsson and Harbison reported as *L. tessellatus seminolensis* and *L. hypsipettus*. Another lot from the Locklin collection (ANSP 18083), correctly identified as *L. hypsipettus*, is labeled "North St. Petersburg; provided as voucher specimen for Olsson and Harbison." However, Locklin's label on the vial states "Caloosa. Ft. Thompson," indicating that the specimen probably came from the banks of the Caloosahatchee River near Ft. Thompson in Hendry County, rather than from St. Petersburg. Olsson and Harbison (1953: 20) also listed *L. brevicaudatus* among the Pliocene fauna of North St. Petersburg, but their voucher specimen of that species (ANSP 18030) proved to be *Latirus stephensae* (see account of that species).

Latirus hypsipettus and *L. caloosahatchiensis* frequently occur together in deposits of the Caloosahatchee Formation. As Olsson and Harbison (1953) observed, the relatively shorter siphonal canal distinguishes *Latirus hypsipettus* from *L. caloosahatchiensis*. The aperture of *L. caloosahatchiensis* is proportionally more elongate than is that of *L. hypsipettus*. Finally, the strength of the ribs and the spiral cords and the degree of constriction of the sutures of *L. caloosahatchiensis* are generally much more subdued than are those of *L. hypsipettus*; however, these characters are variable.

Latirus hypsipettus is the late Pliocene representative of a lineage that extends in North America from the Eocene to the Recent fauna. The holotype (ANSP 9199) of *Latirus sexcostatus* Johnson, 1899, from the Eocene Lower Claiborne Group (Landrum Member of the Cook Mountain Formation) of Texas, is a virtual copy in miniature of the specimen of *L. hypsipettus* illustrated in Fig. 63 (see Johnson 1899: pl. 1, fig. 9; Palmer 1937: pl. 54, fig. 7). Both specimens have identical numbers of whorls, but the length of the holotype of *L. sexcostatus* is only 14.0 mm, whereas the length of the illustrated specimen of *L. hypsipettus* is 24.2 mm. The lineage produced another species, *Latirus jucundus*, that occurs in the early Pleistocene Bermont Formation and still another species, *L. angulatus*, that occurs in the Recent fauna of Florida and the Caribbean Region.

Some specimens of *Latirus hypsipettus* are sufficiently well preserved to demonstrate color pattern. The pattern of dark spiral cords contrasted against a lighter background strongly resembles the pattern found on specimens of *Latirus infundibulum* (Figs. 66-68) and, sometimes, on *Latirus angulatus* (Figs. 69-71) and *L. jucundus*. Both *L. infundibulum* and *L. angulatus* now live along the southeastern coast of Florida (Bullock 1974). However, *L. infundibulum* has a larger, thicker shell with a relatively taller spire and a much longer siphonal canal than does *L. hypsipettus*. Shells of *L. angulatus* are relatively wider and heavier than those of *L. hypsipettus*. Finally, both Recent species attain lengths in excess of 70 mm (Bullock 1974), whereas the largest specimen of *L. hypsipettus* attained a length of only 34.9 mm.

Latirus (Polygona) jucundus McGinty, 1940
(Figs. 69-86)

Latirus jucundus McGinty, 1940: 83, pl. 10, fig. 3; 1970: 54, 56; Hoerle 1970: 64 [list]; Petuch 1988, pl. 24, fig. 7.

Description.--Shell solid, fusiform, to 44.2 mm long, 17.0 mm wide, with 10-1/4 whorls. Protoconch flat at tip, of 2 swollen whorls, with about 6 axial riblets on anterior 1/4 whorl. Teleoconch of about 8-1/4 rounded whorls,

slightly to strongly constricted at sutures. Whorls of spire with 6-8 swollen, rounded axial ribs crossed by 4 spiral cords, central 2 cords strongest, 1-3 faint spiral threads between cords; sutural ramp inflated, with 3-5 undulating spiral threads of varying strength and thin axial lamellae. Body whorl with 6-9 broad, swollen axial ribs crossed by 6-9 strong spiral cords, usually with weaker cord and 2 threads in spaces between; sutural ramp with 4-5 strong spiral threads, reticulated by thin axial lamellae. Siphonal canal relatively short, tapered, anteriorly truncate; dorsum with 4-10 oblique cords diminishing in strength anteriorly, with single spiral threads between all but anteriormost 3 cords; thick, elevated lip attached to inner edge of canal ventrally; umbilicus narrow, shallow to deep, usually chink-like. Aperture subovate, constricted at anal sinus; outer lip arcuate, crenulated by terminations of spiral cords, with 6-11 thin lirae within; distinct ridge emerging onto parietal shield, forming blunt tooth at anal sinus; inner lip thick, distinctly separated from body whorl; columella straight, with 4 plicae emerging from within, anteriormost plication smallest.

Type material.--Holotype, 43.3 mm long, 18.6 mm wide, with 6-1/2 whorls (protoconch missing); UF 23196.

Type locality.--Belle Glade, Palm Beach County, Florida; by original designation (McGinty 1940).

Other material.--1 specimen, 44.2 mm; Ferrell-Mattson Shell Pit, 3.5 km southwest of U.S. Highway 441 on north side of State Road 78, Okeechobee County; FSBC F 37481.--4 specimens, 15.7-27.6 mm; Belle Glade Rock Pit, Palm Beach County; UF 26113.--2 specimens, 17.8, 33.7 mm; Belle Glade Rock Pit; UF 6616.--1 specimen, 39.9 mm; Belle Glade Rock Pit; UF 6588.--1 specimen, 21.3 mm; Belle Glade Rock Pit; UF 26294.--1 specimen, 31.0 mm; Belle Glade; UF 19466.--1 specimen, 38.0 mm (spire broken); pit at intersection of U.S. Highway 441 and State Road 717, 1.6 km east of Pahokee, Palm Beach County; TU 1023.--10 specimens, 21.5-39.7 mm; South Bay (2), Palm Beach County; UF 19567.--9 specimens, 23.2-34.4 mm; South Bay (3), Palm Beach County; TU 978 (8), UF 32437 (1).--1 specimen, 27.8 mm; North New River Canal, 1.6 km south of South Bay, Palm Beach County; TU 580.--1 specimen, 32.4 mm (spire broken); North New River Canal, 2.5 km south of South Bay, Palm Beach County; TU 751.--4 specimens, 24.2-34.1 mm; pit 3.5 km east of U.S. Highway 27, 24 km south of South Bay, Palm Beach County; TU 727 (3), UF 32438 (1).--1 specimen, 32.5 mm; North New River Canal, 8.5 km north of pumping station at Broward County line on U.S. Highway 27, Palm Beach County; TU 746, UF 32439.--3 specimens, 21.0-43.5 mm; spoil along North New River Canal, Palm Beach County; FSBC F 37480.--5 specimens, 25.6-32.5 mm; spoil along North New River Canal; ANSP 53896.--5

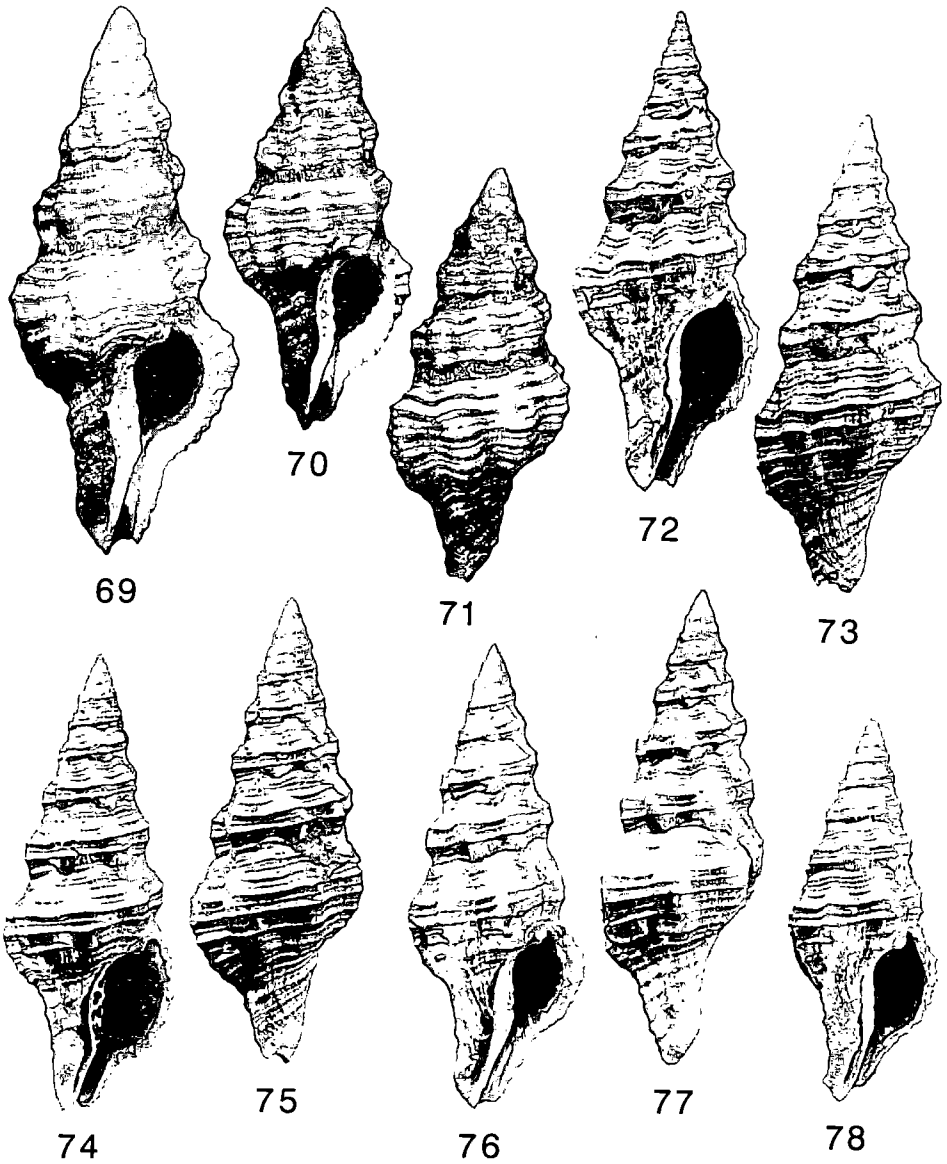
specimens, 30.4-43.9 mm; spoil along North New River Canal; E.J. Petuch collection.--1 specimen, 32.3 mm; Miami Canal, 6.4 km north of pumping station at Broward County line, Palm Beach County; TU 579.--2 specimens, 15.8, 26.8 mm (both broken); Canal L-38W, 1.3 km south of Terrytown, Broward County; TU 973.--4 specimens, 34.5-38.4 mm; 3 km west of Ortona Lock (NE 1/4 Sec. 29, T42S, R30E, Goodno Quadrangle), Glades County; UF 27646.--1 specimen, 42.5 mm; Cochran Shell Pit, Hendry County; UF 24661.

Distribution.--Early Pleistocene; Bermont Formation; Okeechobee, Palm Beach, Broward, Glades, and Hendry counties, Florida.

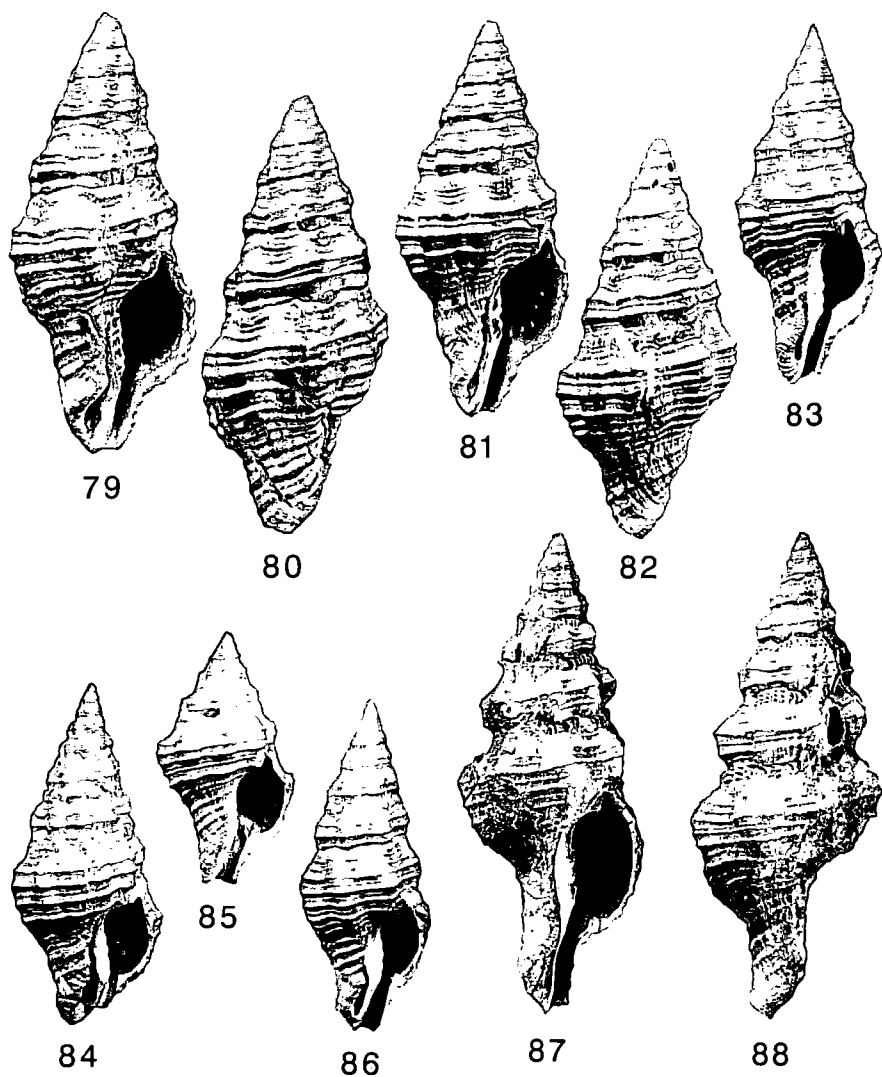
Remarks.--Considerable morphological variation exists among the shells here assigned to *Latinus jucundus*. The fossils range from elongate, slender forms (Figs. 72-78) to relatively broad, solid shells as exemplified by the holotype of *L. jucundus* (Figs. 79, 80) and a specimen from Belle Glade Rock Pit (Figs. 81, 82). The numbers of axial ribs and spiral cords also vary considerably. One especially short, broad specimen (Fig. 85) represents a suspected abnormality whose dimensions even exceed the considerable variability otherwise found among the specimens. Because I find no consistent character that indicates more than one taxon, I conclude that the specimens represent a single species.

Latinus jucundus is closely related to *Latinus angulatus* (Röding, 1798), a Recent Florida and Caribbean species to which considerable morphological variation has also been ascribed. Bullock (1974) reviewed the Recent species of *Latinus* in the Caribbean Region and concluded that *L. angulatus*, *L. brevicaudatus* (Reeve, 1847), *L. spadiceus* (Reeve, 1847), and *L. cymatius* Schwengel, 1940, constitute a single variable species. According to Bullock, "A study of many hundreds of West Indian specimens has resulted in the conclusion that this relatively common species [*L. angulatus*] exhibits more intraspecific variation than any other *Latinus* I have observed." Bullock mentioned several geographically related forms (e.g. "a typical form [of *L. angulatus*] occurring in the southern Caribbean" and "the Virgin Island form of '*brevicaudatus*'"), but he noted that typical *L. angulatus* also occurs in the Virgin Islands and that *L. cymatius* from Florida "is closer to typical *angulatus* than many of the other variations." Bullock also mentioned that "the figured type of *brevicaudatus* seemed to have much in common with a few Indo-Pacific specimens labelled *Latinus lyratus* Rve."

The matter of extraordinary intraspecific variability in *Latinus angulatus* remains open to question. The specimens available for Bullock's study were collected from many locations but usually consisted of very few individuals per location (R.C. Bullock, pers. comm.). Similar but taxonomically distinct species are sometimes difficult to discern in such collections. However, large collections (>10 specimens/site) of live-taken *L. angulatus* made at night by



Figures 69-78.--Figs. 69-71.- *Latirus angulatus* (Röding), Cat Cay, Bahamas (Recent) (FSBC I 37455). Figs. 72-78.- *Latirus jucundus* McGinty. Figs. 72, 73.- Ferrell-Mattson Shell Pit (FSBC F 37481). Figs. 74, 75.- Cochran Shell Pit (UF 24661). Figs. 76, 77.- North New River Canal (FSBC F 37480). Fig. 78.- Belle Glade Rock Pit (UF 6616). Figs. 69-78 x 1.3.



Figures 79-88.--Figs. 79-86.- *Latirus jucundus* McGinty. Figs. 79, 80.- HOLOTYPE, Belle Glade (UF 23196). Figs. 81, 82.- Belle Glade Rock Pit (UF 6588). Fig. 83.- South Bay, TU 978 (UF 32437). Fig. 84.- North New River Canal (Petuch collection). Fig. 85.- 24 km south of South Bay, TU 727 (UF 32438). Fig. 86.- North New River Canal, TU 746 (UF 32439). Figs. 87, 88.- *Latirus irazu* Olsson, HOLOTYPE, Limon, Costa Rica (PRI 21018). Figs. 79-88 x 1.3.

divers off Florida, the Bahama Islands, the Turks and Caicos Islands, and the Bay of Honduras during recent years demonstrate relatively minimal variation among specimens at single sites but great variation between populations at different sites. The magnitudes of difference between some of the sampled populations are sufficient to suggest that several species may be included in an "*L. angulatus* group." *Latirus martini* Snyder, 1988, from the Bay of Honduras, is an example of a species that was unrecognized until recently because its morphological features were considered to occur within the range of variation ascribed to *L. angulatus*. Careful study of large suites of specimens may reveal other species within this "variable" group.

Despite several similarities between specimens of *Latirus jucundus* and *L. angulatus*, I maintain the taxa as separate species for the following reasons. Sutures of the spire are relatively less constricted and the siphonal canal is relatively shorter on specimens of *L. jucundus* than on *L. angulatus*. The central two cords are noticeably stronger than the other two cords on whorls of the spire of *L. jucundus*, whereas the four cords are nearly equal in size on *L. angulatus*. Some specimens of *L. angulatus* exceed 70 mm in length (Bullock 1974), whereas the largest specimen of *L. jucundus* that I examined barely exceeds 44 mm, although Petuch (1988) reported a length of 47 mm for the specimen he illustrated. I have not seen the elongate, slender form of *L. jucundus* among specimens of *L. angulatus*. Finally, as indicated above, I consider the matter of variability in *L. angulatus* to be unresolved. To add *L. jucundus* to the list of synonyms of *L. angulatus* would only add to the variability already ascribed to that species.

Some characters of the 45.5-mm-long holotype of *Latirus irazu* Olsson, 1922, described from the "Gatun Stage" (actually Moín Formation; early Pleistocene) at Puerto Limón, Costa Rica, approach the range of variation described for *L. jucundus*. However, the holotype of *L. irazu* (Figs. 87, 88) is a thinner shell with more constricted sutures, a relatively larger aperture, a more slender, straighter siphonal canal, and more pronounced axial lamellae than occur on specimens of *L. jucundus*. The holotype of *L. irazu* more resembles some specimens of *L. angulatus* (compare Figs. 69 and 87), but it differs from that species by having a thinner shell with a relatively larger aperture and finer spiral sculpture. Although the resemblance between shells of *L. irazu* and *L. angulatus* is strong, I retain *L. irazu* as a separate species until more specimens can be obtained for study and until variation in *L. angulatus* is better understood.

Latirus jucundus is the early Pleistocene representative of a group that contains, in addition to *L. angulatus*, the late Pliocene *L. hypsipettus* and the Eocene *L. sexcostatus*. Like *L. hypsipettus*, some specimens of *L. jucundus* are well enough preserved to have retained a faint pattern of orange-brown spiral cords contrasted against a lighter background, a pattern similar to those of *L. angulatus* and *L. hypsipettus*. Compared to *L. hypsipettus*, specimens of *L.*

jucundus are larger (44-mm versus 35-mm maximum length, both shells with approximately 8 teleoconch whorls); whorls of the spire are wider; apertures of juveniles are longer; and spiral sculpture is much coarser. Characters of *L. sexcostatus* were discussed in **Remarks** for *L. hypsipettus*.

Nearly all of the specimens of *L. jucundus* reported here are from strata of acknowledged Pleistocene age. *Latirus jucundus* occurs with *L. cariniferus* at Belle Glade (Hoerle 1970) and South Bay, and it occurs with *L. maxwelli* along North New River Canal. McGinty (1970) reported that *L. jucundus* occurs with *L. maxwelli* at Ortona Lock, a contention supported by the specimens in lot UF 27646. However, most specimens from Ortona Lock that I found classified as *L. jucundus* in museum collections proved to be juveniles of *L. maxwelli*. The single collection of *L. jucundus* from Miami Canal, where it was found in a lot also containing a specimen of *L. caloosahatchiensis*, suggests that the typically Caloosahatchee-age deposits there are sometimes overlain by lenses of Bermont material. A similar exception involves the specimen (UF 24661) from Cochran Shell Pit, where most shells are of late Pliocene age.

Latirus (Polygona) maxwelli Pilsbry, 1939
(Figs. 89-97)

Latirus maxwelli Pilsbry, 1939: 86, pl. 5, fig. 9.

Description.--Shell solid, fusiform, umbilicate, to greater than 70 mm long, 30 mm wide. Protoconch unknown. Teleoconch of about 8 rounded whorls, constricted at sutures. Whorls of spire with 9 broad, well-rounded axial ribs crossed by 6-7 spiral cords, with 1-3 spiral threads between cords; sutural ramp slightly inflated, with 3-4 weak spiral cords. Body whorl with 9 swollen axial ribs most developed at shoulder, diminishing rapidly posteriorly; ribs crossed by 9-10 spiral cords, with 1-3 well-developed spiral threads between cords; sutural ramp inflated, with 1-2 low spiral cords and 3-4 strong spiral threads. Siphonal canal short, broad, anteriorly truncate; dorsum with 4-5 strong, oblique cords, single weak cords between strong cords, and single spiral threads between weak and strong cords; lip thin, elevated, attached ventrally along inner edge; umbilicus deep, varying from narrow to very wide. Aperture elliptical, constricted posteriorly by strong blunt tooth on parietal shield at anal sinus; outer lip crenulated by terminations of spiral cords, with 10-12 thin lirae within; inner lip thin, slightly elevated; columella straight, smooth, with 4-6 plicae emerging antero-obliquely from interior, 4 anterior plicae largest, subequal.

Type material.--Holotype 64.4 mm long, 27.3 mm wide; ANSP 13534.

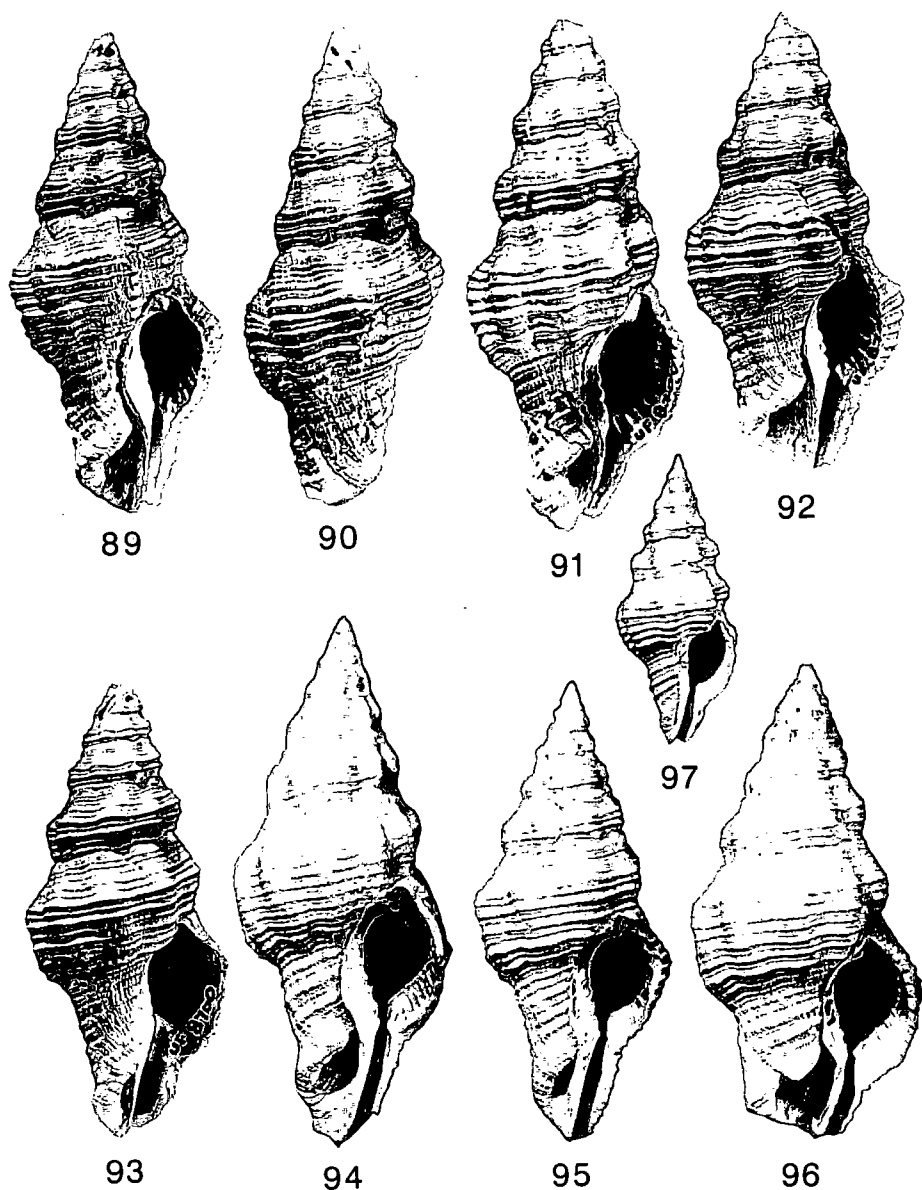
Type locality.--Ortona Lock, Glades County, Florida; by original designation (Pilsbry 1939). Ortona Lock is in Glades County, not in DeSoto County as reported by Pilsbry.

Other material.--6 specimens, 47.0-66.7 mm; Ortona Lock, Glades County; UF 8700.--1 specimen, 51.8 mm (spire broken); Ortona Lock; UF 8695.--3 specimens, 54.0-65.6 mm; Ortona Lock; TU 79.--28 specimens, 21.1-54.9 mm; north side of Caloosahatchee River, 3.2 km west of Ortona Lock (NE 1/4 Sec. 29, T42S, R30E), Glades County; TU 759 (27), UF 32441 (1).--33 specimens, 26.4 mm (both ends broken)-64.6 mm (spire broken); same location; TU 803.--2 specimens, 49.5 mm (broken), 52.4 mm; south side of Caloosahatchee River, 6.9 km west of Ortona Lock (SE 1/4 Sec. 25, T42S, R29E), Glades County; TU 802.--26 specimens, 42.7-65.7 mm; north side of Caloosahatchee River, 8.1 km west of Ortona Lock (NW 1/4 Sec. 36, T42S, R29E), Glades County; TU 767 (23), UF 32440 (3).--5 specimens, 54.1-67.7 mm (all broken); north side of Caloosahatchee River, 8.9 km west of Ortona Lock (NW 1/4 Sec. 35, T42S, R29E), Glades County; TU 768.--1 specimen, 46.8 mm; DeSoto Shell Pit, DeSoto County; FSBC F 37477.--2 specimens, 45.5, 51.2 mm; Griffin Brothers Shell Pit, 12.8 km west of U.S. Highway 27 at Broward County line, Palm Beach County; FSBC F 37479.--1 specimen, 59.6 mm; spoil along North New River Canal, Palm Beach County; FSBC F 37478.--3 specimens, 37.8-61.4 mm; Jacaranda West subdivision, Venice, Sarasota County; FSBC F 39528.--4 specimens, 56.4-69.9 mm (all with broken tips of spires); "Florida"; ANSP 58898, 58899, 62563, 62564.

Distribution.--Early Pleistocene; Bermont Formation; Sarasota, Glades, DeSoto, and Palm Beach counties, Florida.

Remarks.--The majority of specimens with specific locality data were collected from spoil along the Caloosahatchee River at or near Ortona Lock, the type locality. Some of those collections from spoil contain species from both the Caloosahatchee and Bermont formations, but, as noted by McGinty (1970), *Latirus maxwelli* is an index species for the early Pleistocene Bermont Formation. *Latirus maxwelli* is scarce at the DeSoto Shell Pit, as are *Haustellum anniae* and *Vasum floridanum*, two other species that McGinty (1970) identified as Bermont indicators. Other Bermont index taxa collected with *L. maxwelli* at the Jacaranda West subdivision near Venice include *Haustellum anniae*, *Melongena bispinosa*, *Fusinus watermani*, and *Turbinella hoerlei*.

The umbilicus of *Latirus maxwelli* is usually wide but varies even among specimens of similar size. The maximum length of >70 mm for the species is an approximation projected from the largest specimen (ANSP 58898), which has a broken spire.



Figures 89-97.--*Latirus maxwelli* Pilsbry. Figs. 89, 90.-HOLOTYPE, Ortona Lock (ANSP 13534). Figs. 91-93.- Ortona Lock (UF 8700). Figs. 94-96.- 8.1 km west of Ortona Lock, TU 767 (UF 32440). Fig. 97.- 3.2 km west of Ortona Lock, TU 759 (UF 32441). Figs. 89-97 x 1.

Pilsbry (1939:86) stated that *L. maxwelli* "is most nearly related to the living *Latirus trochlearis* and *L. mcgintyi* [both = *L. cariniferus*, fide Bullock 1974:71], but differs conspicuously by the profuse development of spiral sculpture and the weaker axial folds." The spiral sculpture of 9-10 cords on the body whorl indeed separates *L. maxwelli* from *L. cariniferus* (5 cords), *L. stephensae* (6 cords), and *L. nosali* (7 cords). Other features that distinguish *L. maxwelli* from those species include the strong parietal tooth, the thin axial lamellae on the sutural ramp, and the number of columellar plicae. Large specimens of the three species of *Latirus* s.s. may occasionally have a swelling near the posterior sinus; however, none has a distinct tooth there, and all have only four columellar plicae. In contrast, of the three largest specimens of *L. maxwelli*, two have a single small plication posterior to the first four plicae and one has two such additional plicae; smaller specimens have the usual complement of four plicae.

Latirus maxwelli most resembles *Latirus gurabensis* Maury, 1917 (= *L. brevicaudatus santodomingensis* Pilsbry, 1922) from the late Miocene to early Pliocene Gurabo Formation of the Dominican Republic, but the spiral cords of *L. maxwelli* are much more prominent than are those of *L. gurabensis*. The type specimen of *L. brevicaudatus santodomingensis* could not be located at the Academy of Natural Sciences of Philadelphia during May 1989, but according to Pilsbry (1922), the 57-mm-long type specimen differs from the Recent *L. brevicaudatus* (= *L. angulatus*) by having smaller, more numerous spiral cords. Bullock (1974) concurred with Pilsbry that *Latirus "angulatus" santodomingensis* is the closest relative of *L. angulatus*. He noted that *L. angulatus santodomingensis* also has a shorter, wider siphonal canal than *L. angulatus* and a sharp, rather than squarish, angulation of the axial ribs. The sharply angled ribs are evident on the body whorl and final whorl of the spire in Pilsbry's (1922: pl. 25, fig. 4) illustration, but the siphonal canal of the figured specimen seems no shorter or wider than that of the type of *L. brevicaudatus* figured by Bullock (1974: 75, fig. 23) or than those of most species of *Latirus* s.s. Actually, Pilsbry's illustration of *L. brevicaudatus santodomingensis* is virtually identical to the original illustration of *Latirus gurabensis* Maury (1917: pl. 13, fig. 4), except that the anterior portion of the siphonal canal of Pilsbry's specimen is broken off. The two taxa are almost certainly conspecific. In the relatively rough texture of the spiral sculpture, *L. maxwelli* resembles *L. anapetes* Woodring, 1964, a more slender species from the late Miocene to early Pliocene Gatun Formation of Panama. If the implied relationships among these three species are factual, then additional specimens of this lineage remain to be discovered in middle and late Pliocene deposits of Florida and the Caribbean Basin.

DISCUSSION

No species of *Latinus* is known to occur in the more temperate post-Miocene molluscan assemblages of northern Florida, South Carolina, North Carolina, and Virginia, nor is any species known to occur in the estuarine (and relatively more temperate?) faunas of the later Pleistocene Ft. Thompson and Coffee Mill Hammock formations of southern Florida. The absence of *Latinus* species in those deposits is not unexpected. In the Recent fauna of Florida, species of *Latinus* are most common in depths greater than 5-10 m, even at the more tropical southeastern coast and Florida Keys. *Latinus cariniferus* ranges northward off both Florida coasts, but usually as an element of the submerged tropical fauna in depths of 20-40 m. In the Caribbean Sea, where several species occur in shallow water, living *Latinus* are usually found in association with seaward coral reefs or on banks washed by clean oceanic waters. These observations indicate that species of *Latinus* are tropical organisms that have little tolerance for low temperatures or for the fluctuating environmental conditions of estuaries. Conditions similar to those in which *Latinus* live today probably prevailed in the middle Pliocene to early Pleistocene faunas where the Florida fossils occur.

Eight species of *Latinus* are now known from Pliocene and early Pleistocene deposits of Florida. Perhaps because of confusion as to their identities and because of their relative scarcity, species of *Latinus* have been conspicuously absent from most lists of typical taxa of the various stratigraphic units (e.g. Mansfield 1939; Dubar 1958a, 1962, 1974; Olsson 1964), except for that of McGinty (1970), who included *L. maxwelli* and *L. jucundus* as indicators of the Glades Unit (= Bermont Formation). However, because the species are now better known and because none of them seems to occur in more than one of the three principal stratigraphic units, all of the taxa should be useful index species for their respective units.

Two species, *Latinus nosali* and *L. miamiensis*, occur only in middle Pliocene Pinecrest beds of the Tamiami Formation. *Latinus nosali* is known only from the APAC Mine at Sarasota, where it is uncommon, and *L. miamiensis* has been collected only from the now inactive excavation site at Bird Road in Dade County and from Mule Pen Quarry in Collier County. Fewer species are known from Tamiami deposits than from the younger Caloosahatchee and Bermont formations. However, excavations into unlithified strata of middle Pliocene age are relatively uncommon in Florida, and additional species of *Latinus* may be revealed as more of those sites are excavated.

The late Pliocene Caloosahatchee beds contain three species: *Latinus stephensae*, *L. caloosahatchiensis*, and *L. hypsipetius*. The three species occur together at several locations (e.g. Cochran Shell Pit, DeSoto Shell Pit, Mule

Pen Quarry, and Miami Canal), and all have also been collected northward into Sarasota County (*L. hypsipettus* and *L. caloosahatchiensis*, APAC Mine) and Pinellas County (*L. hypsipettus* and *L. stephensae*, North St. Petersburg).

The early Pleistocene Bermont Formation also contains three species: *Latirus maxwelli* from Ortona Lock, the DeSoto Shell Pit, and Sarasota and Palm Beach counties; *L. cariniferus* from Belle Glade and South Bay; and *L. jucundus* from various locations in Palm Beach, Broward, Okeechobee, Glades, and Hendry counties. The stratigraphic situation of *L. maxwelli* is uncertain. The species was described from specimens collected from excavation spoil, presumably of Bermont age, at Ortona Lock. Although McGinty (1970) considered the Ortona Lock fauna to be contemporary with that of the "Glades Unit" at Belle Glade, the two faunas are somewhat dissimilar. *Latirus maxwelli* is considerably more common in Glades County than elsewhere, whereas *L. jucundus* is most common in Palm Beach County and *L. cariniferus*, as a fossil, is known only from that county. Petuch (1988: 118) contends that the Bermont Formation spans two interglacial stages, the Aftonian and the Yarmouth, which were separated by the Kansan Glacial Stage. Although it is possible that each assemblage represents the fauna of a different interglacial stage, it is more likely that the Ortona Lock and "Glades" assemblages simply represent different facies of a single contemporaneous fauna.

Twelve specific or subspecific names have been proposed for Miocene to Pleistocene fossil *Latirus* from the Caribbean Basin. These taxa seem to constitute nine valid species of *Latirus* and one muricid, as follows: *Latirus elongatus* Gabb (= *L. angustatus* Gabb), from strata of unknown age but presumed to be the early to middle Miocene (fide Saunders et al. 1986) Baitoa Formation of the Dominican Republic; *L. fusiformis* Gabb and *L. gurabensis* Maury (= *L. brevicaudatus santodomingensis* Pilsbry), from the late Miocene to early Pliocene (fide Vokes 1979, Saunders et al. 1986) Cercado and Gurabo formations of the Dominican Republic; *L. anapetes* Woodring, from the Chagres Sandstone of the late Miocene to early Pliocene Gatun Formation of Panama and probably from Miocene deposits at the Paraguana Peninsula, Venezuela (Jung 1965); *L. taurus* Olsson, from the late Miocene to early Pliocene Limónes Formation at Toro Cays, northwestern Panama (see Vermeij and Collins 1988 for estimated age of that formation); *L. nematus* Woodring, 1928, from the early Pleistocene Bowden Formation of Jamaica; *L. infundibulum polius* Woodring, 1928, from Bowden and probably from the early Pleistocene Moín Formation at Limón, Costa Rica (Woodring 1928: 254); and *L. infundibulum infundibulum* (Gmelin) (see comments in Woodring 1928) and *L. irazu* Olsson, both from the Moín Formation at Limón.

Latirus (Polygona) recticanalis Weisbord, 1962, was described from the Pleistocene Mare and Playa Grande formations of northern Venezuela. The description was based upon two small (15, 17 mm) shells that, in Weisbord's

illustrations (1962: pl. 30, figs. 17, 18), more resemble a muricid than a fascioliid. Weisbord's statement "Columella with five plaits diminishing in strength anteriorly" would seem to support his placement of the species in *Latirus*. However, the shells have very coarse sculpture compared to other species of *Latirus*; the body whorl bears 7 wide, swollen axial ribs crossed by about 11 strong spiral cords, of which the 2 cords nearest the shoulder are remarkably developed. Petuch (1987) reassigned *L. recticanalis* to *Panamurex* Woodring, 1959 (Muricidae) and reported the species to be living in the Gulf of Venezuela.

Perrilliat Montoya (1963: pl. 5, figs. 13, 14) illustrated a specimen of an additional species of *Latirus* from the Pliocene Agueguexquite Formation at Coatzacoalcas, Mexico, near the southwestern coast of the Gulf of Mexico. The two photographic illustrations are back and side views of a 35-mm-long broadly fusiform shell with wide, swollen axial ribs crossed by 7 or 8 equal-sized spiral cords and about 6 additional cords on the anterior canal. The outer lip is broken back to reveal at least 3 strong plicae on the columella. Perrilliat Montoya evidently meant the figures to represent the turrid species she reported as *Fusiturricula panola* Woodring, 1928, but she confused her figures 11-14, both in the text and in the plate legend, ascribing figs. 11 and 14 to *F. panola* and figs. 12 and 13 to *Crassispira perrugata* (Dall, 1890), another species of Turridae. Additional specimens of this unnamed *Latirus* have been found in the collections at Tulane University. Because the species is not closely related to any of those discussed here, it will be treated elsewhere.

The status of several other of the Neogene Caribbean taxa is uncertain. Pilsbry (1922) proposed that *L. angustatus* was merely a juvenile of *L. elongatus*, and my inspection of the type specimens supports that proposal (see **Remarks** for *L. miamiensis*), but both type specimens are damaged. Comparison of undamaged specimens may reveal them to be separate species.

Petuch (1981) reported Recent specimens, collected from 60-100 m depths off Venezuela, that he identified as *Latirus anapetes*, a species otherwise known only from late Miocene to early Pliocene deposits. Although similar in some respects to *L. anapetes*, the axial ribs of Petuch's illustrated specimen (1981: figs. 49, 50) are so strongly developed posteriorly that they virtually obscure the sutural ramp, whereas the ribs of *L. anapetes* slope gently from the exposed sutural ramp to the periphery of each whorl. Although this difference may seem minor, it creates a markedly different appearance between the fossil and Recent shells. Consequently, I suspect that Petuch's specimens represent an undescribed Recent species descended from the Mio-Pliocene *L. anapetes*.

Bullock (1974) described *Latirus (Polygona) bemaensis*, a Recent species from Barbados that he distinguished from *L. infundibulum*. Bullock's illustration (1974: fig. 13) of the holotype of *L. bemaensis* is virtually identical to the illustration of the holotype of *Latirus (Polygona) infundibulum polius* Woodring (1928: pl. 15, figs. 4, 5), and I consider them to represent a single

species, for which Woodring's name has priority. Consequently, *L. polius* is considered a species distinct from *L. infundibulum*, with which it seems to have occurred sympatrically in the Pleistocene beds of Costa Rica (fide Woodring 1928). According to Vokes (1938), Rutsch (1942), and Jung (1969), a form of *Latinus* in the late Miocene Springvale Formation of Trinidad is intermediate between *L. infundibulum* and *L. polius*. That ancestral form may have produced both of the later species, perhaps during the Pliocene.

Most of the Neogene species of *Latinus* from the Caribbean Basin belong to the subgenus *Polygona*. The oldest species, *L. elongatus* and perhaps *L. fusiformis* from the Miocene and early Pliocene of the Dominican Republic, belong to the lineage that later produced the middle Pliocene *L. miamiensis* and late Pliocene *L. caloosahatchiensis* of Florida and *L. virginensis* of the Recent Caribbean fauna. Another Mio-Pliocene group, known from the Dominican Republic, Panama, and Venezuela, contains *L. gurabensis* and *L. anapetes*, and one of those species may be ancestral to *L. maxwelli* of the early Pleistocene of Florida. The only Caribbean fossil species related to the *L. sexcostatus*-*L. hypsipetthus*-*L. jucundus*-*L. angulatus* (Eocene to Recent) lineage of the southeastern United States is *L. irazu* from the early Pleistocene of Costa Rica; as noted earlier, *L. irazu* might be conspecific with *L. angulatus*. The early Pleistocene to Recent species *L. polius*, *L. infundibulum*, and *L. nematus* are not known from fossil strata in southern Florida.

There are few Caribbean fossil species of *Latinus* s.s. *Latinus taurus*, from late Miocene and early Pliocene deposits of Panama, belongs to the lineage that subsequently produced the late Pliocene *L. stephensae* of Florida and the Pleistocene and Recent *L. cariniferus* of Florida and the Caribbean Sea.

Eleven species of *Latinus* are now recognized in the Recent fauna of the Caribbean Region (exclusive of Brazil). *Latinus cariniferus*, *L. angulatus*, and *L. infundibulum* occur in southeastern Florida and throughout the Caribbean Sea; *L. nematus* occurs in southeastern Florida and the northern Caribbean Sea; *L. virginensis* occurs in the Bahama Islands and throughout the Antilles; *L. macmurrayi* Clench and Aguayo, 1941, and *L. varai* Bullock, 1970, are known only from deep waters (183-348 m) off Cuba; *Latinus* cf. *anapetes* of Petuch (1981) is known only from 60-100 m depths off Venezuela; *L. polius* occurs from Barbados to Brazil (Petuch 1979); *L. eppi* is known only from the southern Netherlands Antilles; and *L. martini* is known only from Honduras in the western Caribbean Sea. The species reported as *Latinus hartvigii* (Shuttleworth, 1856) from the Greater Antilles and the Virgin Islands by Abbott (1974) is actually a species of *Fusinus* Rafinesque, 1815. Other Caribbean species previously classified in *Latinus* by Melvill (1891, 1911) (i.e. *Latinus cayohuesonicus* Sowerby, 1878; *L. funebris* Preston, 1907; *L. ernesti* Melvill, 1910) are now classified in *Teralatinus* Coomans, 1965 (Jong and Coomans 1988), a genus related to *Dolicholatinus* Bellardi. These genera do not belong in the Peristerniinae.

Of the four species of *Latinus* that occur in the Recent fauna of Florida, *L. cariniferus*, *L. infundibulum*, and *L. nematus* are also known as Pleistocene fossils at various Caribbean locations, and *L. angulatus* will also be known as a Pleistocene Caribbean fossil if it and *L. irazu* prove to be conspecific. Of those same four species, only *L. cariniferus* is known from Pleistocene deposits of south Florida, although *L. angulatus* seems to be represented there by the similar *L. jucundus*. This suggests either that *L. infundibulum* and *L. nematus* arrived in Florida relatively recently, or that those species may eventually be found in south Florida Pleistocene deposits. *Latinus polius*, the only other Recent species of the Caribbean fauna that is also known as a fossil, occurs in Pleistocene deposits of Jamaica and Costa Rica but is known living only from the southeastern Caribbean Sea to northeastern South America.

Among the Recent species that lack fossil records, *Latinus virginensis* ranges northward as far as the Bahama Islands and is very similar to the Florida late Pliocene *L. caloosahatchiensis*. However, the lineage that produced those species has existed in the Caribbean Basin for a very long time, as is evidenced by the Florida middle Pliocene *L. miamiensis* and the several Mio-Pliocene species from the Dominican Republic. *Latinus virginensis* may have evolved directly from *L. caloosahatchiensis*, or, alternatively, each could represent a separate divergence from *L. miamiensis* or from the earlier Dominican Republic species.

Of the remaining four Recent species in the Caribbean fauna, two (*L. eppi* and *L. martini*) have very restricted distributions in shallow waters of the southern and western regions of the Caribbean Sea, respectively, and the other two (*L. macmurrayi* and *L. varai*) are known only from relatively great depths off Cuba. Nothing is known of the ancestry of those species.

Petuch (1982c) described a biogeographic phenomenon that he called "paraprovincialism," wherein an abrupt shift in species composition results in mutually exclusive distributions for each member of a closely related molluscan species-pair (sibling species). To qualify as paraprovincial, each member of a Recent allopatric species-pair must be descended from similarly allopatric Pliocene species-pairs. Petuch listed 17 Recent species-pairs from the northern (n) and southern (s) Caribbean Region to support his hypothesis, including three in Fascioliariidae: *Latinus cariniferus* (n) and *L. bernadensis* (s); *Dolicholatinus cayohuesonicus* (n) and *D. ernesti* (s); and *Leucozonina ocellata* (Gmelin, 1791) (n) and *Leucozonina lineata* Usticke, 1969 (s). Petuch related his Recent *Latinus* species-pair to *L. tessellatus* and *L. anapetes*, respectively, that had lived in the northern Caloosahatchian and southern Gatunian provinces.

Neither the interspecific relationships nor the distributions of Petuch's fascioliariid examples support paraprovincialism. *Latinus cariniferus* occurs throughout the Caribbean Basin (Bullock 1974), not just in the northern part, and its ancestry includes the late Pliocene *L. stephensae* of the Caloosahatchee

Formation, the middle Pliocene *L. nosali* of the Tamiami Formation, and the Mio-Pliocene *L. taurus* of the Gatun Formation of Panama. *Latirus bernadensis* (= *L. polius*) occurs from the Lesser Antilles to Brazil in the Recent fauna (Petuch 1979) but has a fossil record in Costa Rica and Jamaica. The relationship of *L. polius* to *L. cariniferus* is so remote that the species are classified in different subgenera. Instead, *L. polius* is closely related to *L. infundibulum*, which, like *L. cariniferus*, occurs in both the northern and southern Caribbean Sea. *Latirus tessellatus* Dall (= *L. caloosahatchiensis*) and *L. anapetes* are not closely related to each other or to *L. cariniferus* or *L. polius*. The species in Petuch's *Dolicholatinus* example (actually *Teralatinus*) also lack paraprovincial distributions: *T. cayohuesonicus* occurs from Florida to Panama and Suriname, and *T. ernesti* occurs from the southern Caribbean Sea northward to Isla Mujeres, Mexico (Coomans 1965). Finally, Faber (1988) concluded that *Leucozonina lineata* Usticke, named by Usticke (1969) as a variety of *L. ocellata* (and thus unavailable: International Code of Zoological Nomenclature, third edition, 1985, Article 16), is not separable from *L. ocellata*.

At least six Recent species of *Latirus* have been reported to occur in Brazil (Bullock 1974; Petuch 1979, 1986b; Rios 1985). *Latirus ogum* Petuch 1979, described from the Abrolhos Archipelago, and *L. vermeiji* Petuch 1986, described from Fernando de Noronha, are known only from their type localities. Rios (1985) reported *L. cariniferus*, *L. angulatus*, *L. ogum*, *L. virginensis*, and *L. infundibulum* from Brazil. His comments (1985: 107) indicate that he considered *L. bernadensis* to be a color form of *L. infundibulum*. It is uncertain which form Rios was reporting, but *L. bernadensis* has been previously reported from Brazil (Petuch 1979). Bullock (1974: 76) noted that Brazilian specimens of *L. angulatus* have "very heavy spiral sculpture and a relatively small aperture"; his illustration (1974: fig. 20) depicts those differences and also seems to indicate more numerous spiral cords. Rios' illustrated specimen of *L. angulatus* (1985: pl. 36, fig. 468) seems to be a juvenile of the form illustrated by Bullock. Brazilian specimens that Rios illustrated as *L. cariniferus* and *L. infundibulum* do not much resemble those species and, in fact, cannot be related to any Caribbean species, fossil or Recent. His illustration of *L. virginensis* is of a relatively shorter, broader shell than the typical Caribbean form, so its identity is also uncertain. Together, these differences indicate a high degree of endemism among Brazilian species of *Latirus*, an expectable condition considering the relatively restricted distributions of the fossil and Recent species from Florida and the Caribbean Region.

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