INFORMATION CIRCULAR 46

UPPER EOCENE AND OLIGOCENE PECTINIDAE OF GEORGIA AND THEIR STRATIGRAPHIC SIGNIFICANCE

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Sam M. Pickering, State Geologist and Division Director

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ILLUSTRATIONS

UPPER EOCENE AND OLIGOCENE PECTINIDAE OF GEORGIA AND THEIR STRATIGRAPHIC SIGNIFICANCE

by

Lloyd N. Glawe[1]

ABSTRACT

Eight pectinid species of the Upper Eocene and Oligocene of Georgia are re-described, illustrated, and evaluated in terms of their stratigraphic usefulness. The species most useful stratigraphically in Georgia are *Amusium ocalanum* Dall, *Chlamys (Aequipecten) clinchfieldensis* Harris, *Chlamys (Aequipecten) cocoana* Dall, and *Chlamys (Aequipecten) spillmani* (Gabb) which are restricted to the Upper Eocene deposits, and *Chlamys (Anatipopecten) anatipes* (Morton) and *Chlamys (Lyropecten) duncanensis* (Mansfield) which are restricted to the Oligocene deposits. *Chlamys spillmani* (Gabb) var. *clinchfieldensis* Harris is made a full species, as *Chlamys (Aequipecten) clinchfieldensis*, and is interpreted as being a direct ancestor of *Chlamys (Aequipecten) spillmani* (Gabb).

INTRODUCTION

Although the Upper Eocene and Oligocene pectinids of Georgia have been previously described in the literature (Tucker-Rowland, 1936; Harris and Palmer, 1946; Harris, 1951), no recent attempt has been made to evaluate their stratigraphic significance. The main thrust of this study is to revise the systematic paleontology and to evaluate the stratigraphic significance of the Upper Eocene and Oligocene pectinids of Georgia. The systematic paleontological study for each species includes: an abbreviated synonomy, the original description, a more complete description if needed, dimensions of the type, occurrence in Georgia, distribution elsewhere in the southeastern United States, and remarks pertaining to the species or to closely related species. Interpretation of the stratigraphic significance of the Georgia pectinid species is based on comparisons made with pectinid material in my collection from Louisiana, Mississippi, Alabama, Florida, and South Carolina.

[1] Northeast Louisiana University

Abundant pectinids were collected from fourteen localities in the Gulf and Atlantic Coastal Plain Province of Georgia (Fig. 1). Since the interpretation of the stratigraphic significance of any fossil group is dependent on local and regional stratigraphic usage, measured and described sections of key exposures are included in Appendix B. The inferred relationships of the Upper Eocene and Oligocene stratigraphic units of the southeastern United States are shown in Figure 2.

The stratigraphic usage in Georgia is presently undergoing a complete re-evaluation in preparation for a new geologic map of Georgia. In order to render the stratigraphy of this report more meaningful to future workers, some comments about some of the stratigraphic terms to be used in Georgia follow:

1. In central Georgia a sandy limestone unit occurs between the relatively pure quartz sand of the Clinchfield and the bioclastic limestone of the Ocala. The sandy limestone in this report is referred to the Clinchfield Sand (see Appendix B, sections I, II, and III).
2. The Ocala Limestone of central Georgia has in the past been referred to the Tivola limestone (Cooke and Shearer, 1918).
3. The white limestone ("chimney rock") exposed on the west bank of the Ocmulgee River at Lower City Park, Hawkinsville, Georgia, is referred to the Marianna Limestone. Lithologically the unit is very similar to the Marianna Limestone at its type locality at Marianna, Florida. Previously this locality has been referred to the Glendon (Brantley, 1916), Suwannee Limestone (Cooke, 1943), and Byram Formation equivalent (Herrick, Pickering, and Sachs, 1968).

ACKNOWLEDGMENTS

The writer is sincerely grateful to Mr. Sam M. Pickering, Jr., Director, and Mr. Paul Huddlestun, Georgia Department of Natural Resources, Earth and Water Division for their assistance throughout this investigation. Mr. Pickering introduced me to

the Georgia pectinids by personally escorting me to many of the fossil localities; Mr. Huddlestun joined me in the detailed collecting of fossil material and gave me invaluable assistance in recognizing the stratigraphic units in Georgia. In addition, I particularly wish to acknowledge the helpful criticism and review in the final preparation of this paper by Dr. H. E. Vokes (Tulane University), Dr. H. R. Cramer (Emory University), and Dr. L. D. Toulmin (Florida State University).

Thanks are due Mr. Alvin M. Phillips, Museum of Geoscience, Louisiana State University, for the loan of pectinid reference material. Special thanks are due my wife, Nancy, for assistance in most phases of the study.

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SYSTEMATIC PALEONTOLOGY

Class BIVALVIA Linnaeus, 1758

Subclass PTERIOMORPHIA Beurlen, 1944

Order PTERIOIDA Newell, 1965

Suborder PTERIINA Newell, 1965

Superfamily PECTINACEA Rafinesque, 1815

Family PECTINIDAE Rafinesque, 1815

Genus *AMUSIUM* Roding, 1798

Amusium ocalanum Dall
Pl. 1, figs. 1-6, 10.

Pecten (Amusium) ocalanus Dall, 1898, Wagner Free Inst. Sci. Trans., v. 3, p. 756, Pl. 29, Fig. 2.

Amusium ocalanum Dall: Harris, 1951, Bull. Amer. Paleont., v. 33, no. 138, p. 10, Pl. 5, Figs. 3-5

DESCRIPTION.—Dall's original description:

"Shell of moderate size, nearly equivalve, quite inequilateral, moderately convex; right valve with the disk nearly smooth, posterior margin produced; ears subequal, nearly smooth, their outer angles a little raised, so that the cardinal margins form a very obtuse angle at the beak; byssal sinus represented by a marked flexure but not a distinct notch; left valve similar, slightly more convex, with about eighteen obsolete rounded ribs separated by narrow, shallow grooves, sharpest near the beak, radiating nearly to the basal margin but becoming less visible there and at the submargins; ears vertically striated, subequal; interior of the disk with about twenty-one pairs of well-marked lirae similar in each valve; hinge with developed cross-striated cardinal crura, auricular crura present; margins of the valves smooth, not crenulated.

The fossils vary from nearly smooth to obviously ribbed; the byssal sinus is more distinct than in the other species and sometimes verges on a notch, and there is a perceptible byssal fasciole."

DIMENSIONS.—Holotype, height 35 mm, width 35 mm, from Levy County Florida.

OCCURRENCE IN GEORGIA.—Common in Ocala Limestone at Muckafoonee Creek below dam near Albany (locality 26); reported from Ocala Limestone at Kinchafoonee Creek near Albany (Harris, 1951); rare in Ocala Limestone at abandoned quarry, Oakland Plantation near Albany (locality 25); rare in Ocala Limestone at Medusa Portland Cement Company quarry, Clinchfield (locality 29), and rare in Cooper Marl at Sugar Hill, 6 miles northeast of Unadilla (locality 30).

DISTRIBUTION ELSEWHERE IN THE SOUTHEASTERN UNITED STATES.—*Amusium ocalanum* is common in the Upper Eocene of Florida (Ocala Limestone) and is rare to common in the Upper Eocene of Alabama (Shubuta Marl and Ocala Limestone).

Genus *CHLAMYS* Roding, 1798

Subgenus *AEQUIPECTEN* Fischer, 1886

CHLAMYS CLINCHFIELDENSIS Stock

DIAGNOSIS.—Eastern North American Eocene chronospecies of the genus *Chlamys* characterized by relatively small (height up to 50 mm), orbicular to suborbicular, nearly equivalved shells, with smooth ribs in the early stages that are progressively more lirate with ontogenetic and phylogenetic development.

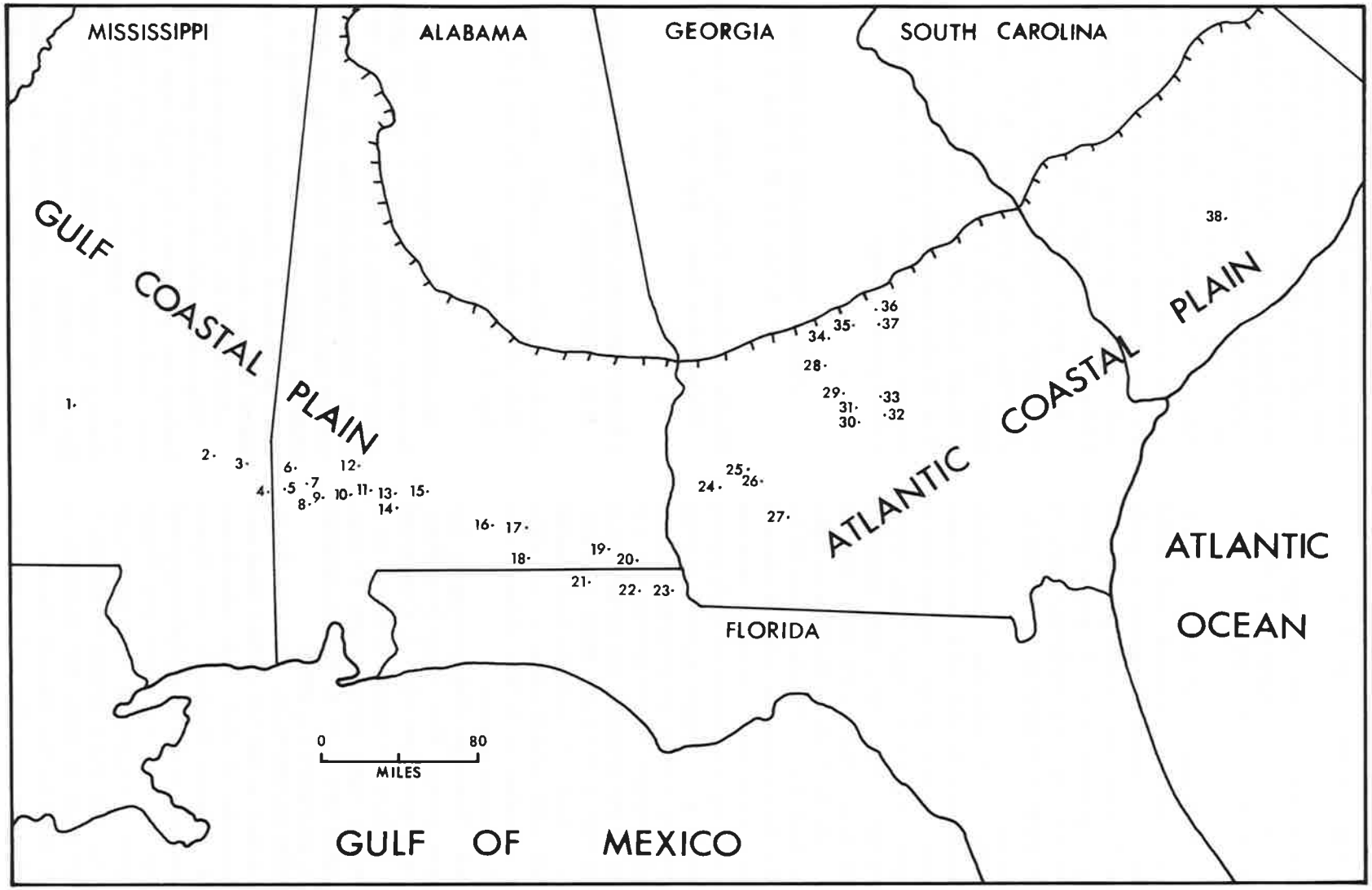

Figure 1. Index map of some important Upper Eocene and Oligocene pectinid localities in the Gulf and Atlantic Coastal Plains of the southeastern United States. Numbers refer to the register of localities in Appendix A. Measured sections for localities 24, 27, and 34-36 are in Appendix B.

Chlamys (Aequipecten) clinchfieldensis Harris
Pl. 1, figs. 7-9; Pl. 2, figs. 6, 9.

Chlamys spillmani (Gabb), var. *clinchfieldensis* Harris, 1951, Bull. Amer. Paleont., v. 33, no. 138, p. 10, Pl. 4, figs. 4-7; Pl. 5, fig. 1.

DIAGNOSIS.—Populations of the *C. clinchfieldensis* stock containing smooth and multilirate-ribbed forms in which 25 percent or more of the individuals have smooth ribs prior to the 25 mm-in-height growth stage. It differs from *Chlamys nupera* (Conrad) in lacking faint lirations on the ribs and interspaces prior to the 25 mm-in-height growth stage.

DESCRIPTION.—Shell orbicular, moderately thick; small; maximum height 45.6 mm (mean height 27.9 mm); nearly equally convex valves; hinge line slightly concave in right valve, nearly straight in left valve; ribs fairly high, rounded, usually smooth, occasionally with lirae near the ventral margin; ribs as wide as interspaces; right and left valves with 21 to 25 ribs (mean 22.4); lirae develop in pairs on opposite sides of ribs and may extend into interspaces; concentric lamellae closely spaced and slightly sinuous in adult part of disk. Ears fairly large, subequal, anterior portion longer than posterior portion, prominently striated with 4 to 6 radial threads on the anterior ear, 4 to 7 radial threads on the posterior ear; byssal notch deep; ctenolium with 2 or 3 teeth. Hinge with provinculum, 1 or 2 pairs of cardinal crura; resilial pit rather small with lateral ridges in the right valve. Interior of valves with faint internal ribs fluted along the ventral margin.

DIMENSIONS.—Holotype (Paleontological Research Institution, Ithaca, New York) from Pennsylvania Cement Corporation Plant 2, Clinchfield quarry (now Medusa Portland Cement Co.), Clinchfield, Georgia, right valve: height 47 mm, length 46 mm (*fide* Mrs. K. V. W. Palmer, personal communication, December 31, 1973).

OCCURRENCE IN GEORGIA.—*Chlamys clinchfieldensis* is common in the Clinchfield Sand and the Ocala Limestone at Rich Hill, abandoned quarry located between Knoxville and Byron (locality 34); common in the Clinchfield Sand and Ocala Limestone at Area 22 kaolin pit, Huber (locality 35); rare in Clinchfield Sand and Ocala Limestone at Georgia Rock Products Company quarry near Arlington (locality 24); common in the Clinchfield Sand at the Georgia Kaolin Co. mine near Gordon (locality 36); and common in the Clinchfield Sand and lower part of the Ocala Limestone at the Medusa Portland Cement Company quarry near Clinchfield (locality 29).

DISTRIBUTION ELSEWHERE IN THE SOUTHEASTERN UNITED STATES.—*Chlamys clinchfieldensis* is known from Moodys Branch Marl (Upper Eocene) localities across the state of Alabama. It is rare at Double Bridges Creek, about 8 miles north of Geneva (locality 19), common in a road cut about 2 miles west of Silas (locality 7), and common in a road cut 3.9 miles west of Gilbertown, Alabama (locality 6).

REMARKS.—Because of the evolutionary development of liration on the ribs in *C. clinchfieldensis*, shells from older beds generally will have all smooth ribs. Samples of shells from younger beds will not only have a larger proportion of specimens with lirae on the ribs, but the average development of lirae will appear at an earlier growth stage.

Chlamys (Aequipecten) spillmani (Gabb)
Pl. 3, figs. 1-3; Pl. 4, figs. 1, 3.

Pecten spillmani Gabb, 1860, Acad. Nat. Sci. Philadelphia Jour., 2nd ser., v. 4, p. 402, Pl. 68, fig. 3.

Chlamys spillmani Gabb: Harris and Palmer, 1946, Bull. Amer. Paleont., v. 30, p. 27, Pl. 6, figs. 3-8.

Chlamys spillmani (Gabb), vars.: Harris, 1951, Bull. Amer. Paleont., v. 33, no. 138, p. 9, Pl. 4, figs. 1-3, Pl. 5, fig. 1.

DIAGNOSIS.—Populations of the *C. clinchfieldensis* stock containing smooth and multilirate-ribbed forms in which more than 75 percent of the individuals have lirae on the ribs prior to the 25 mm-in-height growth stage. It differs from *Chlamys nupera* (Conrad) in having a coarser, more pronounced ornamentation on the main and lateral lirae on the ribs.

DESCRIPTION.—Gabb's original description:

"Equivalve, orbicular; surface marked by about twenty-two radiating ribs, each with one or two very small ones on each side, and with the crests of all minutely granulous; alations ? (both ears are broken in the specimen before me). Locality, Eocene, Alabama. Dr. Spillman."

Shell orbicular, suborbicular in unusually large specimens, small, maximum height 39.5 mm (generally about 30 mm), maximum length 43.6

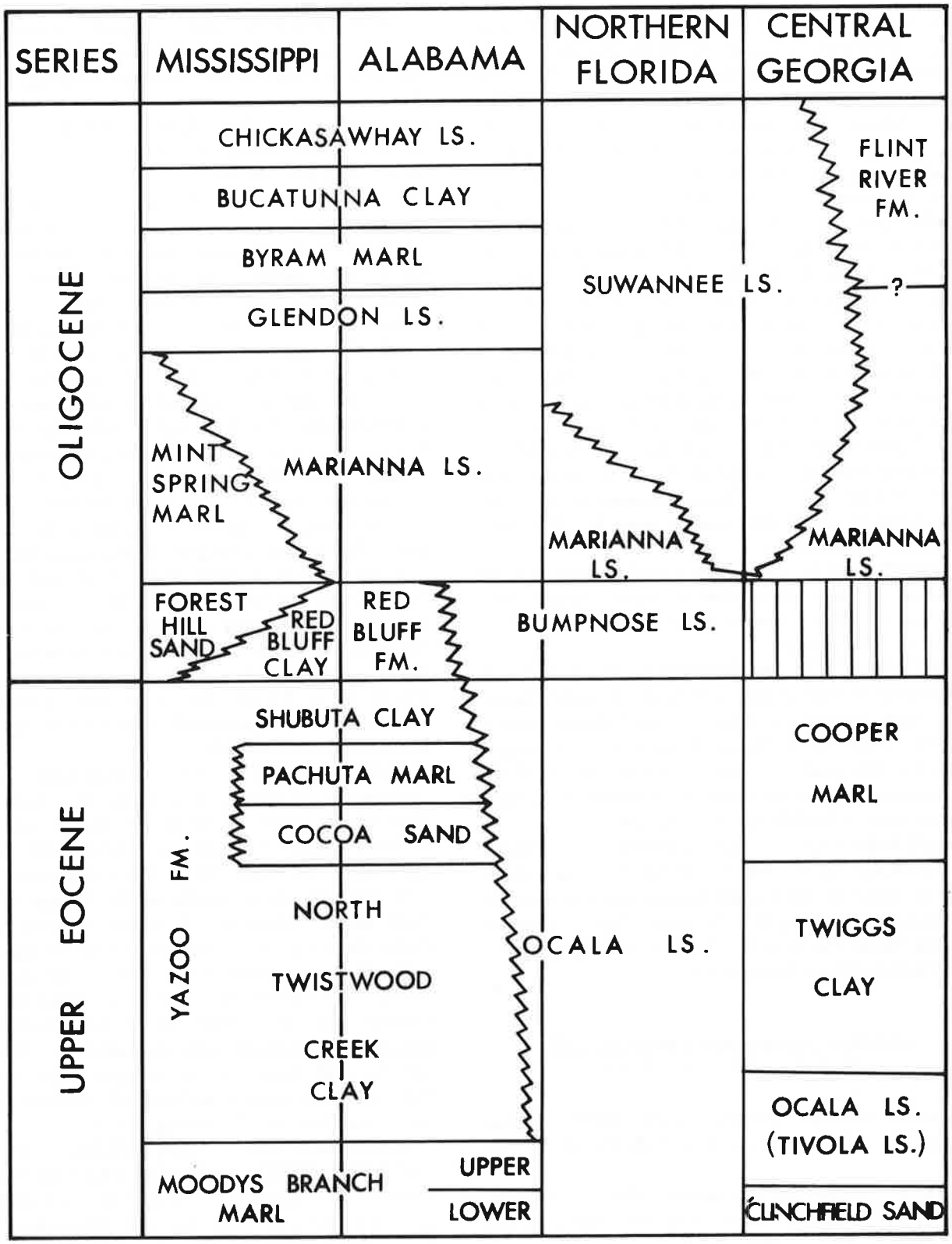

Figure 2. Correlation chart of stratigraphic terminology for the Upper Eocene and Oligocene formations of the southeastern United States. After Glawe, 1969.

mm (generally about 30 mm), mean height and length 22.2 mm, moderately thick, equally convex valves; hinge line slightly concave in right valve, nearly straight in left valve; ribs near beak are low and smooth, then lateral lirae are added on the sides of ribs and increase in numbers with increase in size of shell, lirae extend into interspaces on large specimens; concentric lamellae crossing lirae exhibit pronounced outgrowths; right valve with 22 to 26 ribs (mean 23.7), left valve with 21 to 26 ribs (mean 23.3). Ears fairly small, subequal, anterior ear longer than posterior ear, prominently striated with 4 to 9 radial threads; byssal notch deep; ctenolium with 2 to 4 teeth exposed. Hinge with provinculum and 2 pairs of cardinal crura; resilial pit with ridge along anterior margin in the right valve. Interior of valves with faint internal ribs fluted along the ventral margin. Description based primarily on 100 specimens from the Pachuta Marl Member of the Yazoo Formation at Lone Star Cement Company quarry near St. Stephens, Alabama (locality 9).

DIMENSIONS.—Holotype (Academy of Natural Sciences, Philadelphia) double valve: height 28.1 mm, length 29.0 mm, convexity 12.5 mm, from Shubuta, Mississippi.

OCCURRENCE IN GEORGIA.—Rare in Ocala Limestone at abandoned quarry on Oakland Plantation near Albany (locality 25) and along Muckafoonee Creek below Power Plant dam near Albany (locality 26), and common in upper part of Ocala Limestone at Medusa Portland Cement Company quarry near Clinchfield (locality 29).

DISTRIBUTION ELSEWHERE IN THE SOUTHEASTERN UNITED STATES.—Very abundant in most of the Upper Eocene calcareous units of eastern Mississippi (Pachuta Marl), Alabama (Cocoa Sand, Pachuta Marl, and Ocala Limestone), and Florida (Ocala Limestone).

Chlamys (Aequipecten) cocoana Dall
Pl. 2, figs. 1-5, 7, 8, 10, 11.

Pecten (Chlamys) cocoanus Dall, 1898, Wagner Free Inst. Sci. Trans., v. 3, p. 738, Pl. 34, fig. 23.

Chlamys (Chlamys) cocoanus Dall: Tucker-Rowland, 1936, Amer. Midland Nat., v. 17, p. 1001, Pl. 7, figs. 7, 8.

Chlamys cocoana Dall: Harris and Palmer, 1946, Bull. Amer. Paleont., v. 30, no. 117, p. 32, Pl. 8, fig. 10.

DESCRIPTION.—Dall's original description:

"Jacksonian Eocene of Red Bluff, Mississippi, and Cocoa Post Office, Choctaw County, Alabama; Burns.

Shell small, thin, flattish, oblique, produced behind, with about twenty-five small, low entire ribs, rounded above, and about fourteen interstitial single smaller threads, the tops of all of which are somewhat sparsely concentrically imbricated, the interspaces showing only incremental lines; ears quite unequal, small, the posterior smaller, each with five or six low, hardly scaly radii; inside of the valve obsoletely channeled, the cardinal crura developed. Alt. 23, lat. 23 mm.

This shell differs from *P. membranosus* by its entire and less numerous ribs, and from *P. wahtubbeanus* by its greater obliquity, its entire, less conspicuous, and less densely imbricated ribs."

The above description by Dall is based solely on the holotype, a small, worn left valve. Throughout Alabama this species is usually small and worn, generally having a height of less than 20 mm. In left valves at a growth stage of 10 mm from the beak, there are about 19 to 30 low, primary ribs and 10 to 20 smaller ribs that are added by intercalation. At a distance of 10 mm from the beak in right valves, there are 23 to 30 primary ribs of which 3 to 13 of these ribs have increased by bifurcation. Well preserved, unworn specimens have imbricated external ribs.

OCCURRENCE IN GEORGIA.—*Chlamys cocoana* is common and unusually large in the Clinchfield Sand at Area 22 kaolin pit, Huber (locality 35); common in Clinchfield Sand at Rich Hill, 4.7 miles SE of Knoxville (locality 34); rare and usually as molds in the Twiggs Clay in a ditch along Interstate 75, about 4 miles south of Perry (locality 28); common in the Twiggs Clay at a kaolin mine near Clear Creek, about 5 miles south of Gordon (locality 37); common in the Cooper Marl at a road cut 4 miles northeast of Hayneville (locality 33) (Locality 7 - Pickering, 1970); and common in Cooper Marl at Sugar Hill, about 6 miles northeast of Unadilla (locality 30) (Locality 25 - Pickering, 1970).

DISTRIBUTION ELSEWHERE IN THE SOUTHEASTERN UNITED STATES.—*Chlamys cocoana* is known from Upper Eocene and Oligocene localities in Alabama and Mississippi: Cocoa Post Office, Choctaw County, Alabama, Type; rare in Moodys Branch Marl, 3.9 miles west of Gilbertown (locality 6), and west bank of Tombigbee River, 100 yards north of quarry at St. Stephens, Alabama (locality 9); common in Cocoa Sand,

2.9 miles north of Grove Hill, Alabama (locality 12); common in upper Ocala Limestone, 1.6 miles southwest of Perdue Hill, Alabama (locality 14); and very rare in the basal Red Bluff at Hiwannee, Mississippi (locality 3), and at Little Stave Creek, Jackson, Alabama (locality 10).

Chlamys cocoana has been reported from the Cooper Marl (Oligocene) of South Carolina (Cooke and MacNeil, 1952). My collection from the Cooper Marl at the Carolina Giant Cement Corporation quarry 2 miles north of Harleyville, South Carolina (locality 38) contains a small species of *Chlamys* similar to *Chlamys cocoana* but is probably an unnamed species. More study on this South Carolina species is needed.

REMARKS.—Thirty-nine specimens of *Chlamys cocoana* from the Clinchfield Sand near Huber, Georgia, and one nearly complete specimen from the Cooper Marl at Sugar Hill near Unadilla, Georgia, are unusually large and well preserved. These specimens are particularly meaningful because they provide new information on the late stages of external rib development.

Of the 21 left valves from Huber (height 20 to 32 mm), many specimens exhibit a rib development that is more complex than that observed on the holotype (height 23 mm). On left-valve specimens, there are 20 to 27 (avg. 24.6) prominent primary ribs and 13 to 24 (avg. 19.6) less prominent secondary ribs. The secondary ribs form between the primary ribs by intercalation. However, in some of the larger left valves, the primary ribs may also branch either into two ribs of the same height and width or add low secondary ribs at their sides, or the valves may exhibit both branching of primary ribs and addition of secondary ribs at the sides of the primary ribs. On 7 of 19 left valves, some (1 to 14, avg. 7.7) of the primary ribs have branched before the 20 mm in height growth stage. However, 11 of 19 left valves have 2 to 31 (avg. 9.9) low, secondary ribs that develop at the sides of some of the primary ribs.

On 17 specimens of right valves from near Huber, Georgia, (height 20 to 28 mm) the number of primary ribs ranges from 23 to 27 (avg. 24.4). Most of the primary ribs in the central portion of the disk branch into two ribs of the same height and width at about the 10 mm-in-height growth stage. However, low secondary ribs may be added by either intercalation between primary ribs (5 of 17 specimens) or at the side of primary ribs (13 of 17 specimens) or by both means (5 of 17 specimens). The one large right valve from the Cooper Marl near Unadilla, Georgia, has rib ornamentation similar to the ornamentation just described for the right-valve specimens from the Clinchfield Sand near Huber, Georgia.

Chlamys cocoana and *Chlamys membranosa* (Morton) are similar in internal structure (elevated margins of chondrophore, crenulated ventral margin of the disk) and general features of rib ornamentation. The two species may be distinguished, however, by differences in the details of rib ornamentation. *C. cocoana* has fewer external ribs than *C. membranosa*, and right valves of *C. cocoana* exhibit a characteristic branching of the primary ribs, a feature not observed in *C. membranosa*.

Chlamys (Aequipecten) deshaysi (Lea)
Pl. 3, figs. 7, 8, 10.

Pecten Deshaysii Lea, 1833, Contributions to Geol., p. 87, Pl. 3, fig. 66.

Chlamys (Chlamys) deshayesi (Lea): Tucker-Rowland, 1936, Amer. Midland Nat., v. 17, p. 993, Pl. 5, figs. 2-5.

DESCRIPTION.—Lea's original description:

"*P. Deshaysii:* Shell orbicular, rather compressed; ears nearly equal; substance of the shell rather thick; ribs about twenty-one, large, alternating with as many small ones, all imbricate; beaks pointed."

Additional observations by Tucker-Rowland, 1936:

"Holotype of *dehayesi* Lea, an orbicular, somewhat convex left valve, has a height of 33 and width of 32 mm. About 20 primary, uniform, rounded radials. One major intercostal; sometimes one or two minor ones appear about 18 mm from the margin. Concentric lamellae reflected beakward as they cross the radials. Nearly equal, radially threaded auricles. Internally, obsolete ribs are stronger at the margins than umbonally."

OCCURRENCE IN GEORGIA.—*Chlamys deshaysi* is common in the lowest beds encountered at Georgia Rock Products Company quarry, Arlington (locality 24). These beds also contain *Periarchus lyelli* (Conrad) and are probably equivalent to the lower member of the Moodys Branch Marl (Paul Huddlestun, personal communication, 1972). *C. deshaysi* has been reported from the Moodys Branch on the east bank of the Chattahoochee River about 2 miles above U. S. Highway 84 bridge (Toulmin and LaMoreaux, 1963).

DISTRIBUTION ELSEWHERE IN THE SOUTHEASTERN UNITED STATES.—*Chlamys deshaysi* is known from numerous Middle and Upper Eocene localities in Mississippi and Alabama (Type, Claiborne Bluff on the Alabama River (locality 13)).

REMARKS.—*Chlamys deshaysi* and *Chlamys cawcawensis* (Harris) frequently occur in the same beds at localities in Alabama and many workers lump both forms together as *C. deshaysi.* However, *C. cawcawensis* is restricted to the Upper Eocene (at least in Alabama) and the two species can be distinguished on the basis of differences in right valve external ornamentation. Right valves of *C. cawcawensis* have wide, smooth ribs with lirae on the interspaces only, whereas right valves of *C. deshaysi* have lirae on both the ribs and interspaces. Left valves of the two species have lirae on both the ribs and interspaces and are not significantly different.

The difference in number of ribs observed in *C. cawcawensis* as compared with *C. deshaysi* is very small and probably insignificant. Typically *C. cawcawensis* has about 23 ribs; however at Double Bridges Creek near Geneva, Alabama (locality 19) in a sample containing 14 right valves of *C. cawcawensis*, the number of ribs on the disk varies from 13 to 25 and averages 17.7. In a sample of 59 specimens of *C. deshaysi* from High Bluff on the Choctawhatchee River near Geneva, Alabama (locality 20), the number of ribs on the disk varies from 15 to 23 and averages 19.1.

Subgenus *ANATIPOPECTEN* Hertlein, 1936

Chlamys (Anatipopecten) anatipes (Morton)
Pl. 4, figs. 2, 4-6.

Pecten anatipes Morton, 1833, Amer. Jour. Sci., v. 23, p. 293, Pl. 5, fig. 4.

Chlamys (Chlamys) anatipes (Morton): Tucker-Rowland, 1936, Amer. Midland Nat., v. 17, p. 1004, Pl. 7, fig. 2; Pl. 10, fig. 13.

Chlamys anatipes (Morton): Harris, 1951, Bull. Amer. Paleont., v. 33, no. 138, p. 10, Pl. 5, fig. 2.

DESCRIPTION.—Morton's original description: "With four of five broad convex ribs, longitudinally striated; at the sides large striae replace the ribs. Rarely more than half an inch in diameter. From the overlying limestone of Claiborne, Alabama."

Shell suborbicular, thick, small, maximum height 31.2 mm, maximum length 29.2 mm; both valves convex; ribs broad, rounded, increase in width ventrally, wider than interspaces; 4 to 7 strong ribs on the central portion of the disk and a smaller one on either side; lirae on ribs, interspaces, and submargins; concentric lamellae closely spaced. Ears fairly large, nearly equal, with numerous radial striations; byssal notch deep; ctenolium in right valve with 3 or 4 teeth exposed. Hinge with provinculum, one pair of cardinal crura, and a resilial pit; broad internal ribs fluted along ventral margin.

DIMENSIONS.—Holotype, fragmentary specimen from near Claiborne, Alabama.

OCCURRENCE IN GEORGIA.—Rare in Marianna Limestone on the west bank of the Ocmulgee River at Lower City Park, Hawkinsville (locality 32). Also reported from the Oligocene beds at Red Bluff, seven miles above Bainbridge and on the west bank of Flint River, opposite Little Horseshoe Point, 0.5 mile below Mascot Point and 4.5 miles below Bainbridge, Georgia (Vaughan, Cooke, Mansfield; in Dall, 1916).

DISTRIBUTION ELSEWHERE IN THE SOUTHEASTERN UNITED STATES.—*Chlamys anatipes* is found in the Oligocene formations of Mississippi (Glendon), Alabama (Red Bluff, Marianna, Glendon, Byram), and Florida (Bumpnose); but its presence is always rare.

REMARKS.—Palmer and Brann (1965, p. 144) list the geologic range of *Chlamys anatipes* from Upper Eocene (type) to Oligocene. They apparently consider the type to be from the Upper Eocene because Morton reported it "from the overlying limestone of Claiborne, Alabama." However since Morton (1833, p. 293) also found *Pecten perplanus* Morton (now *Pecten perplanus perplanus*) in the same beds as *C. anatipes* and I have found *P. p. perplanus* only in Oligocene beds (Glawe, 1969), I conclude that the type of *C. anatipes* (if found in place) came from the Oligocene beds near Claiborne, Alabama.

Subgenus *LYROPECTEN* Conrad, 1862

Chlamys (Lyropecten) duncanensis Mansfield
Pl. 3, figs. 4-6, 9.

Pecten (Lyropecten) duncanensis Mansfield, 1934, Wash. Acad. Sci. Jour., v. 24, p. 332, figs. 1-3.

Chlamys (Lyropecten) duncanensis (Mansfield): Tucker-Rowland, 1938, Mus. Royal Hist. Nat. Belgique Mem., ser. 2, fasc. 13, p. 7, Pl. 5, fig. 22.

DESCRIPTION.—Mansfield's original description:

"Shell small, rather thin, inequilateral, weakly inflated, the left valve more convex than the right. Right anterior ear with a moderately deep notch and sculptured with five rather strong radials, the innermost of which lies close to the submargin, and with transverse closely-spaced imbrications; right posterior ear with six strong, imbricated radials. Disk of right valve sculptured with 23 to 25 (24 on holotype) squarish, scabrous and imbricated ribs, separated by intervals of about the same width as the ribs. The early portion of each rib is narrowly rounded and the later portion nearly square; the latter is undercut on the sides and is ornamented on the top with three scabrous threads, the medial one of which is the strongest. The interradial spaces on the smaller specimens are either without a radial or, if present, it is only faintly indicated. A fragment of a larger shell (Fig. 1, U.S.N.M. No. 373056) shows one interradial thread of moderate strength in each space. Ribs and interspaces crossed by imbrications whose edges are about one millimeter apart. Left valve sculptured similarly to the right, except that the interradial thread appears to be more strongly developed. Submargins low and marked with faint radials."

DIMENSIONS.—Holotype, right valve; height, 23 mm, length, 22.5 mm, convexity, 4 mm, from Duncan Church, Washington County, Florida.

OCCURRENCE IN GEORGIA.—*Chlamys duncanensis* is common in the upper beds at the Dixie Lime and Stone Company quarry (Oligocene) near Bridgeboro (locality 27), rare and small in the Marianna Limestone along the west bank of the Ocmulgee River at Lower City Park in Hawkinsville (locality 32), and possibly occurs in the Bainbridge area. According to Mansfield (1934, p. 33), *Pecten duncanensis* (now *Chlamys duncanensis*) is closely allied to, if not the same as, specimens figured and incorrectly referred by Dall (1916, p. 492) to *Pecten suwaneensis* Dall (now *Chlamys suwaneensis*) from the Glendon Chert (Limestone) at Bainbridge, Georgia.

DISTRIBUTION ELSEWHERE IN THE SOUTHEASTERN UNITED STATES.—*Chlamys duncanensis* is common in the Glendon Limestone near Heidelberg (locality 2) and rare in the Byram Marl near "old" Byram, Mississippi (locality 1); common in the Glendon Limestone near Millry (locality 8), rare in the Glendon Limestone near St. Stephens (locality 9), Glendon Flat Station (locality 11), and Frisco City (locality 15), and rare in the Byram Marl at Hart's Bridge on Five Runs Creek, Alabama (locality 18); and common in the Suwannee Limestone at Natural Bridge, Walton County (locality 21) and near Duncan Church (type locality), Washington County, Florida (locality 22).

REMARKS.—*Chlamys duncanensis* has a trilirate rib development similar to the rib development of *Pecten perplanus byramensis* Gardner that also occurs in the northern Gulf Coast Oligocene formations. However *C. duncanensis* differs from *P. p. byramensis* by having interspace lirations, a convex left valve, a valve shape that is slightly produced in the posterior, and a ctenolium present in even the largest specimens—features not observed in *P. p. byramensis.*

Genus *Pecten* Müller, 1776
Pecten sp.
Pl. 4, figs. 7-9

DESCRIPTION.—Shell suborbicular, small, maximum height about 30 mm; biconvex valves, right valve strongly convex, left valve moderately convex; ribs low, rounded, about as wide as interspaces, with 2 or 3 lirae on ribs and 1 or 2 lirae on interspaces; concentric lamellae widely spaced; right valve with 21 ribs, left valve with 19 ribs. Ears fairly small, nearly equal with prominent radial striations; byssal notch shallow. Interior of valves with distinct internal ribs fluted along the ventral margin.

OCCURRENCE IN GEORGIA.—Rare to common as internal and external molds in road cuts of Flint River Formation near Buck Creek (locality 31) (Locality 15 - Pickering, 1970), about 6 miles NW of Hawkinsville and near Sugar Hill Church (locality 30) (Locality 26 - Pickering, 1970), about 11 miles west of Hawkinsville.

REMARKS.—Specimens of *Pecten* sp. illustrated in this report are not of the *Pecten perplanus* stock

of Glawe (1969), (previously referred to as *P. perplanus* Morton, *P. poulsoni* Morton, or *P. byramensis* Gardner). *Pecten* sp. has lirae on both the ribs and interspaces. Species of the *Pecten perplanus* stock have one to three lirae on the ribs but never liration on the interspaces.

STRATIGRAPHIC SIGNIFICANCE AND PALEONTOLOGIC RELATIONSHIPS

Pectinids from the Coastal Plain of Georgia hold a key to the understanding of the relationships between the Gulf of Mexico and Atlantic Ocean faunas of the Late Eocene and Oligocene. According to Cheetham (1963), a deepwater strait referred to as the Suwannee Strait extended across panhandle Florida and southern Georgia during the Late Eocene. The strait and adjacent shallow-water shelf to the north permitted mixing of the waters of the Gulf of Mexico and Atlantic Ocean about 650 miles farther to the north than they do now.

The stratigraphic occurrence and relative abundance of the Upper Eocene and Oligocene pectinids of Georgia are shown on Figure 3. The presence of pectinids in the formations is reported as either R (rare) or C (common). Six species denoted by asterisks in Figure 3 are believed to be stratigraphically useful in Georgia and surrounding states: *Amusium ocalanum* Dall, *Chlamys (Anatipopecten) anatipes* (Morton), *Chlamys (Aequipecten) clinchfieldensis* Harris, *Chlamys (Aequipecten) cocoana* Dall, *Chlamys (Lyropecten) duncanensis* (Mansfield), and *Chlamys (Aequipecten) spillmani* (Gabb).

Amusium ocalanum is restricted to the Upper Eocene deposits of the southeastern United States. The species is more abundant in the carbonate-rich units (Ocala Limestone - Florida and Georgia) than in the more detrital units (Cooper Marl - Georgia, Shubuta Clay - Alabama).

Chlamys anatipes is restricted to the Oligocene deposits of the southeastern United States. It has a widespread occurrence in carbonate-rich formations from Mississippi (Glendon) to Alabama (Red Bluff, Marianna, Glendon, Byram) to Georgia (Marianna) and to northern Florida (Bumpnose), but the relative abundance of *C. anatipes* is always low. Even though *C. anatipes* is rare, it is useful stratigraphically because the shell of the species has distinctive broad, striated ribs that permit identification of the species based on small fragments of the shell.

Chlamys clinchfieldensis is interpreted as being an excellent stratigraphic marker fossil. It has a relatively widespread geographic distribution (central Georgia to western Alabama) and a short geologic range. Populations of *C. clinchfieldensis* thrived best in the Late Eocene carbonate-rich deposits of southcentral Georgia (Clinchfield Sand and lower part of the Ocala Limestone) and evolved to *C. spillmani* during the deposition of the upper part of the Ocala Limestone.

Chlamys spillmani is common in the upper part of the Ocala Limestone in Georgia, the Ocala Limestone of Florida, and the Upper Eocene carbonate-rich units of Alabama and Mississippi (Pachuta Marl and Ocala Limestone). The species evolved from *C. clinchfieldensis* during the deposition of the Ocala Limestone of Georgia and migrated westward and southward to carbonate banks (Alabama-Mississippi and Florida) when the muds of the Twiggs Clay were deposited in Georgia. The details of the evolutionary development of *C. spillmani* in Florida remain to be studied; however the form found in the Upper Eocene deposits of western Alabama and eastern Mississippi appears to have developed to a phylogenetically more advanced stage of external rib ornamentation than observed on the form found in Georgia.

Chlamys cocoana is common in the Upper Eocene detrital formations of Georgia (Clinchfield Sand, Twiggs Clay, Cooper Marl). It has a particularly large, thick, highly ornamented shell at localities where relatively high energy depositional conditions are inferred (Clinchfield Sand, some beds of the Cooper Marl). When found in the Twiggs Clay, *C. cocoana* is generally preserved as molds of small individuals. *C. cocoana* is also known from the more detrital units of the Upper Eocene and Oligocene of Alabama (Moodys Branch Marl, Cocoa Sand, Shubuta Clay, Red Bluff Formation) where the species is widespread but small and sparse.

Chlamys duncanensis is restricted to the Oligocene formations of the southeastern United States. The species ranges from exposures at Byram, Mississippi, to central Georgia and is rare to common in the carbonate-rich units (Glendon Limestone and Byram Marl - Mississippi and Alabama, Suwannee Limestone - panhandle Florida, Marianna Limestone and Suwannee Limestone - Georgia).

Chlamys deshayesi is common from numerous Middle and Upper Eocene localities in Mississippi and Alabama and is reported from South Carolina by Harris (1919). The Upper Eocene occurrence of

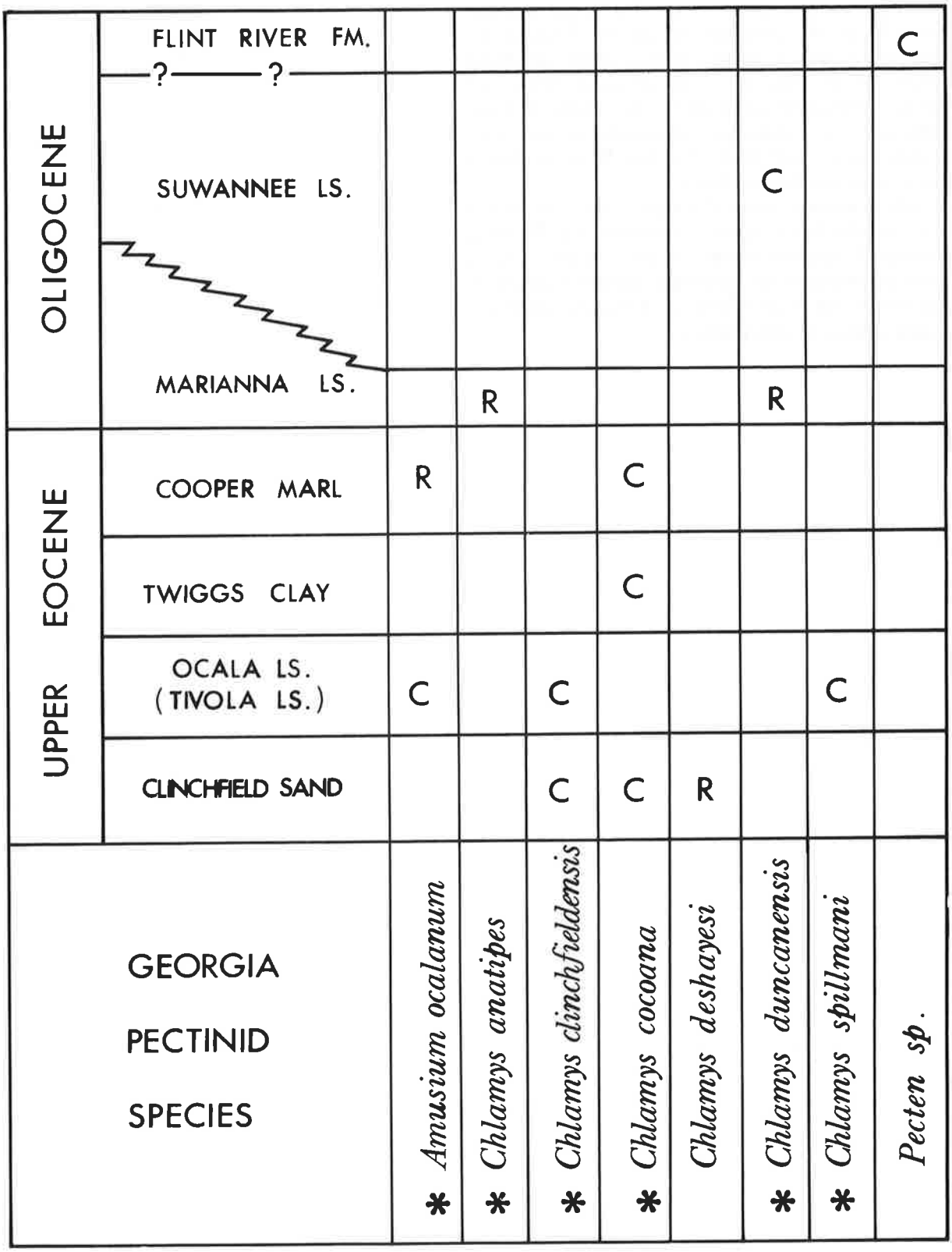

Figure 3. Stratigraphic occurrence and relative abundance of Upper Eocene and Oligocene pectinids of Georgia. Relative abundance is expressed as R (rare) of C (common); asterisks denote stratigraphicically useful species.

C. deshayesi in Georgia links the distribution of the species from the Atlantic to the Gulf Coast. *C. deshayesi* is not a useful stratigraphic indicator because of its relatively long geologic range and great morphological variability. When more material of this species is available, meaningful morphological differences will likely be found to render it greater stratigraphic usefulness.

Little is known about the distribution of *Pecten* sp. from the Flint River Formation of Georgia. However I suspect some of the occurrences of *Pecten* reported in the literature as *Pecten poulsoni* from Oligocene chert blocks in Alabama and Georgia may represent this form.

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APPENDICES

Appendix A: Register of Numbered Localities

Mississippi

1. Byram Marl type locality: 0.3 mile east of "old" Byram on west bank of Pearl River at suspension bridge. West of center, sec. 19, T. 4 N., R. 1 E., Hinds County.

2. Glendon Limestone: 1.4 miles SE of Heidelberg in road cut on County Highway 528. NW¼ sec. 2, T. 10 N., R. 10 E., Jasper County.

3. Red Bluff Formation near type locality: east bank of Chickasawhay River, 1.0 mile west of Hiwannee. NE¼ sec. 28, T. 10 N., R. 7 W., Wayne County.

4. Marianna Limestone: road cut on Waynesboro-Silas Road, 5.5 miles SW of Isney, Alabama. Sec. 19, T. 9 N., R. 5 W., Wayne County.

Alabama

5. Pachuta Marl: road cut 1.9 miles SE of Isney. NE¼ sec. 12, T. 9 N., R. 4 W., Choctaw County.

6. Moodys Branch Marl: road cut 3.9 miles west of Gilbertown. NE¼ sec. 28, T. 11 N., R. 4 W., Choctaw County.

7. Moodys Branch Marl: road cut 2.0 miles west of Silas. Sec. 2, T. 9 N., R. 4 W., Choctaw County.

8. Glendon Limestone: road cut 3.9 miles NW of Millry. Probably NW¼ sec. 12, T. 8 N., R. 4 W., Washington County.

9. Upper Eocene to Oligocene formations: Lone Star Cement Company quarry near Tombigbee River, 2.2 miles NE of the present town of St. Stephens. Sec. 13, T. 7 N., R. 1 W., Washington County.

10. Middle Eocene to Oligocene formations: Little Stave Creek. 3.0 miles north of Jackson. Secs. 29 and 30, T. 7 N., R. 2 E., Clarke County.

11. Glendon Limestone type locality: overgrown quarry north of the abandoned Glendon flag station on the Southern Railway between Jackson and Walker Springs. NE¼ sec. 2, T. 6 N., R. 2 E., Clarke County.

12. Cocoa Sand: road cut 2.9 miles north of Grove Hill on U. S. Highway 43. NW¼ sec. 15, T. 9 N., R. 3 E., Clarke County.

13. Middle and Upper Eocene formations: Claiborne Bluff, east bank of Alabama River at U. S. Highway 84 bridge. Sec. 30, T. 7 N., R. 6 E., Monroe County.

14. Shubuta Clay, Red Bluff Formation, and Marianna Limestone: road cut and stream bank 1.6 miles SW of Perdue Hill. SW¼ sec. 7, T. 6 N., R. 6 E., Monroe County.

15. Marianna Limestone and Glendon Limestone: road cut 3.5 miles NW of Frisco City. SE¼ sec. 15, T. 6 N., R. 6 E., Monroe County.

16. Ocala Limestone: west bank of Sepulga River beneath County Highway bridge at Brooklyn. SW¼ sec. 33, T. 4 N., R. 13 E., Conecuh County.

17. Moodys Branch Marl: east bank of Conecuh River beneath County Highway 42 bridge, about 6 miles SW of Andalusia. Probably sec. 29, T. 4 N., R. 15 E., Covington County.

18. Byram Marl: west bank of Five Runs Creek at Hart's Bridge. Sec. 26, T. 2 N., R. 15 E., Covington County.

19. Moodys Branch Marl: Double Bridges Creek, about 8 miles NW of Geneva. Sec. 31, T. 2 N., R. 21 E., Geneva County.

20. Moodys Branch Marl: High Bluff on south side of Choctawhatchee River, about 12 miles NE of Geneva. NE¼ sec. 9, T. 2 N., R. 23 E., Geneva County.

Florida

21. Suwannee Limestone: Natural Bridge, about 8 airline miles ESE of Florala, Alabama. SE¼ sec. 26, T. 6 N., R. 20 W., Walton County.

22. Suwannee Limestone: small abandoned quarry 300 yards NE of Piney Grove Church (formerly Duncan Church). SW¼ NE¼ SE¼ sec. 36, T. 4 N., R. 14 W., Washington County.

23. Upper Eocene and Oligocene formations: Sam Smith's quarries, access road 5.5 miles NW of Marianna on State Highway 73. Sec. 23, T. 5 N., R. 11 W., Jackson County.

Georgia

24. Clinchfield Sand and Ocala Limestone: Georgia Rock Products Company quarry, about 4 miles west of Arlington, Calhoun County.

25. Ocala Limestone: abandoned quarry on the Oakland Plantation, about 8 miles NW of Albany, Lee County.

26. Ocala Limestone: Muckafoonee Creek below power plant dam, 0.7 mile NE of Albany, Dougherty County.

27. Suwannee Limestone: Dixie Lime and Stone Company quarry, 6.5 miles SW of Bridgeboro, Mitchell County.

28. Twiggs Clay: west ditch of south-bound lane along Interstate Highway 75, about 4 miles south of Perry, Houston County.

29. Clinchfield Sand and Ocala Limestone: Medusa Portland Cement Company quarry near Clinchfield, Houston County.

30. Cooper Marl and Flint River Formation: in ditches and in pasture north of road at Sugar Hill, about 6 miles NE of Unadilla, Houston County (Localities 25 and 26 - Pickering, 1970).

31. Flint River Formation: road cut near Buck Creek, about 6 miles NW of Hawkinsville on U. S. Highway 341, Pulaski County (Locality 15 - Pickering, 1970).

32. Marianna Limestone: west bank of the Ocmulgee River at Lower City Park in Hawkinsville, Pulaski County.

33. Cooper Marl: road cut about 4 miles E of Hayneville, Houston County (Locality 7 - Pickering, 1970).

34. Clinchfield Sand, Ocala Limestone, and Twiggs Clay: Rich Hill abandoned quarry, 0.5 mile south on access road which is 4.7 miles SE of Knoxville on County Highway 42, Crawford County.

35. Clinchfield Sand, Ocala Limestone, and Twiggs Clay: Area 22 kaolin pit, about 4 miles NE of Huber, Twiggs County.

36. McBean Formation (?), Clinchfield Sand, and Twiggs Clay: Georgia Kaolin Company mine no. 59B, access road off Georgia State Highway 18, 1.5 miles south of Gordon, Wilkinson County (Stop 4, Pickering, 1971).

37. Twiggs Clay: Kaolin mine near Clear Creek, about 5 miles south of Gordon, Wilkinson County.

South Carolina

38. Cooper Marl: Carolina Giant Cement Corporation quarry, about 2 miles north of Harleyville, Dorchester County.

Appendix B: Measured Sections

I. Georgia Rock Products Company quarry, about four miles west of Arlington, Georgia (locality 24).

	Thickness (feet)
Ocala Limestone	
4. Limestone, white, bioclastic with hard and soft beds; contains bryozoans and *Chlamys clinchfieldensis*	10.0+
3. Limestone, white; with corals, oysters, and abundant molds of mollusks	3.0
Clinchfield Sand	
2. Limestone, sandy, buff; with very coarse-grained quartz sand, *Periarchus lyelli lyelli*, and *Chlamys clinchfieldensis*	12.0
1. Limestone, sandy, buff, hard, pelletoid; with very coarse-grained quartz sand, *Periarchus* cf. *P. lyelli floridanus*, and *Chlamys deshayesi*. Bed 1 was found only in one area where large blocks were removed from quarry floor	2.0+

II. Rich Hill quarry (abandoned), access road off County Highway 42, 4.7 miles southeast of Knoxville, Georgia (locality 34).

	Thickness (feet)
Twiggs Clay	
4. Clay, olive	18.0+
Ocala Limestone	
3. Limestone, cream, bioclastic; with bryozoans, *Chlamys clinchfieldensis* and *Periarchus lyelli pileussinensis*	21.0
Clinchfield Sand	
2. Limestone, sandy, cream, soft with a ledge near base; contains *Chlamys clinchfieldensis*, *Chlamys cocoana*, and *Periarchus lyelli lyelli*	10.0
1. Sand, limonitic; with *Chlamys cocoana*	4.0+

III. Area 22 Kaolin pit near Huber, Georgia (locality 35).

	Thickness (feet)
Twiggs Clay	
4. Clay, olive; with thin, sandy, fossiliferous limestone beds	69.0+

Ocala Limestone

3. Limestone, cream, bioclastic; with bryozoans and *Chlamys clinchfieldensis*	21.0

Clinchfield Sand

2. Limestone, sandy, buff, quartz sand; with *Periarchus lyelli lyelli*, *Chlamys clinchfieldensis*, and *Chlamys cocoana*	3.0
1. Sand, limonitic, calcareous; with corals and *Chlamys cocoana*	9.0+

IV. Georgia Kaolin Company mine no. 59B (Stop 4, Pickering, 1971) near Gordon, Georgia (locality 36).

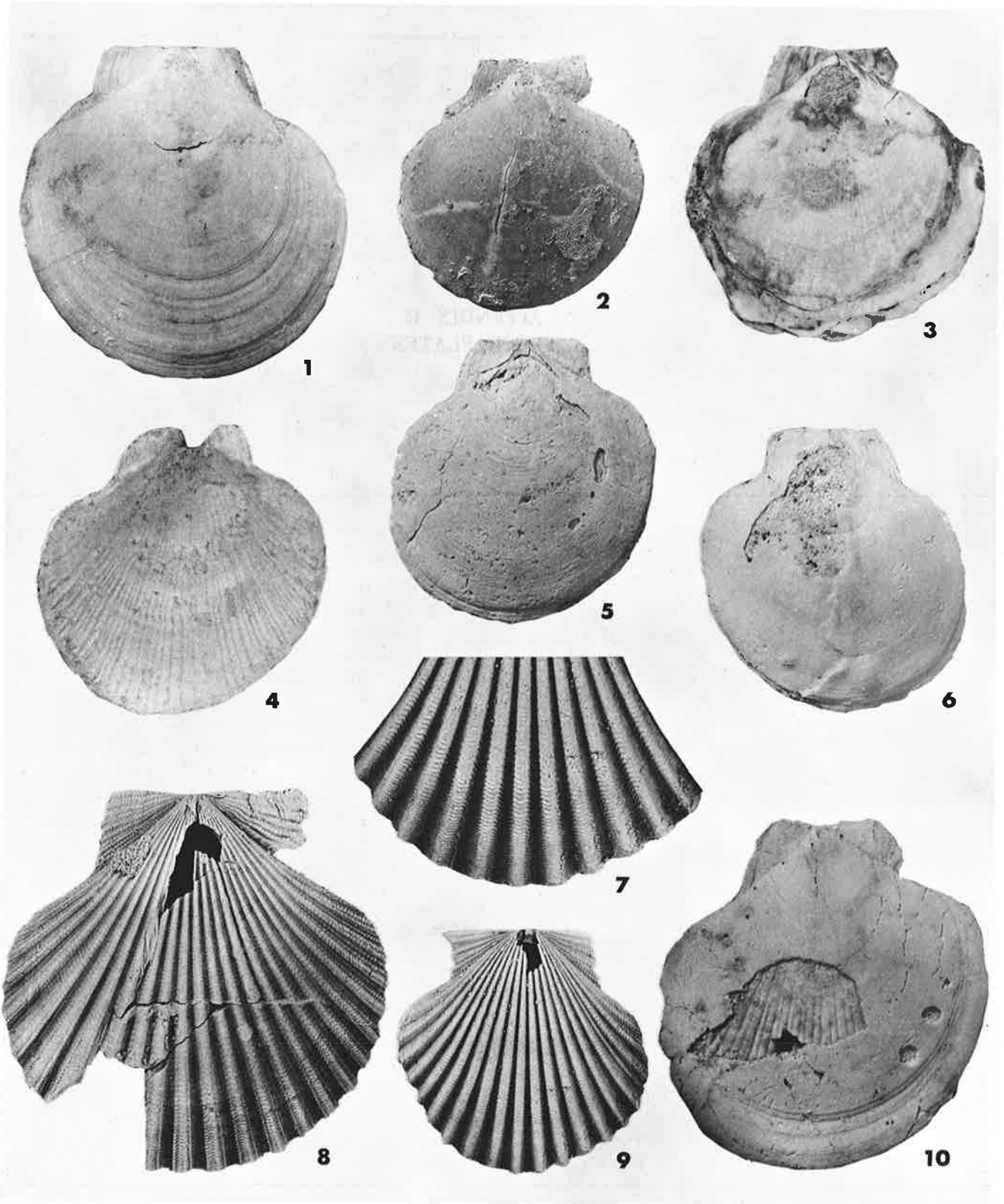
	Thickness (feet)
Twiggs Clay	
4. Clay, grey, calcareous, hackly to blocky fracture, fossiliferous in places	42.0+
Clinchfield Sand	
3. Sand, greenish-grey, argillaceous; contains abundant bryozoans, *Chlamys clinchfieldensis*, and *Periarchus lyelli pileussinensis*	3.0
2. Limestone, pale orange, sandy; contains bryozoans, oysters, *Chlamys clinchfieldensis*, and *Periarchus lyelli*	1.0
McBean Formation (?)	
1. Marl, olive grey, argillaceous, coarse sand to pebble size quartz grains, calcareous, pyrite nodules at base; contains oysters, other pelecypods, and fish teeth	0.5-3.0

V. Dixie Lime and Stone Company quarry near Bridgeboro, Georgia (locality 27).

	Thickness (feet)
Suwannee Limestone	
5. Clay, red, sandy, with silicified mollusks	5.0+
4. Limestone, white, weathers brown, bioclastic; contains *Chlamys duncanensis*, *Clypeaster cotteaui*, and abundant molds of mollusks	2.5
3. Limestone, same as bed above but with algal balls and *Cassidulus gouldi*	2.0
2. Limestone, white, nodular, bioclastic, with green clay pockets; contains *Spondylus* sp., *Lepidocyclina* sp., oysters, *Chlamys duncanensis* (rare), and algal balls	16.5
1. Limestone, cream, crumbly, bioclastic, with numerous small pockets of green clay; contains *Lepidocyclina* sp., *Clypeaster cotteaui*, *Chlamys duncanensis*, and abundant algal balls	54.0+

APPENDIX C
FOSSIL PLATES

PLATE 1



EXPLANATION OF PLATE 1

(All figures x 1.5 except Figure 7)

Figures 1-6, 10. *Amusium ocalanum* Dall

1. Left valve exterior, Ocala Limestone, Upper Eocene; Sam Smith's quarries, 5.5 miles NW of Marianna, Florida (locality 23).

2. Right valve exterior with encrusting bryozoans, Cooper Marl, Upper Eocene; Sugar Hill, 5.5 miles NE of Unadilla, Georgia (locality 30).

3. Right valve exterior, Ocala Limestone, Upper Eocene; Muckafoonee Creek below dam, Albany, Georgia (locality 26).

4. Left valve interior showing internal ribbing; same formation and locality as Figure 3.

5. Right valve exterior of double-valve specimen; same formation and locality as Figure 3.

6. Left valve exterior of double-valve specimen (Figure 5). same formation and locality as Figure 3.

10. Right valve exterior with broken portion exposing internal ribbing; same formation and locality as Figure 1.

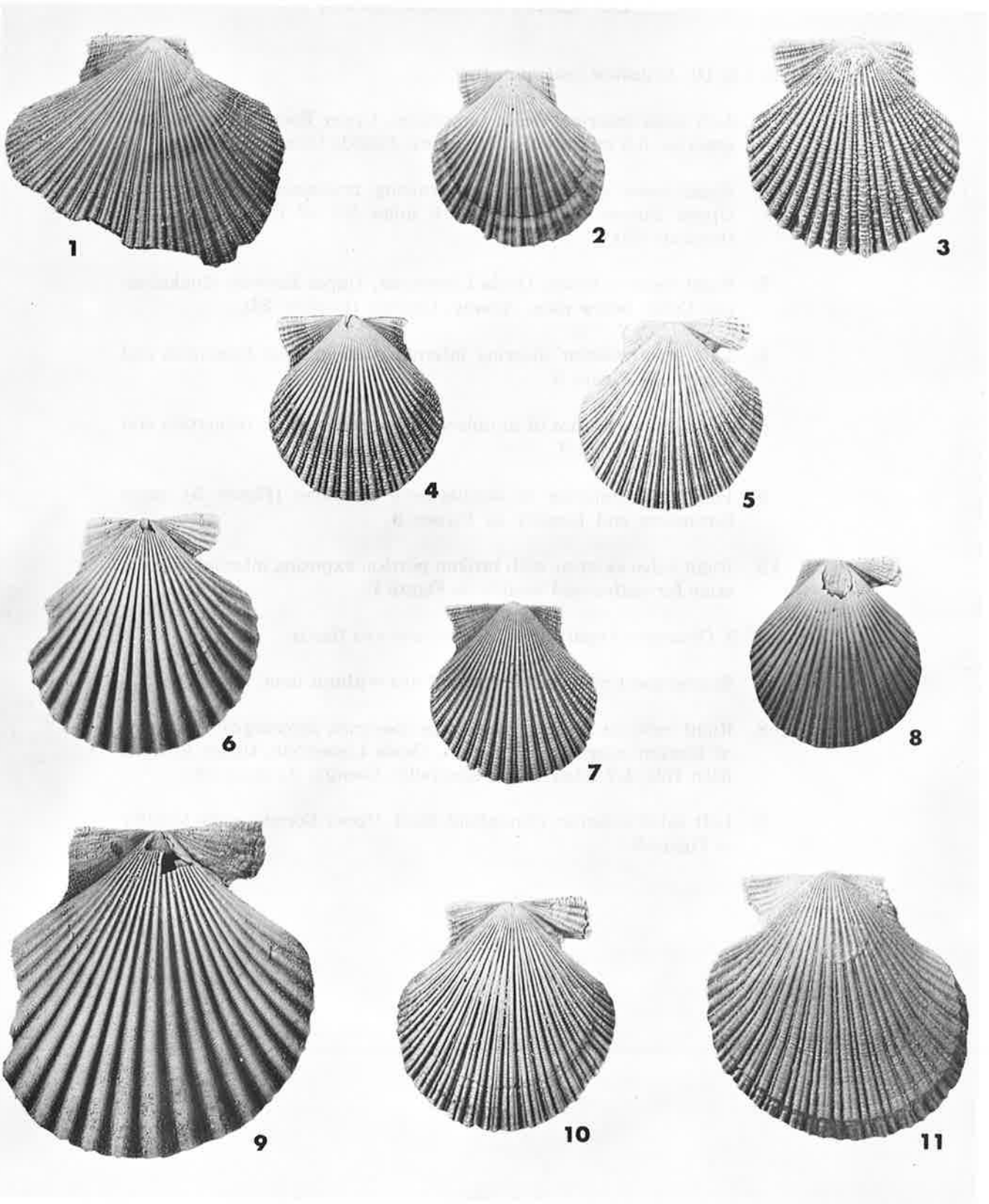
Figures 7-9. *Chlamys (Aequipecten) clinchfieldensis* Harris

7. Enlargement of Figure 9 showing ribs without lirae.

8. Right valve exterior, broken large specimen showing development of liration near ventral margin, Ocala Limestone, Upper Eocene; Rich Hill, 4.7 miles SE of Knoxville, Georgia (locality 34).

9. Left valve exterior, Clinchfield Sand, Upper Eocene; same locality as Figure 8.

PLATE 2



EXPLANATION OF PLATE 2
(All figures x 1.5 except Figures 4, 7, and 8)

Figures 1-5, 7, 8, 10, 11. *Chlamys (Aequipecten) cocoana* Dall

1. Right valve exterior showing branching ribs, Cooper Marl, Upper Eocene; Sugar Hill, 5.5 miles NE of Unadilla, Georgia (locality 30).

2. Left valve exterior of worn specimen showing how secondary ribs are added by intercalation, specimen compared with holotype and considered conspecific, Ocala Limestone, Upper Eocene; beneath bridge, 1.6 miles SW of Perdue Hill, Alabama (locality 14).

3. Left valve exterior of well preserved, unworn specimen showing addition of secondary ribs by intercalation, Clinchfield Sand, Upper Eocene; Area 22 Kaolin pit, Huber, Georgia (locality 35).

4. Left valve exterior of well preserved specimen (magnification x 3), note how the early worn portion of the disk compares favorably with Figure 2, Cocoa Sand, Upper Eocene; road cut 2.9 miles north of Grove Hill, Alabama (locality 12).

5. Right valve exterior of well preserved specimen showing branching of primary ribs and addition of secondary ribs at the sides of the primary ribs; same formation and locality as Figure 3.

7. Left valve exterior of well preserved specimen (magnification x 2); same formation and locality as Figure 4.

8. Right valve exterior of worn specimen (magnification x 2) showing branching of primary ribs; same formation and locality as Figure 4.

10. Right valve exterior of a large, well preserved specimen showing branching of primary ribs and addition of secondary ribs at the sides of the primary ribs; same formation and locality as Figure 3.

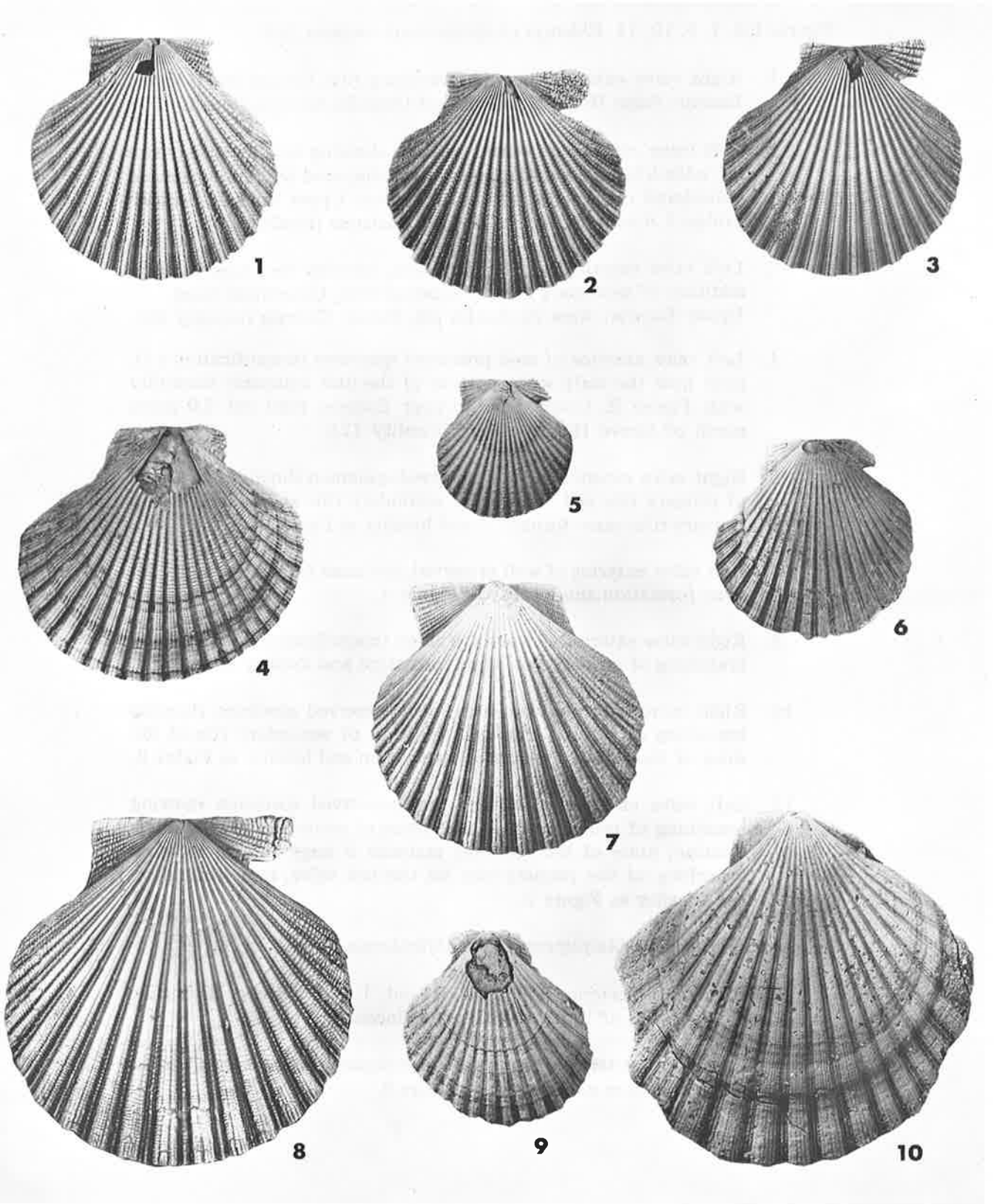
11. Left valve exterior of a large, well preserved specimen showing branching of primary ribs and addition of secondary ribs by intercalation; none of the Alabama material is large enough to show branching of the primary ribs on the left valve; same formation and locality as Figure 3.

Figures 6, 9. *Chlamys (Aequipecten) clinchfieldensis* Harris

6. Right valve exterior, Clinchfield Sand, Upper Eocene; Rich Hill, 4.7 miles SE of Knoxville, Georgia (locality 34).

9. Right valve exterior of large specimen showing no lirae on the ribs; same formation and locality as Figure 6.

PLATE 3



EXPLANATION OF PLATE 3
(All figures x 1.5 except Figure 5)

Figures 1-3. *Chlamys (Aequipecten) spillmani* (Gabb)

1. Left valve exterior showing lateral lirae on ribs and pronounced outgrowths where concentric lamellae cross over the ribs, Pachuta Marl, Upper Eocene; Lone Star Cement Company quarry near St. Stephens, Alabama (locality 9).

2. Right valve exterior, Pachuta Marl, Upper Eocene; road cut 1.9 miles SE of Isney, Alabama (locality 5).

3. Right valve exterior; same formation and locality as Figure 1.

Figures 4-6, 9. *Chlamys (Lyropecten) duncanensis* (Mansfield)

4. Right valve exterior showing trilirate ribs and lirae in the interspaces, Glendon Limestone, Oligocene; same locality as Figure 1.

5. Right valve exterior of juvenile (magnification x 2), Marianna Limestone, Oligocene; west bank of Ocmulgee River at Lower City Park in Hawkinsville, Georgia (locality 32).

6. Right valve exterior, Suwannee Limestone, Oligocene; Dixie Lime and Stone Company quarry near Bridgeboro, Georgia (locality 27).

9. Left valve exterior; same formation and locality as Figure 6.

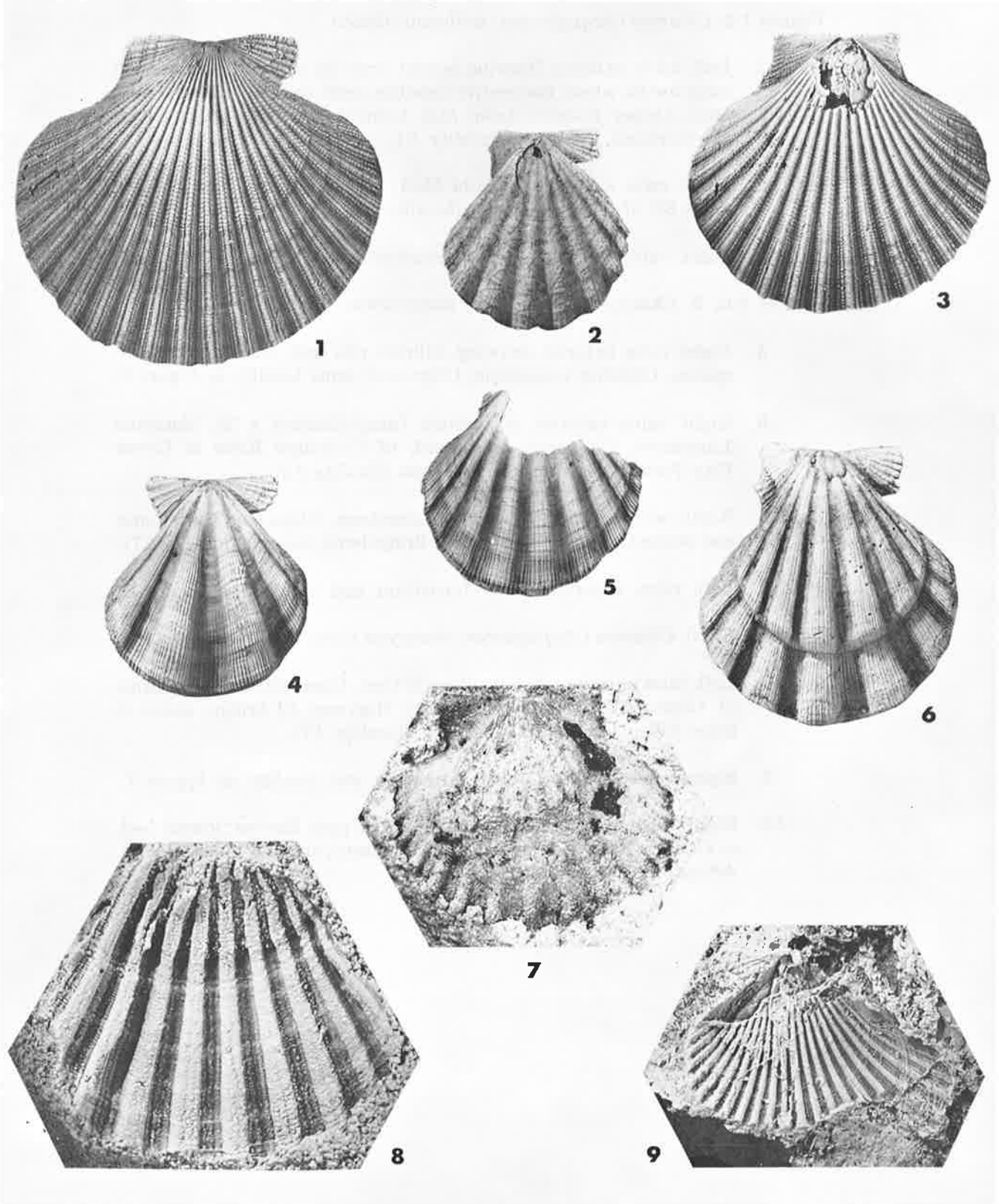
Figures 7, 8, 10. *Chlamys (Aequipecten) deshayesi* (Lea)

7. Left valve exterior, Moodys Branch Marl, Upper Eocene; east bank of Conecuh River beneath County Highway 42 bridge, about 6 miles SW of Andalusia, Alabama (locality 17).

8. Right valve exterior; same formation and locality as Figure 7.

10. Right valve exterior, Clinchfield Sand, Upper Eocene; lowest bed at Georgia Rock Products Company quarry, about 4 miles west of Arlington, Georgia (locality 24).

PLATE 4



EXPLANATION OF PLATE 4
(All figures x 1.5 except Figures 2, 8, and 9)

Figures 1, 3. *Chlamys (Aequipecten) spillmani* (Gabb)

1. Right valve exterior, exceptionally large specimen showing development of liration in interspaces, Ocala Limestone, Upper Eocene; west bank of Sepulga River beneath bridge at Brooklyn, Alabama (locality 16).

3, Right valve exterior, Ocala Limestone, Upper Eocene; Penn-Dixie (Medusa) Cement Company quarry west of highway, Clinchfield, Georgia (locality 29).

Figures 2, 4-6. *Chlamys (Anatipopecten) anatipes* (Morton)

2. Right valve exterior (magnification x 2), Marianna Limestone, Oligocene; west bank of Ocmulgee River at Lower City Park in Hawkinsville, Georgia (locality 32).

4. Right valve exterior, Marianna Limestone, Oligocene; road cut on Waynesboro-Silas road, 5.5 miles SW of Isney, Alabama (locality 4).

5. Exterior fragment; same formation and locality as Figure 2.

6. Right valve exterior, Glendon Limestone, Oligocene; Lone Star Cement Company quarry near St. Stephens, Alabama (locality 9).

Figures 7-9. *Pecten* sp.

7. Left valve internal mold showing internal fluting, Flint River Formation, Oligocene; near Sugar Hill Church, about 11 miles west of Hawkinsville, Georgia (locality 30).

8. External mold (magnification x 2) showing lirae on both the ribs and interspaces; same formation and locality as Figure 7.

9. Right valve external mold (magnification x 2) showing lirae on both the ribs and interspaces, Flint River Formation, Oligocene; road cut 6 miles NW of Hawkinsville, Georgia (locality 31).