FACIES FAUNAS AND FORMATIONS[1]

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ABSTRACT—Present knowledge of facies, faunas and formations is reviewed. Usage of the various facies designations is discussed and exemplified from the North American Tertiary.

As early as 1795, Hutton (1795, pp. 540-564), announced the theory of Uniformitarianism—Key to the past is the present. This concept has stimulated a great deal of interest on the part of geologists to study the sedimentary processes at work today in order to obtain an objective method for reconstructing the environmental conditions of the past. More recent articles on sedimentation are by Lowman (1949), Trask (1950), Ladd (1951), Phleger (1951), Shepard (1951), Holle (1952), Bates (1953), Fisk, *et al.* (1953), Illing (1954), and others. Contributions to the ecology of the living Foraminifera were made by Natland (1930, 1933), Lowman (1949), Phleger (1951), Akers (1952), Crouch (1952), Parker (1952), Bandy (1953a), Miller (1953), Parker, Phleger and Peirson (1953), and others. Paleoecology is adequately deduced by Natland (1933), Lowman (1949), Israelsky (1949), Wilbert (1951), Ellison (1951), Crouch (1952), Puri (1953a) and Bandy (1953b). The conflicting opinions on the concept of facies as applied in geologic history are covered by Moore, McKee, Muller, Speiker, Wood, Sloss and Krumbien, E. C. Dapples (Longwell, 1949) and Puri (1953a).

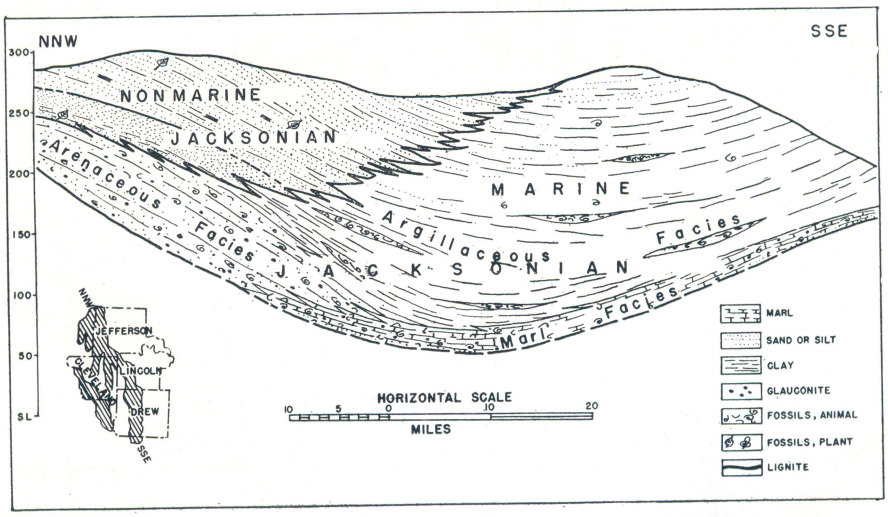

FIG. 1—Stratigraphic Diagram of Jackson deposits in South-Eastern Arkansas. (Redrawn after Wilbert, 1951).

Several definitions of the term facies exist but the generally accepted one is that of Moore (1949, p. 8) who defines sedimentary facies as "areally segregated parts of a differing nature belonging to any genetically related body of sedimentary deposits." If lithology or a physical aspect of a facies

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is the distinguishing factor, its magnitude may extend from a member to a group. These are *lithofacies* and are purely lithologic units since the inorganic and organic elements in a sedimentary environment are given like treatment without analysis of the nature of the faunal elements. Hence a certain lithofacies within a genetically related body of sediments could be classed as "argillaceous facies," "arenaceous facies" or "marl facies." An excellent example of such a usage is by Wilbert (1951), who in a cross-section (Fig. 1) shows the relationship of various facies in the upper Eocene (Jackson) of Arkansas. Comparison of the faunal groups within these facies is shown on an accompanying chart. (Fig. 2).

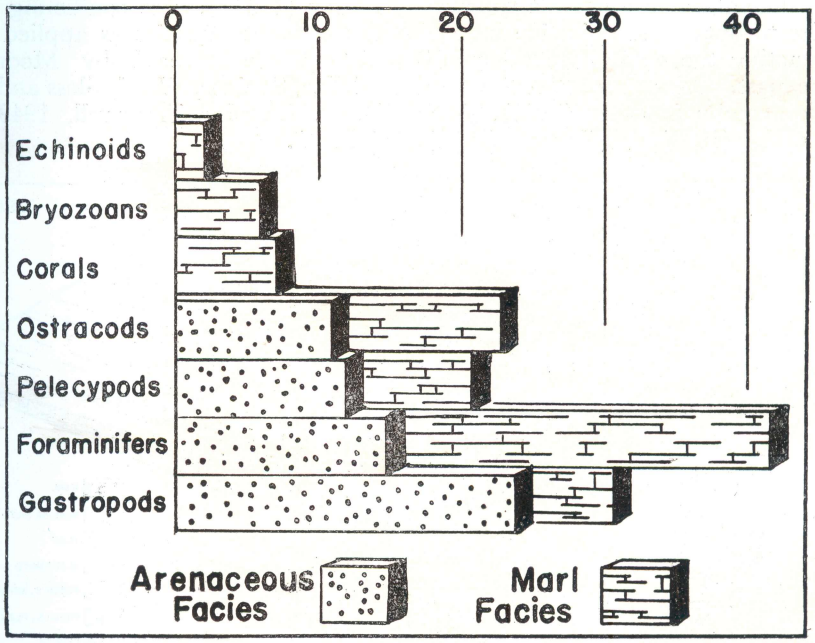
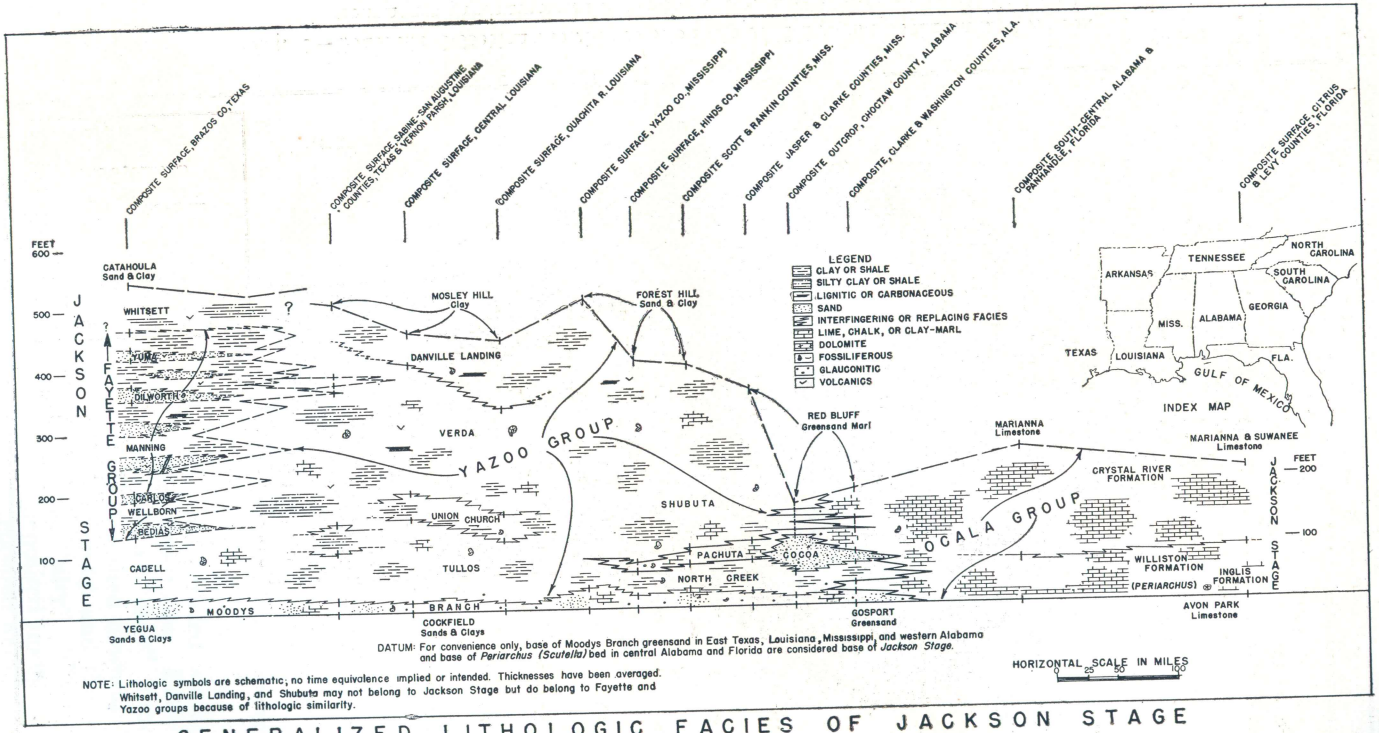


FIG. 2—Numerical comparison of species present in the Arenaceous and Marl Facies of the Jackson deposits in South-Eastern Arkansas. (Redrawn after Wilbert, 1951).

Another usage of lithofacies is designation by alphabet such as Lithofacies A (instead of a lithologic term) or Lithofacies B, based on two lithologically different but laterally gradational beds. Designation of lithofacies by geographic names is preferable because it not only ties a certain lithofacies to its type locality but also gives it a definite name by which it could later be known. Such a designation often prevents ambiguity which may otherwise develop by an alphabet designation. Instances of such a designation are by Murray (1952) and Puri (1953a).

Murray (1952, pp. 80-82), after a regional study of the Jackson (upper Eocene) deposits of the Gulf Coastal Plain came to the conclusion that three well developed lithofacies exist in this area. Irrespective of the nature of their fauna, he recognized three lithofacies as rock groups, and suggested geographic names for their reception. In the western Gulf Region, arenaceous and volcanic lithofacies of the Jackson State are included in the Fayette group; the dominantly argillaceous lithofacies in the central Gulf Region are included in the Yazoo group; and the calcareous lithofacies of the eastern Gulf are included in the Ocala group. Each of these three groups is composed of several lithologic units (formations) which laterally merge into one another. Murray's concept with some modifications appears on Figure 3.

Similar lithofacies have been recognized in the Paleocene, and in the lower and



GENERALIZED LITHOLOGIC FACIES OF JACKSON STAGE
(MODIFIED AFTER G.E. MURRAY)

Fig. 3

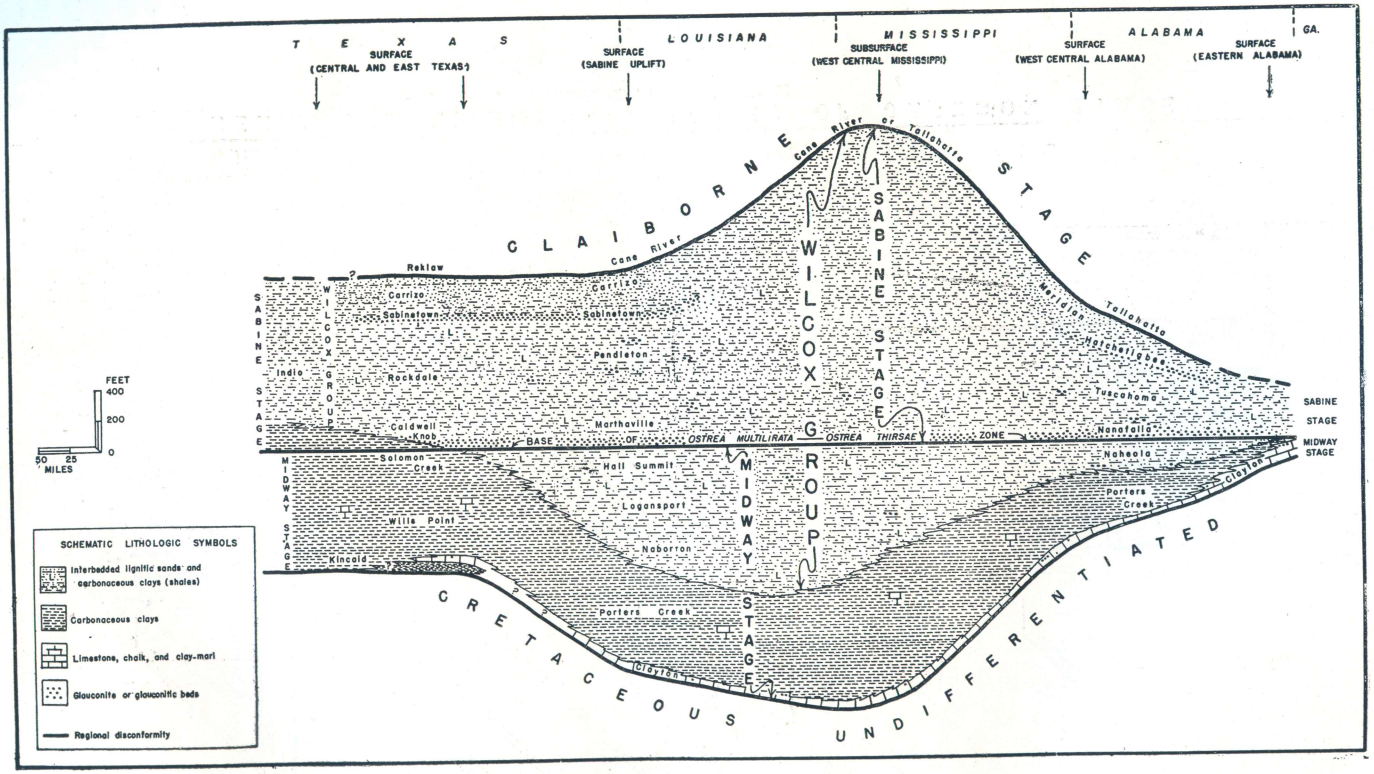


FIG. 4—Generalized Section showing relationship of Midwayan Sabinian and Wilcox Sediments in Central Gulf Coastal Plain. Thicknesses are generalized in general vicinity of arrows. Lithology is schematic (After G. E. Murray).

middle Eocene of the Gulf Coast. That lithofacies may merely be areally segregated groups of designated stratigraphic units irrespective of their age is amply illustrated by the lithofacies recognized in the Midway (Paleocene) and Sabine (lower Eocene) Stages. Murray (1953, p. 53) has proposed the term Wilcox group for the dominantly continental to deltaic deposits of both Midway (Paleocene) and Sabine (lower Eocene) stages. So defined, the Wilcox group embraces laterally merging sediments of both Paleocene and lower Eocene age which have been differentiated into several formations (fig. 4).

Within the three Miocene stages (Tampa, Alum Bluff, and Choctawhatchee) both litho- and bio-facies are recognized (fig. 5). The Tampa Age dawned in Panhandle Florida with the transgression of the sea

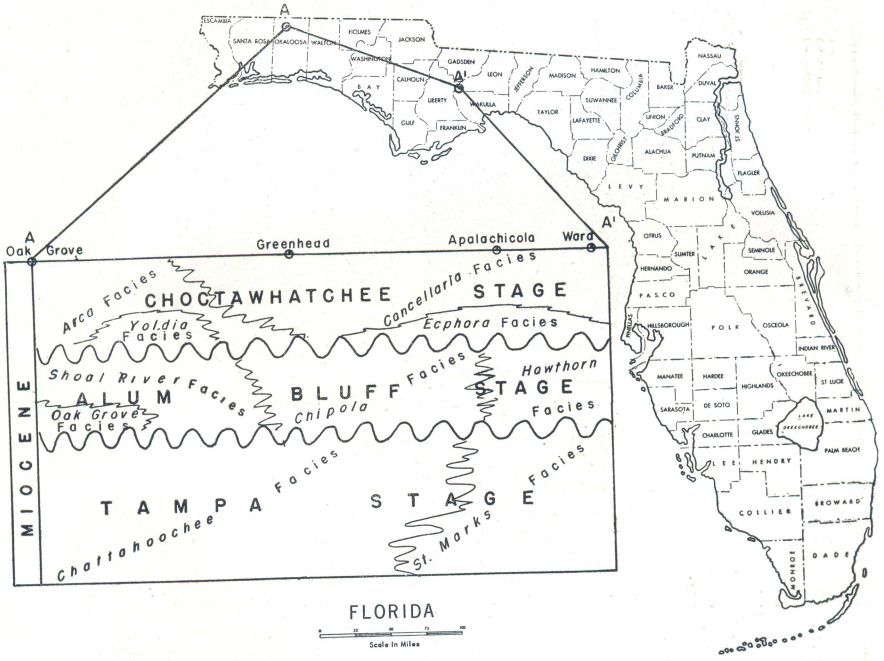
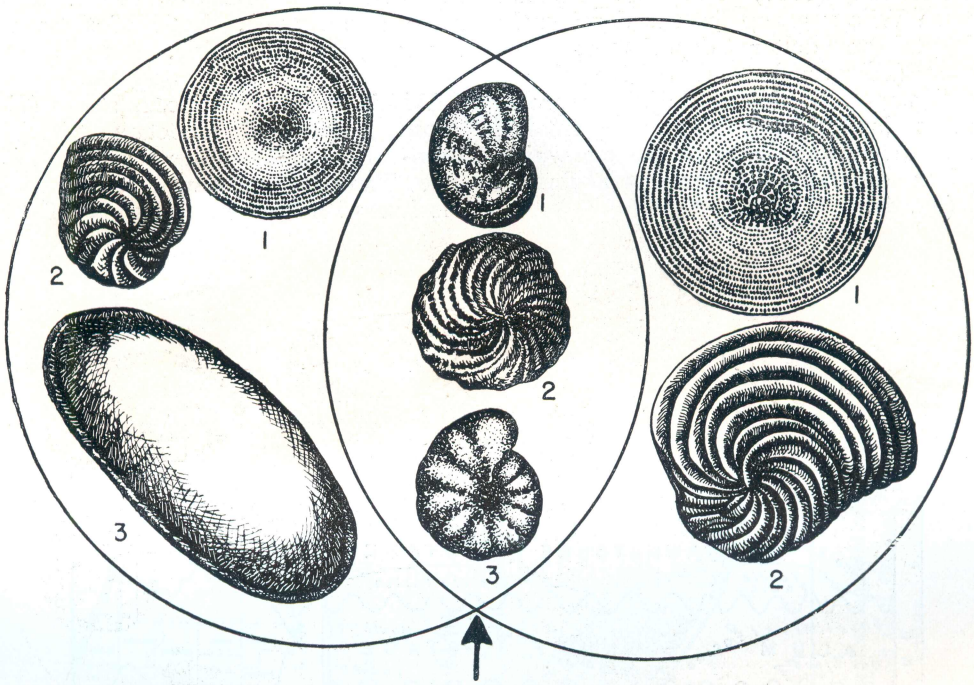


Figure 5

Diagramatic Stratigraphic Section along A A' showing the Miocene Facies Terminology

Puri (1953) used the term facies as a subdivision with the three stages of the Florida Miocene since changes in environments are clearly expressed by vertical and horizontal changes in both lithology and fauna of these sediments. The number of facies thus recognized in this sense is a measure of the recurrence of similar conditions throughout geologic time. Lithologically and faunally dissimilar components with the three stages over the eroded surface of Oligocene or older limestones. Early in this transgressive period a "limy" lithofacies (St. Marks) was deposited downdip and late during this transgression and the regression that followed, a "silty" (Chattahoochee) lithofacies was deposited updip. The St. Marks facies was deposited under deeper water conditions where the precipitation of lime was in progress and only minor quantities of clastic,

largely quartz sand, were available during its deposition. Since larger Foraminifera thrive on a calcareous mud bottom, species of *Archaias*, *Peneroplis*, *Puteolina* and *Sorites* attained their maximum development in these limy muds. Species of these genera is very much like the brackish water fauna now living in St. Andrew's and Apalachicola Bays. Preponderance of species of *Clithrocytheridea*, *Krithe*, *Elphidium*, *Peneroplis*, and *Archaias* would suggest a moderately warm, shallow-water environment for



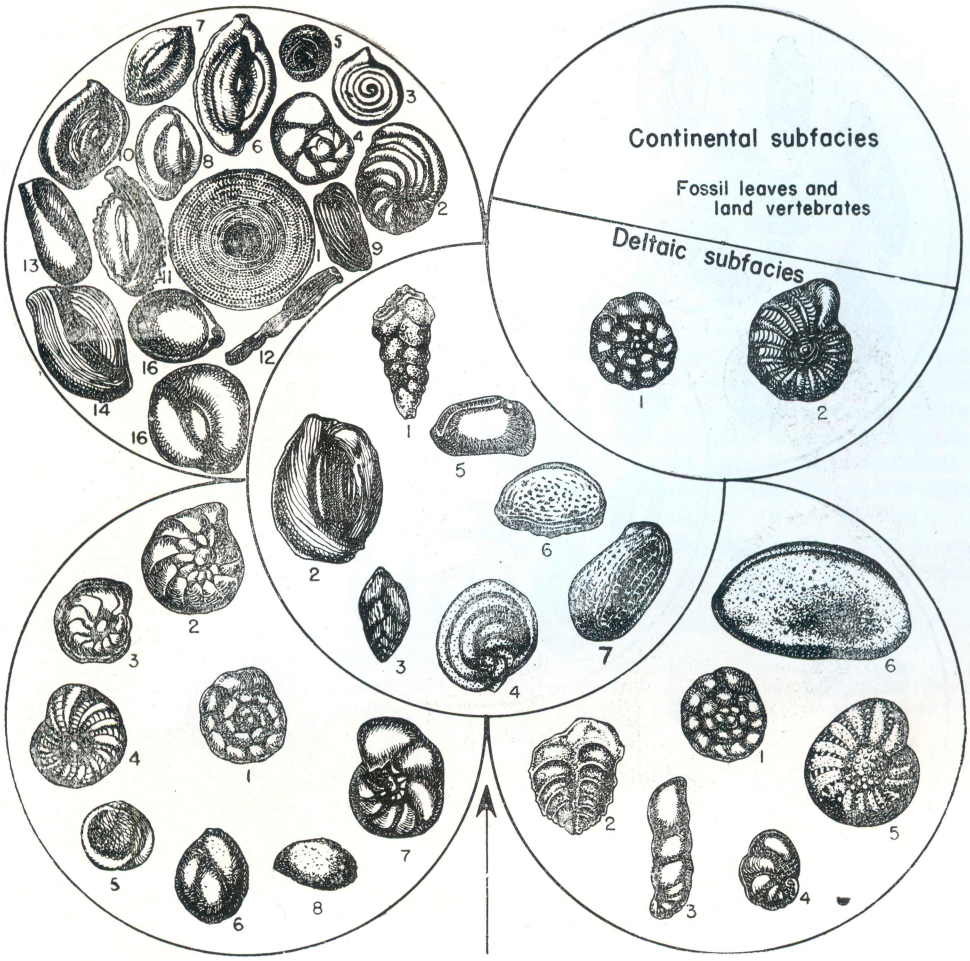
Left Circle :
CHATTAHOOCHEE FACIES
1. *Sorites* sp.
2. *Puteolina proteus*
3. *Haplocytheridea* sp.

Right Circle :
ST. MARKS FACIES
1. *Sorites* sp.
2. *Puteolina proteus*

FIG. 6—Dominant and diagnostic assemblages of the Tampa Stage. Overlap of circles represents species common to both facies.

present in the "limy" St. Marks facies have two to three times the diameter attained by the individuals of the same species in the "silty" Chattahoochee facies which was deposited near shore where more terrigenous material was available. These terrigenous sediments of the Chattahoochee facies were deposited rather rapidly, without much sorting of grains. The fauna at most places the Chattahoochee sediments. Dominant assemblages of the Tampa Stage appear on figure 6.

Sediments of the Alum Bluff Stage were deposited unconformably on the Tampa. Alum Bluff Stage is divided into four lithofacies: Hawthorn, Chipola, Oak Grove and Shoal River.



Upper Left Circle

CHIPOLA FACIES

1. *Sorites* sp.
2. *Puteolina proteus*
3. *Cornuspira involvens*
* 4. *Discorbis candeiana*
5. *D. orbicularis*
* 6. *Quinqueloculina candeiana*
* 7. *Q. chipolensis*
8. *Q. lamarckiana*
9. *Q. subpoeyana*
*10. *Massilina quadrans*
*11. *M. spinata*
*12. *Articulina miocenica*
*13. *Triloculina oblonga*
*14. *T. quadrilateralis*
15. *T. rotunda*
16 *Pyrgo subsphaerica*

Lower Left Circle

OAK GROVE FACIES

1. *Streblus beccarii parkinsoniana*
2. *Amphistegina chipolensis*
3. *A. floridana*
4. *Elphidium advenum*
5. *Globulina gibba*
6. *G. inaequalis*
7. *Hanzawaia concentrica*
*8. *Haplocytheridea okaloosensis*

Upper Right Circle :

HAWTHORN FACIES

1. *Streblus beccarii*
2. *Elphidium* sp.

Lower Right Circle

SHOAL RIVER FACIES

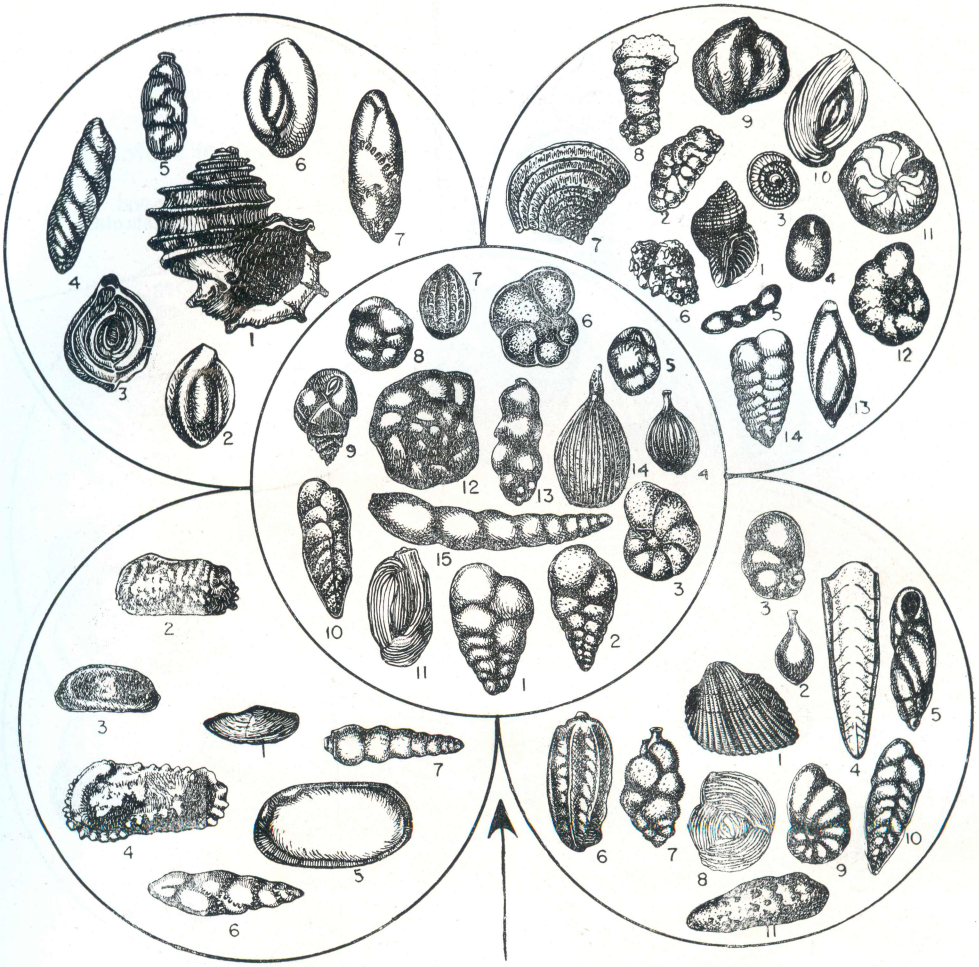
1. *Streblus beccarii*
*2. *Textularia warreni*
*3. *Marginulina glabra*
*4. *Lamarckiana atlantica*
5. *Elphidium gunteri*
6. *Haplocytheridea bassleri*

Centre Circle

1. *Textularia agglutinans*
2. *Quinqueloculina crassa subcuneata*
3. *Sigmoilina tenuis*
4. *Cycloloculina miocenica*
5. *Cytheromorpha dalli*
6. *Hemicythere amygdala*
7. *Cytheretta karlana*

FIG. 7—Dominant and diagnostic assemblages of the Alum Bluff Stage. Centre circle represents diagnostic Alum Bluff species common between all three facies.

*Characteristic species



Upper Left Circle

ECPHORA FACIES

*1. *Ecphora quadricostata umbilicata*
*2. *Quinqueloculina contorta*
*3. *Spiroloculina depressa*
*4. *Marginulina dubia*
*5. *Uvigerina parkeri*
6. *Massilina* sp.
*7. *Virgulina (Virgulinella) gunteri*

Lower Left Circle

YOLDIA FACIES

*1. *Yoldia waltonensis*
2. *Favella rugipunctata*
3. *Cytherideis fabula*
1. *Textularia gramen*
2. *Textularia candeiana*
3. *Valvulineria floridana*
4. *Lagena sulcata*
5. *Cassidulina crassa*

4. *Actinocythereis exanthemata*
5. *Cytheretta spencerensis*
6. *Virgulina miocenica*
* 7. *Nodogenerina advena*

Upper Right Circle

CANCELLARIA FACIES

* 1. *Cancellaria propevenusta*
* 2. *Acervulina inhaerens*
* 3. *Patellina corrugata*
* 4. *Lagena quadrata*
* 5. *Nodosaria calomorpha*
* 6. *Textularia foliacea occidentalis*
* 7. *Pavonina miocenica*
* 8. *Rectocibicides miocenica*
* 9. *Triloculina asperula*
*10. *Massilina gunteri*

Centre Circle

6. *Globorotalia menardii*
7. *Lagena hexagona*
8. *Cassidulina laevigata*
9. *Bulimina marginata*
10. *Bolivina marginata multicostata*
11. *Amphistegina lessonii*
12. *Elphidium incertum*
13. *Pyrulina albatrossii*
*14. *Textularia floridana*

Lower Right Circle :

ARCA FACIES

* 1. *Arca rubisiniana*
* 2. *Lagena clavata*
3. *Cancris sagra*
* 4. *Plectofrondicularia floridana*
5. *Buliminella elegastissima*
* 6. *Siphogenerina lamellata*
7. *Uvigerina auberiana*
* 8. *Flintina floridana*
9. *Nonion grateloupi*
10. *Bolivina marginata*
11. *Bolivina floridana*
11. *Quinqueloculina costata*
12. *Buccella mansfeldi*
13. *Angulogerina occidentalis*
14. *Lagena substriata*
15. *Dentalina communis*

FIG. 8—Dominant and diagnostic assemblages of the Choctawhatchee Stage. Centre circle represents diagnostic Choctawhatchee species common among all four facies.

* Characteristic species

Hawthorn lithofacies consists of continental, deltaic and pro-deltaic sands, fullers earth and clays. The continental portion of this lithofacies is leaf-bearing. The fauna of the rest of this lithofacies is rather meagre; only sporadic individuals of species of *Streblus beccarii* Linn. vars., *Elphidium* sp. and *Haplocytheridea bassleri* Stephenson occur and suggest a near shore to brackish-water environment.

The Chipola lithofacies were deposited downdip under warm-water inner neretic conditions by the transgressive Alum Bluff sea over the sediments of the Tampa Stage. Both the organic tests and the precipitation of calcium carbonate attributed to the calcareous nature of the sediments. Puri (1953a) postulates a depth of 60 fathoms under warm (20°-30°C) water conditions for the deposition of the Chipola sediments. This conclusion is drawn on the percentage of the species of Miliolidae to the total species and varieties in each sample and preponderance of such forms as *Quinqueloculina candeiana* d'Orbigny, *Q. lamarckina* d'Orbigny, *Spiroloculina depressa* d'Orbigny, *Hauerina* cf. *miocenica* Cushman, *Triloculina rotunda* d'Orbigny, *T. quadrilateralis* d'Orbigny, *Articulina advena* d'Orbigny, *Puteolina proteus* (d'Orbigny), *Archaias* sp., *Sorites* sp., *Cornuspira involvens* Reuss, *Discorbis candeiana* d'Orbigny and *D. orbicularis* (Terquem).

Shoal River lithofacies and Oak Grove facies are the brackish water updip equivalent of the Chipola lithofacies. Dominant assemblage of the Shoal River lithofacies as *Textularia warreni* Cushman and Ellisor, *Marginulina glabra* d'Orbigny, *Streblus beccarii* (Linn.) vars., *Elphidium gunteri* Cole and *Haplocytheridea bassleri* Stephenson. *Haplocytheridea bassleri* is also dominant in the modern bays. The rest of the fauna, though not living at present in the bays, is represented by empty tests that are washed in the bays from the open sea at high tides.

Dominant and diagnostic species of the Alum Bluff Stage appear on fig. 7.

An excellent example of facies faunas occurs within the Choctawhatchee Stage. Four "faunizones" (*Yoldia*, *Arca*, *Ecphora* and *Cancellaria*), named after the characteristic molluscan index fossils that they contain, were once thought to be superimposed upon one another. This supposed superposition was based on the evolution of their fauna, but such a relationship was never proved to exist in the field. Vernon (1942) doubted this supposed superposition and proved that at least in Washington and Holmes counties these "faunizones" were mere facies in as much as they interfingered with one another. Recently Puri (1953a) has shown that such a lateral gradation exists throughout Florida Panhandle and that these "faunizones" represent facies faunas which were deposited contemporaneously at varying depth. Lithologically the sediments of the Choctawhatchee Stage are a homogeneous mass of grey to blue shell marls which could only be distinguished by their fauna. Dominant and diagnostic assemblages of the *Yoldia*, *Arca*, *Ecphora*, and *Cancelleria* biofacies appear on figure 8.

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