

NOTES ON THE GENUS *AGNOCARDIA* (MOLLUSCA: CARDIIDAE)  
WITH THE DESCRIPTION OF A NEW SPECIES FROM THE  
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## I. ABSTRACT

Nine species, including one from the Lower Eocene of France and eight, ranging in age from Claibornian (Middle Eocene) to basal Pleistocene, from the western Atlantic fossil faunas are here referred to the genus *Agnocardia* Stewart, 1930; also included is one new species from the Middle Pliocene of Florida. Two species, one from the Oligocene of Germany and one from the Middle Eocene of California, mentioned by Stewart in his discussion, are here considered as not being members of the taxonomic group.

## II. INTRODUCTION

*Agnocardia*, originally described as a subgenus of *Trachycardium* Mörch, 1853, by Stewart (1930, p. 264) with *Cardium* (*Trachycardium*) *claibornense* Aldrich (1911, p. 3, pl. 1, fig. 4) as type species, has been considered a subgenus of *Acanthocardia* Gray, 1851, by Keen (1969, p. 585; 1980, p. 16) and as a separate genus by the writer (1977, p. 153) and by Dockery (1982, p. 69). Although the hinge of the Middle Eocene type species is unknown, that of the Lower Oligocene (Vicksburgian) *Cardium glebosum* Conrad (1848, p. 292) has been well illustrated by Dockery (1982, text figs. 39, 40-1 and pl. 32, figs. 2a, 3a). It is similar to that of *Cardium aculeatum* Linnaeus, 1758, type species of *Acanthocardia*, in being relatively long with the cardinal and lateral teeth on a straight line relative to each other; however, the surface ornamentation of the two genera is strikingly different. That of *Agnocardia* consists of 40 or more flat-topped radial costae, separated by square-sided interspaces of half or less the width of the ribs, that bear on their upper surface spines of an inverted "V" shape. Com-

monly on the medial part of the valve ribs, with rather short and low, closely approximate spines, alternate with those bearing more distantly spaced, high, prominent ones (see pl. 2). In contrast, *Acanthocardia aculeata* is ornamented by approximately one-half as many radial ribs, which are wider, with broadly rounded upper surfaces and proportionately wider, less sharply delimited interspaces; the ribs bearing roundly nodose, spike-like spines that tend, on the median and posterior parts of the valve, to rise from the mid-point of the rib-width and anteriorly to become heavy, transverse nodes. The inverted "V" spines of *Agnocardia* are somewhat like those of *Cardium isocardia* Linnaeus, type species of *Trachycardium*, but are laterally symmetrical without the strong ventral prolongation of the posterior side that is characteristic of the latter genus. Furthermore the hinge of *Trachycardium* is relatively shorter and arched, with the laterals more ventral in position than the cardinal teeth.

SPECIES HERE REFERRED TO  
*AGNOCARDIA*

The following species appear to be referable to *Agnocardia*:

1. *Cardium convexum* Deshayes (1858, p. 559, pl. 55, figs. 18-21); Lower Eocene (Cuisian), Aizy, Paris Basin. This appears to be the earliest species yet known, and in-so far as the writer is aware, the only European species referable to this genus. The writer has seen no specimens, but examination of the illustrations given by Cossmann and Pissaro (1906, pl. 18, sp. 69-18) reveals the alteration of spine size on adjacent costae and a hinge of typical form. The figures are stated to be twice natural size, suggesting a specimen with a length of approximately 7 mm; Cossmann

(1886, p. 157) previously had cited a specimen also from Aizy that is 12.5 mm in diameter, stating that the species is always very rare.

2. *Cardium (Trachycardium) claibornense* Aldrich (1911, p. 3, pl. 1, fig. 4); Claibornian Eocene (? = Archusa Marl Member of Cook Mountain Formation) at De Soto, Clarke County, Mississippi. The Aldrich illustration was reproduced by Harris (1919, pl. 41, fig. 8), together with a detail of the surface ornamentation (his fig. 8a) of a fragment from the Gosport Sand at Claiborne, Alabama. An additional specimen (his fig. 9) from Colliers Ferry, Burleson County, Texas, said by Harris (*ibid.*, p. 132) to have "very much the general appearance of *claibornense*," does not represent this species, according to Palmer and Brann (1965, p. 27).

Aldrich's description states that the shell is large, "covered with numerous ribs which are square in section and ornamented with close-set triangular imbrications . . . The sunken spaces between the ribs are not half their width . . . height 35, breadth 33 mm." A study of the original illustration, which appears to be about two-thirds natural size, suggests that there are at least 47 costae.

Upper Eocene forms tentatively referred to this species, as "cf. *claibornense*," have been reported from the Santee Limestone of South Carolina (Harbison, 1944, p. 6, pl. 1, figs. 6, 8), and from the Inglis Formation and the Avon Park Limestone, Levy County, Florida (Richards in Richards and Palmer, 1953, p. 52, pl. 11, figs. 5, 6). It should be noted, however,

that two incomplete external molds of specimens from the Inglis, collected from spoil dumps made during the construction of the Florida Cross-State Barge Canal near Inglis, Florida (TU localities 778, 812) show an alternation of spine size on adjacent radials that is much more pronounced than that shown by Harris on the small surface area in his figure 8a (see pl. 2, fig. 4). The Upper Eocene Florida specimens may well represent a different species but are too incomplete to permit any certain conclusions.

3. *Cardium glebosum* Conrad (1848, p. 122), spelled (in faunal lists) as "*C. (Trachycardium) globosum* C." by Conrad (1865, p. 7) (not *C. globosum* Bean, 1839, Jurassic, England). *Agnocardia glebosum* was described from the "Eocene" (= Lower Oligocene) near Vicksburg, Mississippi, where it was said to be "rare and obtained only in fragments." For a full synonymy with illustration of the incomplete holotype specimen, plus more complete specimens from the Red Bluff, Mint Springs, and Byram formations of the Vicksburg Group, and excellent drawings of the hinge and interior of the valves, the reader is referred to Dockery's monograph of the Vicksburg Bivalvia (1982, pp. 69-70, pl. 32, figs. 1-5, text. figs. 39, 40-1). Exception must be taken, however, to his statement that *A. glebosum* differs from the Chipolan (Lower Miocene) *A. acrocome* (Dall) "in having A-shaped spines of equal strength on its radial costae rather than alternating rows of strong and weak spines." Although it appears that the spines on the more ventral portion of the ribs on adult

#### PLATE 1

##### Figures

1-3. *Agnocardia spinosifrons* H. E. Vokes, n. sp.

1. Paratype USNM 377406 ( $\times 1$ ); Length 42.5 mm, height 48.5 mm.

2. Paratype USNM 377407 ( $\times 3$ ); Length 14.8 mm, height 14.5 mm.

3. Holotype USNM 377405; Length 31.3 mm, height 33.7 mm.

3a. ( $\times 1.5$ ); 3b ( $\times 6$ ) enlarged detail of surface ornament to show differing size of spines on alternate ribs.

All specimens from locality TU 1177; Pinecrest Formation (Pliocene), Collier County, Florida.

4. *Agnocardia acrocome* (Dall)

USNM 234512 ( $\times 1.5$ ); Length 35.5, height 37.5 mm.

Locality TU 830; Chipola Formation (Lower Miocene), Tenmile Creek, Calhoun County, Florida.

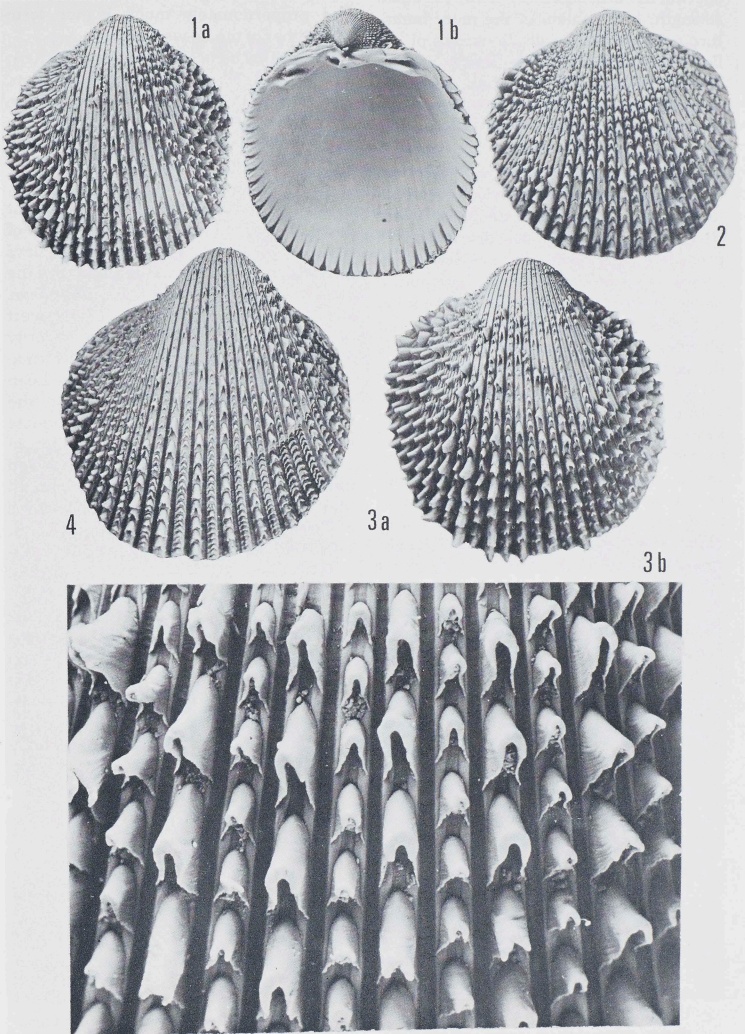


PLATE 1

specimens are more or less of equal strength, examination of the more immature area (see especially Dockery's pl. 32, fig. 4) shows that the alternation of spine size occurs also in this species. An immature valve in the Tulane University collections from the Red Bluff Formation at TU 642 has 42 radial ribs.

Dall (1916, p. 498) included "*Cardium* (*Trachycardium*)" *glebosum* Conrad in the fauna of the Upper Oligocene beds at Flint River, Georgia, and (p. 488) also listed it as present in the "Ocala." Since the Ocala Limestone is of Upper Eocene age and to be correlated with the Inglis Formation and the Avon Park Limestone, cited above, it may be that Dall's Ocala form is the same as that cited by Richards (1953) as "cf. *claibornense*."

Harris (1951, pl. 41, figs. 11, 12) subsequently illustrated two "imprints of exteriors" of a cardiid collected from the Ocala Limestone at the Dixie Lime Products quarry at Reddick, Florida, that certainly represents a species of *Agnocardia*; unfortunately he does not indicate the degree of magnification, if any. If the figures are of natural size they do not agree with the characteristic ornamentation on areas of equivalent rib size on either *A. claibornense* or *A. glebosum*. It is also to be noted that the internal molds of "*Cardium* sp. (with pointed beaks)" (*ibid.*, pl. 41, figs. 7, 8) from the same locality at Reddick to which Harris refers the imprints as "prob-

bly" of the same species, are of a narrower and proportionately much higher form than either of the above species.

4. *Cardium acrocome* Dall (1900, p. 1081; 1903, pl. 48, fig. 2); Chipola Formation, Lower Miocene (Burdigalian), Calhoun County, Florida. Dall's original illustration and description of the immature type specimen were reprinted by Gardner as *Cardium* (*Acanthocardia*) *acrocome* (1926, p. 133, pl. 22, fig. 7). She also stated that "the type [which came from the banks of the Chipola River "1 mile below Baileys Ferry"] is unique." Subsequent Tulane University collections contain 36 valves from exposures along Tenmile Creek, west of the Baileys Ferry area, the majority being from the basal strata of the formation; however, only two valves have been recovered from exposures along the Chipola River. Similar disproportionate differences in the relative distribution of other cardiid species have been observed (see Vokes, 1977, p. 148, table 2); the most unusual being the more than 13,300 valves of *Trigoniocardia simrothi* (Dall) (1900, p. 1104; 1903, pl. 48, fig. 8) collected from exposures along the Chipola River, with but two valves being found in the Tenmile Creek section. The sediments at the localities from which these collections were made are so similar in composition and grain size as to give no hint of the ecological factors responsible for the distributional differences.

The variation in spine size on the adja-

## PLATE 2

### Figures

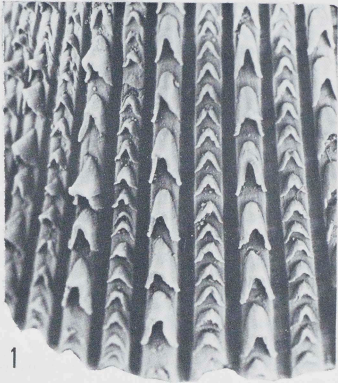
#### 1-3. *Agnocardia acrocome* (Dall)

1. USNM 234512 ( $\times 4$ ); detail of surface ornament of specimen shown on plate 1, figure 4. Locality TU 830.
2. USNM 377400 ( $\times 6$ ); lateral view to show differing height of spines on alternate ribs. Locality TU 830.
3. USNM 377401 ( $\times 6$ ); view of surface of unusual specimen having two ribs with small spines between two large-spined ones on median surface. Locality TU 951.

All specimens from Chipola Formation (Lower Miocene), Tenmile Creek, Calhoun County, Florida.

#### 4. *Agnocardia* new species ?

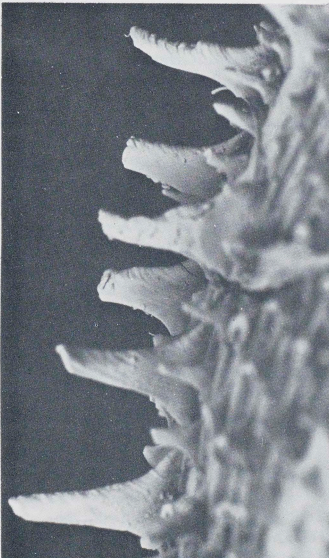
1. USNM 377399 ( $\times 3$ ); view of mold of exterior of valve surface showing strong variation in spine size on fragmentary valve. Locality TU 778, Inglis Limestone (Upper Eocene), Florida Barge Canal, south of Inglis, Florida.



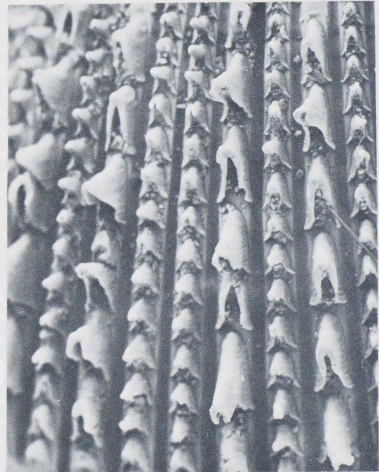
1



4



2



3

cent ribs is more strikingly developed in *A. acrocome* than in the other species referable to this genus, the differences being expressed both in the relative strength of the spines and in their total heights (see pl. 2, figs. 1-3). Anteriorly the alternation of spine sizes tends to remain, but on some specimens the finer ones may increase in size until they approach that of the heavier ones. Posteriorly, however, an interesting variation occurs: the weak postero-ventral angulation is marked by the presence of a strong-spined rib; followed posteriorly by a low-spined one, then another strong-spined one with four low-spined ones intervening before the next strong-spined one. Posterior to this there are three or four low-spined ribs followed by two or three strong-spined ones near the posterior dorsal margin. The number of costae varies from 45 to 47, the majority having 46. The largest specimen, from TU locality 951 on Tenmile Creek, has a height of 55.6 mm and a length of 46.7 mm; Dall's immature type had a height and length of 7.5 mm.

5 (?) *Cardium (Trachycardium) pessoae* Maury (1925, pp. 306 [Portuguese], 307 [English]; pl. 17, figs. 15, 18); Pirabas Formation, Lower Miocene, Rio Pirabas, Pará, Brazil. The shape of the internal mold, 35 mm long and 40 mm high, with a long, straight hinge, is very similar to that characteristic of *Acrocome*. Maury's figure of the external mold of the anterior portion of the shell clearly shows the presence of inverted "V"-shaped spines on the ribs, but it is not certain whether there is an alternation in spine size nor, in fact, if the spines are laterally symmetrical or have a degree of prolongation on their posterior flank. Maury's description of the spines as being "A-shaped, or lambda-shaped" in no way solves the problem. The number of ribs is said to be "about fifty."

This is the only South American species of which the writer is aware that might be referable to *Agnocardia*.

6. *Cardium (Trachycardium) cinderellae* Maury (1917, p. 375, pl. 62, fig. 4); "Zone B" Gurabo Formation, Lower Pliocene, near Los Quemados, Dominican Republic. Known only from the Dominican Republic where it is relatively rare, *A. cinderellae*

has essentially the same number of costae as *A. acrocome*, varying between 44 (holotype, *vide* Maury) and 49, with the average on the specimens presently available for study being 47. The costae tend to have a shallow, median groove that is coincident in position with the dorsal end of the spines; the narrow slightly raised margins of the grooves bear the lateral terminations of the spines that, however, flare out from their base and extend over the margins of the inter-rib areas. Posteriorly there tend to be three or four smaller-spined ribs between the more strongly ornamented ones, while the ribs reaching the anterior margin of the valve have spines of approximately equal strength on each one. The spines of *A. acrocome* are distinctly less flared out laterally and seldom overhang any of the inter-rib areas; furthermore, they are relatively narrower and more "pinched in" near their upper ends, thus having a more distinctly spinose appearance.

7. *Cardium (Trachycardium) cinderellae* Maury, variety *alternatus* Hubbard (1920, p. 115, pl. 19, figs. 2, 3, 4); Lares Formation, (?) Upper Oligocene, Porto Rico. Described as having a "sculpture like *C. cinderellae* Maury but the shell is larger, shorter, and more convex. It may possibly deserve a specific name, but the specimens are too fragmental to warrant this." Combined with the differences in valve shape and proportion is the statement that the surface has only "about thirty-six broad flat ribs" in contrast to the average of 47 ribs in *A. cinderellae*. This, plus the difference in geologic age of the two forms, makes it probable that *Agnocardia alternata* (Hubbard) is a valid species.

8. *Agnocardia spinosifrons* n. sp. Pinecrest Formation, Lower Pliocene, Florida (see description, below).

9. *Cardium (Acanthocardia?) dissidipictum* Woodring (1925, p. 135, pl. 18, figs. 10, 11); basal Pleistocene, Bowden, Jamaica. The type is a relatively small specimen (length 23 mm, height 23.4 mm) but Woodring also cites a "restored broken valve" of "approximately 35 mm length and 37 mm height." A topotype fragment in the Tulane collections, 37 mm in length, has ribs that show a rib-top width of 2.6

mm, while a broken valve that has a height of 32.5 mm, has rib-tops that are but 1.2 mm wide at their ventral extremity; the relative proportions of these rib-tops would suggest that the fragment came from a valve that was at least 70 mm in height. Woodring cites the type as having 43 radial ribs; the broken valve mentioned above has 46. The spines tend to be laterally compressed toward their midheight, but their ventral ends, and to some extent their lower sides, flare out over the narrow, channeled interspace margins in a manner similar to that observed on *A. cinderellae*.

As suggested by Stewart (1930, p. 265), *A. dissidectum* appears to be the last surviving member of the genus.

#### SPECIES INCORRECTLY REFERRED TO AGNOCARDIA

In his original discussion of *Agnocardia*, Stewart (1930, p. 265) referred two species to it that, in the opinion of the present writer, are not members of this genus:

1. *Cardium sorrentoensis* M. A. Hanna (1927, p. 285, pl. 41, figs. 10, 12, 14); La Jolla Formation, Middle Eocene, San Diego County, California, and also cited as present in the Simi Valley area (*ibid.*, p. 260). The ornamentation of the ribs, as described by Hanna and shown in his figure 14, consists of costae with "chevron-shaped spines" alternating with others that have only "smaller node-like spines," which appear to be rounded and of an *Acanthocardia*-like form, although much smaller in size. This alternation is well depicted by Keen (1980, pl. 3 fig. 9a), who also shows that the intercostal areas, described by Hanna as being "about as wide as the ribs," are marked by a radial ornament that seems to represent narrow grooves.

The presence of alternation of rib-top ornament is indeed suggestive of *Agnocardia*, but the nature of the nodose finer spines plus the relatively wider intercostal areas with a radial ornamentation, are distinctive and together with its early Middle Eocene age – essentially about the same as that of the first appearance of the genus – implies a different ancestry.

2. *Cardium rectispina* von Koenen (1893, p. 1148, pl. 76, fig. 5a-d). Stewart (1930, p. 265) also suggested that *Agnocardia* "may be represented in the . . . Oligocene of Germany – Lattorfien – by 'C.' *rectispina* von Koenen." Examination of von Koenen's figure 5d shows that the costae on this small form – the type has a width of 7.7 mm and a height of 8.1 mm – bear spines of the same size on adjacent ribs, with the intercostal areas, which are slightly narrower than the ribs, bearing rather well-developed transverse threads or laminae. There is also some suggestion that the posterior wing of the chevron-shaped spines is slightly longer than the anterior and is somewhat like that of species of *Trachycardium* s.s., but the shape of the hinge is more that of *Acanthocardia*.

#### III. SYSTEMATIC DESCRIPTION

Family CARDIIDAE Lamarck, 1809

Subfamily CARDIINAE Lamarck, 1809

Genus AGNOCARDIA Stewart

*Agnocardia* STEWART, 1930, Acad. Nat. Sci. Phila., Spec. Publ. 3, pp. 37, 294.

Type species: *Cardium (Trachycardium) claibornense* Aldrich, 1911, by original designation.

AGNOCARDIA SPINOSIFRONS H. E. Vokes,  
new species

Plate 1, figures 1-3

*Diagnosis:* Shell moderately large, sub-circular in outline, in adult stage slightly higher than long, with a relatively low, roundly inflated umbo; anterior and ventral margins broadly and regularly rounded, posterior only slightly convex; surface ornament of 43 or 44 radial costae each bearing numerous inverted "V"-shaped spines, those on the ribs of the anterior and median portions of the valve surface tending to vary in strength and number on alternate costae but becoming more equal in strength toward the ventral margin of the larger specimen, there being four larger spines contrasted with six smaller ones per centimeter on the mid-height of the valve and four vs. five on the same ribs at the ventral margin; with four or five costae with fine spines immediately posterior to the last strong-spined rib, then three small-spined ones, succeeded by three stronger-spined ones; individual spines tending to be "pinched in" at mid-

height and when complete showing a prolonged elongation at their ventral terminus, lateral margins slightly flared below but not extending over the inter-rib areas; costae on the anterior and the anterior part of the median area with grooves that are aligned with the dorsally pointed ends of the spines; inter-rib areas about one-half to one-third the width of the adjoining costae, narrower anteriorly than on median or posterior areas, and smooth or with narrow growth rugae; interior margins denticulate; hinge typical of the genus.

*Holotype*: USNM 377405; length 31.1 mm, height 33.7 mm, diameter (right valve) 14.2 mm. Locality TU 1177.

*Paratype*: USNM 377406; length 42.5 mm, height 48.5 mm, diameter (right valve) 20.6 mm. Locality TU 1177.

*Paratype*: USNM 377407; length 14.8 mm, height 14.5 mm, diameter (left valve) 7.3 mm. Locality TU 1177.

*Type locality*: TU 1177, Pinecrest Formation, Mule Pen Quarry, north side of Florida highway 846, 9.1 miles east of U. S. highway 41 at Naples Park (SE¼Sec. 24, T48S, E26E), Collier Co., Florida.

*Discussion*: The median-sized specimen, which has been selected as holotype of this species because of the better preservation of the spinose rib ornament, compares in general size with the Tulane specimen of *A. dissidipictum* (Woodring) from Bowden, Jamaica, but differs in shape, having a straighter, more dorsoventrally trending posterior margin, and in the nature of the spinous ornament, the spines being smaller and more numerous on the Jamaica specimen, with seven and nine spines per centimeter as compared with four or five on the same relative area of the present species. Furthermore, the basal portion of the ribs, while slightly flaring, do not project over the intercostal areas as they do in both *A. dissidipictum* and the Dominican *A. cinderellae*.

The specific name *spinosisifrons* is derived from the Latin terms, *spinosisus*—"spiny or thorny" and *frons*—"foliage."

#### IV. LOCALITY DATA

The following are Tulane University fossil localities:

778. Inglis Formation, Upper Eocene. Florida Cross-State Barge Canal at U. S. highway 19, just south of Inglis, Levy County, Florida.

812. Inglis Formation, Upper Eocene, Florida Cross-State Barge Canal, south side, ca. 1.5 miles west of U. S. highway 19, at Inglis, Levy County, Florida.

830. Chipola Formation, Lower Miocene. Tenmile Creek, at power line crossing about one mile west of the Chipola River (SE¼ Sec. 12, T1N, R10W), Calhoun County, Florida.

951. Chipola Formation, Lower Miocene. Tenmile Creek, about 1¼ miles west of Chipola River (SE¼ Sec. 12, T1N, R10W), Calhoun County, Florida.

1177. Pinecrest Formation, Middle Pliocene. Mule Pen Quarry, north side of Florida highway 846, 9.1 miles east of U. S. highway 41 at Naples Park (SE¼ Sec. 24, T48S, R26E), Collier County, Florida.

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## REVIEW

FOUNDATIONS OF STRUCTURAL GEOLOGY, by R. G. Park. Published by Blackie & Son Limited, Glasgow and London, 1982, viii + 135 pp., illus., paper \$17.95 (distributed in the USA by Chapman and Hall, New York)

This book provides a brief introduction to Structural Geology and is intended to stimulate reader interest in this subject and to encourage him to pursue more advanced textbooks and scientific papers in this field. Thus, it includes a short and simple explanation of many of the concepts,

principles, and terms used in modern structural studies. It is both clear and coherent as well as brief and efficient in its language and treatment. It should serve as a handbook useful to the student as a study guide or outline of the subject. It is generally up-to-date and well written. The index and the lists of references for further reading at the end of each section are most useful. It is recommended for those who need a condensed outline treatment of structural geology.

—H.C.S.