

OBSERVATIONS ON THE GENUS *DIMYA* (MOLLUSCA: BIVALVIA) IN THE
CENOZOIC FAUNAS OF THE WESTERN ATLANTIC REGION

HAROLD E. VOKES

TULANE UNIVERSITY

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I. ABSTRACT

The bivalved molluscan genus *Dimya*, heretofore known to be represented in the western Atlantic faunas by one Miocene species and variety from the Dominican Republic (*D. grandis* and var. *divaricata*, both of Dall, 1896) and two Recent species from the Caribbean Sea and adjacent areas (*D. argentea* Dall, 1886, and *D. tigrina* Bayer, 1971), proves to be more widely distributed in the paleontological record. Three new species are described: *D. alleni*, from the Cook Mountain Formation, middle Eocene of Louisiana; *D. rufaripa*, from the lower Oligocene Red Bluff Formation of Mississippi; and *D. fimbriostata*, from the lower Pleistocene Moin Formation of Costa Rica. In addition, other specimens from the Moin Formation are referred to *D. tigrina* Bayer, and, three valves from the well-known Bowden, Jamaica, locality serve to document the occurrence of the genus in that fauna.

The geologic and the geographic distribution of the known fossil and Recent species of *Dimya* and *Dimyodon* is discussed. It is concluded that *Dimya* probably is descended from the Upper Triassic to middle Oligocene genus *Dimyodon*, possibly first appearing in the late Cretaceous, but certainly present in the Paleocene and achieving widespread distribution in the

middle and upper Eocene of the Old World Tethyan faunas before becoming relatively rare and apparently confined to the deeper water facies of Oligocene and later faunas. The Pleistocene forms here described constitute the first known records of its occurrence in deposits of that epoch. A number of Recent species are known from the western Atlantic and the Pacific faunas; the average depth for the 47 available dredging records for these species is 311 meters, the few available bottom temperature records average slightly over 59°F (15°C).

Annotated lists of those species that have been referred, at one time or another, to *Dimya* and *Dimyodon* are appended.

II. INTRODUCTION

In 1969, James A. Allen of Alexandria, Louisiana, sent the writer several specimens of a small bivalve species that proved to be referable to the genus *Dimya* Rouault, 1850. These had been collected from deposits of the Cook Mountain Formation of middle Eocene (Claibornian) age at Columbus, Louisiana, shortly before that area was flooded by the waters impounded behind the Toledo Bend Dam on the Sabine River. A survey of the literature on the genus revealed only one described western Atlantic fossil species and variety (*D.*

grandis Dall and var. *divaricata* Dall, 1896*, "Oligocene [*sic*], Santo Domingo") and one Recent species, *D. argentea* Dall, 1886. Subsequently, in 1970, Moore described a new genus *Dimyella*, with its minute type species *D. starcki* found attached to the roof of a salt-water cave or tunnel on the island of Cozumel, Quintana Roo, Mexico. In 1971 Bayer added a second Recent species of *Dimya*, *D. tigrina*, from off Punta Piedras, Colombia, and also described a new genus *Basiliomya*, with type species *B. goreau* from Discovery Bay, Jamaica, and off Andros Island in the Bahamas. Thus, as of this writing, there are in the western Atlantic Recent faunas four species, two referable to *Dimya* and two to other, presently monotypic, genera, with still but the one fossil species and its variety.

Examination of the paleontological collections at Tulane University disclosed, in addition to the specimens submitted by Mr. Allen and herein named *Dimya allen*, n. sp., more than 500 valves of *D. grandis* Dall and its variety *divaricata* Dall from the upper Miocene of the Dominican Republic, three specimens of an undetermined species from the famous Bowden, Jamaica, locality (TU 705) and more than 400 specimens of a new, relatively large shelled species, *D. fimbriocostata*, from the Moín Formation, Pleistocene of Costa Rica, from whence we also have a dozen specimens of a much smaller form that appears to represent *D. tigrina* Bayer.

Finally, during the period of preparation of this manuscript the writer, temporarily immobilized by a broken ankle, was passing the time picking out well-preserved specimens present in the smaller sieve fractions saved from some of the Tulane field collections. To his amazement he noted a specimen of *Dimya* in the first "spread" of material from the Red Bluff Clay, lower Oligocene, of Mississippi (locality TU 226). This stimulated a careful examination of all material from that site with the result that more than 140 specimens were found. David Dockery, of the Mississippi Geologic Survey, found 178 additional specimens in his collections from the Red

Bluff as exposed on Sand Branch Creek, Mississippi (TU 1291), and subsequent collecting from these and adjacent localities added an additional 354 specimens of this new species, which is herein named *Dimya rufaripa*.

Species referred to the genus *Dimya* have a more-or-less inequilateral, inequivalved shell that is made variable in shape by its sessile habit; the right valve, which is attached to some foreign object, is slightly larger than the left that fits inside its outer edge. Both valves have the outer layers composed of a micaceous-appearing substance, pearly white in color in Recent species, that was described as "nacreous" by Dall (1886, p. 228). The inner, visceral area of the valves is formed of a porcellanous material that is most notably developed inside of the pallial line but which extends in an apparently thinner glaze to a line of small pits that often are prolonged inward on the surface as rather strongly marked, radiately subparallel wrinkles. These, according to Dall (1886, p. 229), are "due to the papillae on the mantle-edge which are strongest at their distal ends, and which there form a narrow band of elevated waves and grooves which borders the mantle cavity of the shell." In some of the smaller shelled species, and in the more immature individuals of larger ones, these wrinkles may continue across the visceral area almost up to the hinge (see pl. 1, fig. 5; pl. 2, fig. 6). The marginal area between the line of pits and the pallial line tends to become a raised ridge dorsally toward the hinge area, with the shell falling away rather sharply toward the median part of the visceral area and more gently laterally toward the valve margins. These ridges are most strongly developed on the left (free) valve, but in both valves the pits or wrinkles of the marginal area extend up along the crests of the ridges, where they tend to be more strongly developed than in the ventral portions.

Most distinctive, however, are the scars of the adductor muscles. The anterior one is single, elongate-elliptical in shape, and well impressed along the antero-dorsal portion of the entire pallial line. The posterior scars consist of two subequal, ovate, and closely adjacent impressions that are somewhat more ventral in position than is the anterior one and also are inside of the pallial line.

*Bibliographic references for all species may be found in the list that is appended to the text of this paper.

The hinge is marked by a resilium situated in a small, triangular, pit-like socket under the cavity of the low and inconspicuous umbo. This socket is margined in the right valve of larger shelled species by slightly raised and roughened borders that appear to represent feebly developed crura and fit between the rounded upper surface of the resilium socket and the extended dorsal ends of the raised lateral ridges of the left valves (see pl. 2, figs. 1b, 2a; pl. 3, figs. 5, 7b). In smaller shelled species, and in immature individuals of the larger ones, the raised lateral ridges are proportionately less developed and do not impinge upon the dorsal area, leaving a transversely striated "hinge-line" that is bisected by the resilium pit with the marginal "crura" very weakly developed. Dall (1886, p. 228) says of *D. argentea*, the "ligament is hardly perceptible, linear, nearly as long as the hinge-line," and Bayer (1971, p. 223), in his description of *D. tigrina*, says: "The thin, linear external ligament is visible along the whole hinge line." This feature is usually not preserved in the fossil specimens, apparently because the valve is so thinned along its area of attachment that the outer layers are easily broken away.

As noted by Yonge (1975, p. 549), the presence of both external and internal ligaments is a character that readily distinguishes the Dimyidae from the Pectinidae and Spondylidae. This same condition occurs, in somewhat modified form, in the Plicatulidae and both the latter family groups also agree in lacking a foot — present in the pectinids and spondylids. These features have led Yonge to propose that the Dimyidae and Plicatulidae be united in a superfamily Plicatulacea, separated from the Pectinacea to which both previously have been referred. However, under the Rules of Zoological Nomenclature (Article 36) the superfamily name must be Dimyacea and attributed to Fischer, 1886, although it was first used as of superfamily rank by Pilsbry (1922, p. 413).

The genus *Dimya* appears to have been developed from the genus *Dimyodon* "Munier-Chalmas" Fischer, 1886 (p. 937), with the type species (by monotypy) *D. schlumbergeri* "Munier-Chalmas" Fischer, from the Bathonian of Herouville, France. This latter genus differs primarily in having single anterior and posterior adductor scars, both of which are located ad-

acent to the pallial line. The cardinal crura are also somewhat more strongly developed and are striated. *Dimyodon* appears to be primarily Mesozoic in its distribution, having been reported in Europe from the upper Triassic (*D. richthofeni* Bittner, 1895), the Jurassic (*D. schlumbergeri*), and the Cretaceous ("*Ostrea*" *nilssoni* Hagenow, 1842; *D. bohmi* Stolley, 1892; *D. costatus* Grönwall, 1900, etc.). *Dimyodon nilssoni* also has been reported as occurring in the Upper Cretaceous of the Northern Range of Trinidad (Trechmann, 1935, p. 173) and it seems almost certain that "*Dimya*" *subrotunda* Felix, 1891, from the Neocomian (Lower Cretaceous) near Tehuacan, Puebla, Mexico, also is to be referred to *Dimyodon*, rather than to *Dimya*. The original illustrations are not adequate to permit any definite conclusions, but the description mentions a muscle scar on each side of the valve on a lineation "which perhaps represents a mantle impression" (freely translated), a feature that, as noted above, is distinctive of *Dimyodon*. This genus persists into the Paleogene in Europe, for the illustrations of *Dimyodon similis* von Koenen, 1893, and especially also those of the same species given in Sokolow (1905, p. 48 [Russian], 80 [German], text fig. 2, pl. 12, figs. 14a-c, 15a-c, 16a, b; pl. 13, figs. 3a, b) from the Lattorfian (lower Oligocene) of Germany and the Ukraine, respectively, attest to the accuracy of the generic determination, although Zelinskaya *et al.* (1968, p. 53, pl. 14, fig. 12) refer the species to *Deuteromya* Cossmann (= *Dimya*) and cite the age as upper Eocene. A subspecies, *D. similis interstricta* Noszky, 1939, has been described from the Rupelian, middle Oligocene, of Hungary.

"*Dimyodon*" *storrsi* J. P. Smith, 1927, from the upper Triassic Hosselkus Limestone of California, was identified as *Dimyodon* on the basis of the shape and ornamentation, the hinge and interior of the valves being unknown, but according to Smith "it has a strong similarity to *Dimyodon intusstriatum* Emmrich [sic], of the Rhaetic beds of Austria. . ." Cox and Hertlein in the *Treatise on Invertebrate Paleontology* (p. N378), note that *Ostrea intusstriata* Emmrich, 1853, is the type of species of *Dimyopsis* Bittner (1895, p. 219), which genus they consider a synonym of *Atreta* Ettlalton, 1862, assigned to the family Plicatul-

ulidae. Species referred to *Atreta* are externally very similar to those of *Dimyodon* but differ in being monomyarian. Hence the systematic position of *D. storrsi* must be considered as uncertain until the nature of its internal structures can be determined.

Stratigraphic range — The genus *Dimya* has been reported as occurring in the Upper Cretaceous of North Africa — *D. libyca* Quaas, 1902, and *D. checchiai* Serra, 1936. Examination of the original illustrations suggests that both species are to be referred to *Dimyodon*. *Dimya* has been reported from the Paleocene of Belgium, questionably from the "Poudingue de Ciply" by Vincent, 1930, as "*Dimya* ? sp.?", and more definitely from the "Calcaire de Mons" by Glibert and Van de Poel, 1973, as "*Dimya* sp. ?."

The genus appears to have "flowered" during the Eocene, especially in the region of the Tethyan seaway. The writer has found records of eleven Eurasian Tethyan species that have been referred to *Dimya* (see appendix listing, this paper); some of these forms may well prove to be synonyms of one or another in the list. They are from Spain, southwestern France and the Paris Basin, northern Italy, the northern Alps of Austria and Bavaria, Bulgaria, Libya, Egypt, the Ukraine and western Punjab, India. During the middle Eocene the genus reached the United States (this paper) and New Zealand (undescribed species, Maxwell, 1978, p. 16). The upper Eocene is represented in South Australia by *D. sigillata* Tate, and in New Zealand by *D. westonensis* Maxwell.

Following the Eocene there is a marked decline in the number of recorded fossil species. Prior to this report only one species and a subspecies have been reported from the Oligocene: *D. fragilis* von Koenen, 1893, described from the Lattorfian (lower Oligocene) of Germany and also reported from the same horizon in the Ukraine (Sokolow, 1905, p. 47, pl. 13, figs. 9-12); a subspecies *D. f. punctata* Noszky, 1939 — as "*Dymia*"[sic], known from the Rupelian (middle Oligocene) of Hungary. The geologic age of *D. raulini* (Cossmann and Peyrot, 1914) — as *Deuteromya* — is reported as "Helvetian?," but the authors state that the stratigraphy at the type locality is so uncertain that all that can be said

with assurance is that it is younger than *D. deshayesiana* Rouault, 1850, which is Lutetian (middle Eocene) in age.

Species of known Miocene and Pliocene age are confined, in Europe, to the Italian sections. Two were described in 1897 as subspecies of the Oligocene *D. fragilis* von Koenen — *D. f. miopliocenica* Sacco (Helvetian, middle Miocene, to Plaisancian, lower Pliocene) and *D. f. crassiplicata* Sacco (Tortonian, upper Miocene). A third form, *D. extenuiplicata* (Sacco) (new name for *Ostrea tenuiplicata* Seguenza, 1879, non Sowerby), reported as ranging from the Aquitanian (early Miocene) to the Astian (lower Pliocene) of Calabria, may prove to be a synonym of *D. fragilis miopliocenica*. In his discussion of the latter, Sacco (1897, p. 41) noted that Seguenza had described and figured a similar form under the pre-occupied name of *Ostrea tenuiplicata* but added that, if the description and figures [exterior only] were accurate, the form lacks the characteristic double muscle impressions of *Dimya*. He apparently had overlooked the discussion by Dall (1886, p. 231) who wrote: "The figure of *Ostrea tenuiplicata* of Seguenza resembled *Dimya* so much in its exterior that I requested Professor Seguenza to examine the interior and inform me of the character of the muscle impressions. He did so, and also most kindly sent me two valves which determine the correctness of my suspicions. The shell is an undoubted *Dimya*."

The known Mio-Pliocene record, exclusive of Europe, consists only of *D. dissimilis* Tate, 1886, uppermost Oligocene (?) to Lower Pliocene, South Australia; *D. kaiaparaensis* Laws, 1944, from the (?) lower Miocene of New Zealand; and of *D. grandis* Dall and *D. g. divaricata* Dall, 1896, from the upper Miocene of the Dominican Republic. The Pleistocene forms described herein are, insofar as the writer has been able to learn, the first reported from that epoch.

In contrast to the sparsity of the dimyids in the Oligocene-Pleistocene interval is their relative abundance in the Recent faunas. There are at least 13 described Recent forms that have been referred to the genus *Dimya* (two of these, *D. radiata* and *D. r. takii* both of Kuroda, have been placed in the synonymy of *D. filipina* Bartsch by Habe, 1971, p. 330). These 13

named forms include two from the western Atlantic Ocean. (*D. argentea* Dall, 1886, and *D. tigrina* Bayer, 1971), two from the eastern Pacific Ocean (*D. californiana* Berry, 1936, and *D. coralliotis* Berry, 1944), two from the Hawaiian Islands (*D. mimula* and *D. molokaia*, both of Dall, Bartsch and Rehder, 1938), and seven from the western Pacific area, two of which, as noted above, may be synonyms of a third form. These seven include *D. corrugata* Hedley, 1902 (type of *Dimyarina* Iredale, 1936) from off New South Wales, Australia; *D. maoria* Powell, 1937, from off Three Kings Islands, North Island, New Zealand; *D. lima* Bartsch, 1913, from the Philippines and Indonesia; *D. filipina* Bartsch, 1913, from the Philippines and, if Habe is correct in his synonymizing of *D. radiata* and *D. r. takii*, from off southern Japan; and *D. japonica* Habe, 1971, from south and central Japan.

Curiously there appear to be no known Recent species from the eastern Atlantic Ocean, the Mediterranean Sea or the Indian Ocean, all of which are more or less adjacent to the region of the early Tertiary Tethyan seas in which the genus had its first "flowering."

Ecologic Observations — Available bathymetric data indicate that the majority of the Recent species are inhabitants of outer shelf and continental slope depths. The average of the 47 dredging records with depth information available for dimyid species is 311 meters. There is, of course, variation in this factor between different species; the average depth of the 19 stations from which such data on the occurrence of *D. argentea* has been reported is 354.6 meters, while the types of *D. tigrina* Bayer, the other known western Atlantic species, were dredged between 75 and 79 meters. The species with the deepest average occurrence appears to be *D. lima* Bartsch in which the average of ten records is 429 meters; however, Bartsch (1913, p. 307) questions one record in which the depth (83 fathoms) was taken from a chart rather than from a sounding. This appears to be too shallow relative to the normal range of the giant limid species on which the *Dimya* was growing and is less than one half the depth of the next shallower record for *D. lima*. If this station be ignored, the average depth for *D. lima* is 459.5 meters.

In the opinion of the writer the apparent disappearance and scarcity of species of *Dimya* after its Eocene flowering is to be explained as the result of its migration to deeper waters in the face of competition from more "aggressive" shallow-water species.

Only a few records are available as to bottom temperature at stations from which species of *Dimya* have been collected. Five of these are cited by Dall (1886, p. 231) for *Dimya argentea*; these range from 54.5°F at 248 fathoms (453.5 meters) off St. Croix, Virgin Islands, to 70.7°F at 73 fathoms (133.5 meters) off Barbados. The average for all five stations is 61.4°F. There are eight records cited by Bartsch (1913, pp. 306-7) for *D. lima* which, as noted above, has the deepest average occurrence. The temperatures at these stations ranged from 47.4°F to 63.6°, the average being 54.7°. The coolest temperature occurred at the most northerly station, 13°53' N latitude, with the warmest at one of the more southern ones located at 6°11'50" N. Of special interest is the fact that for five stations, intermediate in position between 8°36'26" and 9°31'50"N., the range in temperature was only one degree Fahrenheit — from 53.3° to 54.3°, even though the depth range was from 175 fathoms (320 meters) to 432 fathoms (790 meters).

Single locality records are available for three other species: *D. filipina* Bartsch — 63.1°F, depth 108 fathoms (192 meters); *D. mimula* Dall, Bartsch and Rehder — 65.5°F, 127-130 fathoms (ca. 235 meters) and *D. molokaia* Dall, Bartsch and Rehder — 72°F, 66-96 fathoms (ca. 148 meters). Both of the latter species were described from the Hawaiian Islands. These few records are too insufficient to permit any conclusions save the fact that species of the genus *Dimya* are inhabitants of only the warmer portions of the outer shelf and slope waters.

III. ACKNOWLEDGMENTS

The writer wishes to record his deep appreciation of the kindness of Mr. James Allen of Alexandria, Louisiana, for sending the specimens that stimulated this study, and to Mr. David Dockery, a graduate student at this university who is studying the bivalve faunas of the Vicksburg Group, Oligocene, for the loan of 178 spec-

imens of the form here described as *Dimya rufaripa* collected from the Red Bluff Clay on Sand Branch in Mississippi. He is also indebted to Dr. Myra Keen, Stanford University (Emeritus), whose constructive criticisms and suggestions were most helpful.

IV. SYSTEMATIC PALEONTOLOGY

Superfamily DIMYACEA Fischer, 1886

[Pilsbry, 1922]

Family DIMYIDAE Fischer, 1886

Genus DIMYA Rouault, 1850*

Dimya ROUAULT, 1850, Mém. Soc. Géol. France, (ser. 2) v. 3, pt. 2, p. 470 (Mém. 7, p. 14; 1848 ?)

Margariona ("Dall MS") KOBELT, 1882, Nachrbl. Deutsch. Malakozool. Gesell., v. 14, nos. 11-12, p. 186 [no species cited; put in synonymy of *Dimya* by Dall, 1886].

Deuteromya COSSMANN, 1903, Rev. Crit. Paléozool., v. 7, p. 68 [unnecessary new name for *Dimya* Rouault, non *Dimya* Menke, 1830, a suborder name that does not pre-occupy a genus-group name — see ICZN Art. 52].

? *Dimyarina* IREDALE, 1936, Rec. Australian Mus., v. 19, p. 269 [type species: *Dimya corrugata* Hedley, 1902].

Type species, by monotypy, *Dimya deshayesiana* Rouault, 1850, Mém. Soc. Géol. France, (ser. 2) v. 3, pt. 2, p. 471, pl. 15, figs. 3, 3a, 3b. Eocene, Bos d'Arros, Southern Aquitaine, France.

DIMYA ALLENI H. E. Vokes, n. sp.

Plate 1, figures 1-5

Description: Shell small, averaging about 5 mm in length — the largest entire valve being but 6.1 mm high (one broken specimen suggesting a possible maximum height of about 8 mm); round to roundly ovate in outline, attached by the right valve. Left valve smooth, usually with a raised boss-like elevation above the attachment surface, occasional specimens revealing a few scattered, broadly rounded microscopic riblets mainly toward the posterior lateral margin. Shell material with a micaceous appearance externally but with a relatively thick, white

chalky coating internally over the visceral area. Hinge-line variable in length, depending upon the attachment area, but tending to be moderately elongate and occasionally sub-auriculate, with the triangular capping over the small resilial pit subcentral and, in the left valve, topped by a slightly projecting, very small umbo. The row of radial markings on the outer edge of the visceral area usually consisting in the left valve of slightly elongate radial pits that appear to have received corresponding low radial ridges on the right; however, considerable variation occurs even within the same specimen. Anterior adductor scar elongate, elliptical, impressed on the pallial line dorsal to the mid-height of the visceral area of the valve; posterior scars duplicate, the two units being relatively large for the size of the valve, rounded and located more or less diagonally transverse, with the more ventral scar situated just inside the weakly marked pallial line.

Type locality: Sabine River, Columbus, Sabine Parish, Louisiana.

Occurrence: Cook Mountain Formation, middle Eocene.

Holotype, USNM 263960; height 6.4 mm, length 6.2 mm, diameter (left valve) ca. 1.2 mm. (Plate 1, fig. 2)

Paratype A, USNM 263959; height 6.0 mm, length 6.3 mm, diameter (right valve) ca. 1.6 mm. (Plate 1, fig. 1)

Paratype B, USNM 263961; height 5.6 mm, length 5.5 mm, diameter (left valve) ca. 1.3 mm. (Plate 1, fig. 3)

Paratype C, USNM 263962; height 5.1 mm, length 6.0 mm, diameter (left valve) ca. 1.2 mm. (Plate 1, fig. 4)

Paratype D, USNM 263963; height 7.2 mm, length 6.9 mm, diameter (right valve) ca. 1.1 mm. (Plate 1, fig. 5)

Remarks: *Dimya alleni*, the oldest presently known western Atlantic Tertiary dimyid, may be distinguished from the other known species from this region by its small size and essentially smooth surface lacking the radial ornament that is well-developed on the comparably small lower Oligocene *D. rufaripa*, n. sp., or the Pleistocene and Recent *D. tigrina* Bayer. Available illustrations of the middle Eocene *D. deshayesiana* Rouault, the type species of the genus, reveal a finely ribbed shell that is about twice the size of the present species and has the paired posterior adductor scars located proportionately much higher in the valve.

This new species is named in honor of James A. Allen of Alexandria, Louisiana, an avid collector of the lower Tertiary fos-

*According to Dall (1886, p. 228, ft.) "Rouault's paper was read in 1847, but seems to have been published in 1848 [as a separate], while the volume appeared in 1849." Sherborn, however, gives the date as 1850. Fischer, (1886, p. 936) cites it as of 1859, an obvious typographical error that has been copied by a number of subsequent authors.

sil faunas of this State, who first noted the unique characteristics of the specimens in his collection.

All specimens were collected from outcrops of the Cook Mountain formation, middle Eocene (Claibornian), located in the banks of the Sabine River near Columbus, Louisiana, prior to the flooding of the area by the waters of the Toledo Bend Reservoir.

DIMYA RUFARIPA H. E. Vokes, n. sp.

Plate 1, figures 6-9

Description: Shell small, averaging about 5 mm in height — the largest specimen being 7.2 mm high and 8.3 long; round to roundly ovate, attached by the right valve; left valve smaller, fitting inside the outer edges of the right. Both valves, outside of the area of attachment, ornamented by fine, rounded, divaricating radial ribs with round-bottomed interspaces of almost equal width; the individual ribs essentially of equal strength from their first appearance at the edge of the attachment area to the valve margin, with each rib divaricating repeatedly to accommodate the increased width toward the marginal area. The attachment area of the right valve tending to mirror the surface ornament of the object to which it was cemented; that of the left smooth and generally somewhat raised to form a boss-like elevation from the lower, outer edges of which the radial ornament trends across a lower and flatter marginal area. The shell material having, especially in the marginal areas, a distinctly micaceous appearance. Hinge-line variable in length, depending upon nature of attachment, generally short, with a small umbonal angle immediately above the triangular capping of the small, ovate resilial pit. Visceral area with a white, porcellaneous coating, strongest inside of the entire pallial line; unlike the other species here discussed, in the area between the pallial line and the row of pits or low ridges seemingly not covered with the porcellaneous coating, the area being almost dark gray to black in color and smooth except for widely spaced, low, rounded, irregularly radial riblets that cross from the outer row of ridges and pits to the inner edge of the coated portion of the visceral area. The riblets becoming much more numerous and closely adjacent as they enter upon the raised crura-like dorsal margins of the area. In the left valve the outer row characteristically appearing to have been marked by narrow grooves that divide; a small raised area into two closely approximate ridges, the crests of the ridged margins of the right being received in the inter-ridge grooves of the left. External to the outer row of ridges the shell margins smooth in the right valve up to the extreme outer edge, where the thinned shell ma-

terial becomes slightly corrugated by the ends of the external ribs; in the left valve the ventral margins beyond the outer row of ridges and grooves tending to be reflexed to fit inside the more concave interior of the right. Anterior adductor scar elongate-elliptical, located on the pallial line moderately high on the valve and well impressed; posterior scar duplicate, the two units being dorso-ventral to each other, both situated well within the pallial line.

Type locality: TU 226, Chickasawhay River, at Hiwannee, Wayne Co., Mississippi.

Occurrence: Red Bluff Clay, lower Oligocene.

Holotype, USNM 263965; height 6.5 mm, length 6.4 mm, diameter (right valve) 2.9 mm. (Plate 1, fig. 7)

Paratype A, USNM 263964; height 6.9 mm, length 7.3 mm, diameter (right valve) 2.1 mm. (Plate 1, fig. 6)

Paratype B, USNM 263966; height 5.8 mm, length 5.0 mm, diameter (left valve) 0.8 mm. (Plate 1, fig. 8)

Paratype C, USNM 263967; height 5.2 mm, length 5.7 mm, diameter (left valve) 1.1 mm. (Plate 1, fig. 9)

All specimens from locality TU 226, Red Bluff Clay, lower Oligocene.

Remarks: *Dimya rufaripa*, n. sp., may be distinguished by its small size and the relatively fine, divaricate external radial ribbing. The older *D. alleni*, although similarly small, is almost smooth externally and *D. tigrina*, which is a little larger, has a somewhat more irregular radial ornament that is frilled by raised, concentric growth lamellae. The European lower Oligocene *D. fragilis* von Koenen (1893, p. 1065, pl. 69, figs. 5a-c, 6a-c), similarly small, is almost smooth, lacking the divaricate radial ornament.

The above description is based upon 679 specimens from five localities in the Red Bluff Clay, lower Oligocene of eastern Mississippi. It is of interest to note that of the 250 specimens in which the right valve was found attached to identifiable shell substrate, 240 were on valves or fragments of valves of pelecypod species; only ten were on fragments of a weakly ornamented gastropod and not one specimen was found attached to any of the rather abundant corals. Almost one-half of those attached to pelecypods (122 of 250) were found on the relatively smooth upper valves of ostrids, the remainder were on species of *Spondylus*, *Astarte*, *Corbula*, *Protocardia*, etc.

The specific name is in reference to its occurrence in the Red Bluff Clay (*rufus* = red; *ripa* = river bank). Specimens in the collection are from TU localities 226, 642, 1288, and 1289, on the Chickasawhay River near Hiwannee and from Sand Branch Creek, Wayne Co., Mississippi, TU locality 1291.

DIMYA GRANDIS Dall

Plate 2, figures 1-7

Dimya grandis Dall, 1896, in GUPPY and DALL, U.S. Natl. Mus., Proc., v. 19, no. 1110, p. 328 ["Oligocene of the Portrero, Rio Amina, Santo Domingo, Bland."] Dall, 1898, Wagner Free Inst. Sci., Trans., v. 3, pt. 4, p. 764, pl. 35, fig. 8; DALL, 1915, in SCHUCHERT *et al.*, U.S. Natl. Mus., Bull. 53, pt. 1, p. 226 [Cotypes 113799]; PILSBRY, 1922, Acad. Nat. Sci. Phila., Proc., v. 73, p. 413.

Dall described this, the only previously reported fossil species from the western Atlantic faunas, as follows:

"Shell large for the genus, ostreiform, attached by the right valve; externally smooth or (in the variety *divaricata*) rather strongly sculp-

tured with close-set dichotomous radiating ribs; internally smooth and nacreous near the edges; the visceral area with a porcellanous, finely granulated coat, posterior adductor leaving a duplex scar, as in *D. argentea* Dall; anterior scar single, small, close to the pallial border and high up in the valve; pallial area bordered by a line of minute, fringe-like, short grooves; cardinal crura raised on each side of the small, subtriangular socket for the resilium, behind which they join, forming in the right valve a keystone-shaped projection which fits inside the pair on the left valve. Alt. 32, lat. 30 mm.

"The genus *Dimyodon*, Munier-Chalmas, is characterized chiefly by its undivided posterior adductor scar, the tooth-like crura being present though feeble in the typical *Dimya*. The present form has the scars of *Dimya* and well-developed crura. . . ."

The only previously published illustration of this species was that of Dall (1898, pl. 35, fig. 8), who gave a view of the interior of an upper, left valve. The caption for this figure includes: "lon. 33 mm." The height, as measured on the illustration is 30.5 mm, and it must be assumed that the figured specimen is not that whose meas-

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| Locality TU 705, Bowden Formation, lower Pleistocene, Bowden, Jamaica. | |

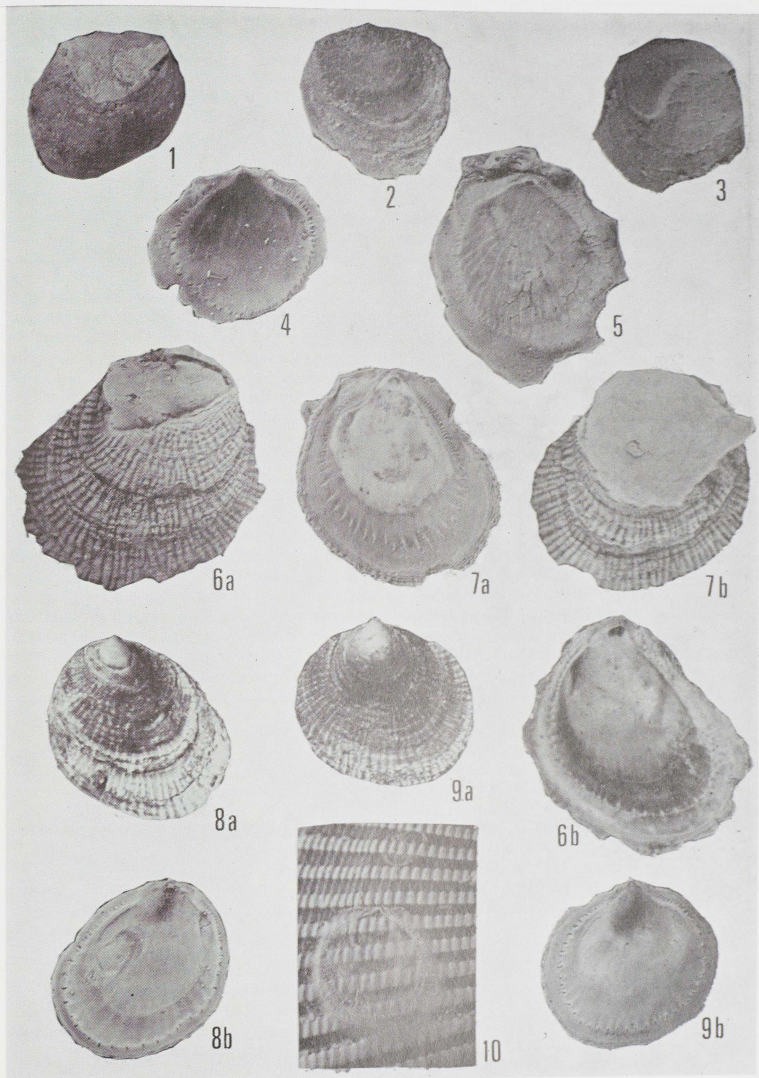


PLATE 1

urements were given by Dall in the original description for it is longer and slightly lower than the latter.

This well-named species appears to be the largest yet referred to *Dimya*. The writer has not had access to all published illustrations of species referred to the genus, but the average of the 43 measurements of other described species noted in the literature is: height 12.06 mm, length 12.13 mm. It must be added, however, that none of the 539 specimens of *D. grandis* (including 68 referable to the variety *divaricata* Dall) in the Tulane University collections attain dimensions as large as those cited by Dall. Our largest specimen is a right valve from TU 1254, which is 31.8 mm high and 27.4 mm long; our largest topotype is 28 mm high and 27.4 mm long.

There seems to be a distinctive tendency for the inner margins of the left valve immediately adjacent to the procellanous visceral area to become raised, almost like enlarged crura, and to be "pinched in" a little below the hinge area (see pl. 2, figs. 1b, 4). This is not apparent in the right valves, and indeed, there is some basis for the suggestion that these enlarged areas of the left valves fit within the raised marginal areas of the right valves.

It is to be noted that of the 539 valves present in the Tulane University collections, only 68 show the radial ornamentation of the variety *divaricata*. In the majority of the individuals in our collections this

ornament is rather weakly developed; the specimen here figured (pl. 2, fig. 7) is that valve on which ribbing is most prominently displayed.

Dall described this species from the "Oligocene of the Portrero [*sic*, = Potrero], Rio Amina, Santo Domingo." The strata exposed at this locality were subsequently referred to the Gurabo Formation of Maury (1919, p. 591) by Vaughan and Woodring (1921, in Vaughan *et al.*, p. 130 — USGS loc. 8516) who suggested (p. 100) a possible Helvetian, middle Miocene age for that formation. More recently, Seiglie and Cucurullo (1971), who studied, in part, the planktonic foraminiferal faunas of the Mao Adentro Limestone, which, according to Vaughan *et al.*, (1921, p. 74), "appears" to be gradational upon the Gurabo, assign a lowermost Pliocene, zone N-18, age to that formation; this would strongly suggest an upper Miocene age for the Gurabo deposits.

Dimya grandis and variety *divaricata* although rather widely distributed in the deeper water facies of the Gurabo Formation are abundantly represented at only one locality, TU locality 1254, from which we have 193 valves. At this site there were two lenticular units, apparently the result of turbidity flows, dipping eastwardly across a road cut. The maximum thickness of each unit was approximately 30 inches, but their total lengths could not be determined. These lenses contained a vast num-

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5. USNM 263973 (× 2.5); height 11.9 mm, length 13.4 mm, diameter (right valve) 5.5 mm. Locality TU 1210.	
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Topotype, USNM 263975; height 18.0 mm, length 22.8 mm, diameter (right valve) 4.5 mm. Locality TU 1219.	

All specimens from the Gurabo Formation, upper Miocene, Dominican Republic.

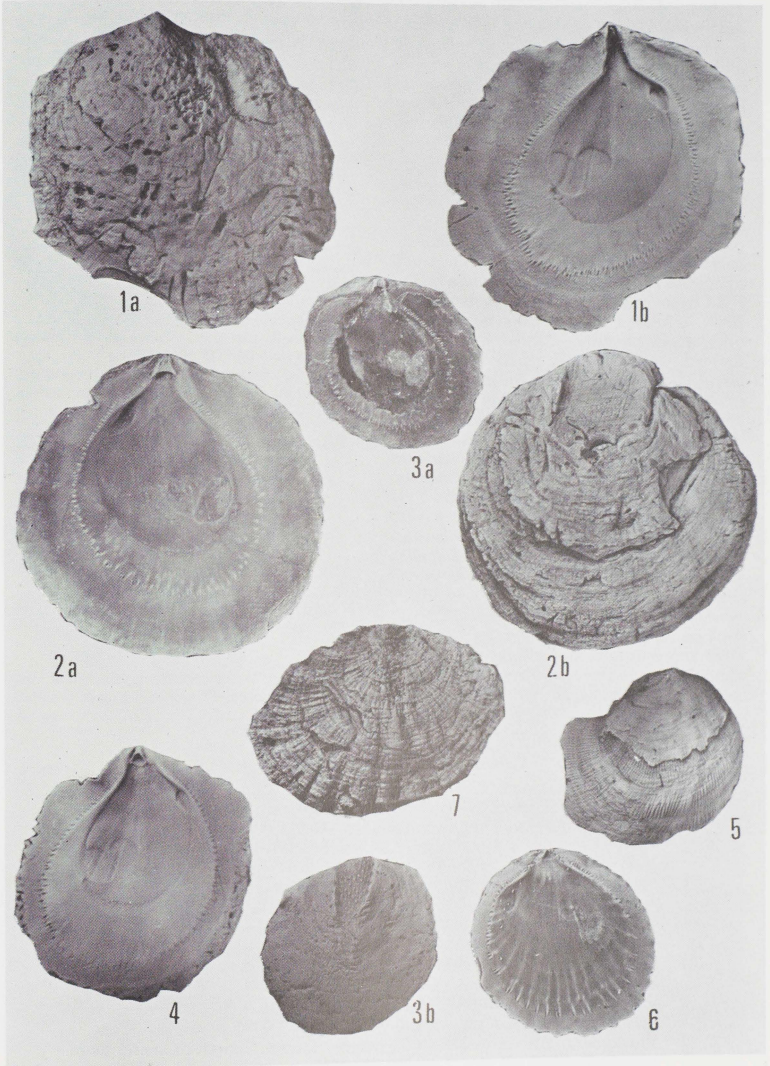


PLATE 2

ber of valves of *Dimya*, many of which were broken and only a few were found that were paired; in addition we collected several broken valves of a large *Amussium*, and three *Ostrea haitensis*. There were molds of other forms, both gastropods and bivalves, and, unfortunately, the inner aragonitic layers of the dimyids also had been removed by solution. Ten other localities have yielded fewer but better preserved specimens; included are 31 topotype valves from the Rio Amina near Potrero (TU 1219), seven from TU 1225 on an arroyo entering the Rio Mao, 35 from four localities (TU 1210, 1211, 1215, 1277) in bluffs along the Rio Gurabo, 142 from cuts on the road from Los Quemados to Sabaneta (TU 1209, 1279), 14 from a deep arroyo that crosses the Santiago/Janico road (1227), and one from a bluff on the Rio Verde near Santo Cerro (TU 1250). In addition, 116 juvenile (?) valves were secured from a small lense that appears to represent a turbidity flow, which transported shallower water material rich in foraminifera and small mollusks into the typical deeper water siltstone facies of the Gurabo Formation (loc. TU 1227A).

In view of this relatively wide distribution it is difficult to account for the fact that it has not been reported from collections made from this area before or since Dall's original description and illustration. It may well be, in view of the size of the shells and their more or less nondescript appearance that those specimens collected were considered, uncritically, to pertain to immature

ostreids or plicatulids; indeed, Pilsbry (1922, p. 413) in his "Revision of W.M. Gabb's Tertiary Mollusca of Santo Domingo" notes that "three valves of the typical form and two of var. *divaricata* were found among unsorted oyster valves."

- Figured topotype, USNM 263969; height 28.0 mm, length 27.4 mm, diameter (left valve) 3.3 mm; locality TU 1219. (Plate 2, fig. 1)
 Figured topotype, USNM 263970; height 26.0 mm, length 26.9 mm, diameter (right valve) 5.0 mm; locality TU 1219. (Plate 2, fig. 2)
 Figured topotype, USNM 263971; height 15.2 mm, length 16.2 mm, diameter (right valve) 2.1 mm; locality TU 1219. (Plate 2, fig. 3)
 Figured topotype, USNM 263972; height 23.5 mm, length 21.6 mm, diameter (left valve) 2.9 mm; locality TU 1219. (Plate 2, fig. 4)
 Figured specimen, USNM 263973; height 11.9 mm, length 13.4 mm, diameter (right valve) 5.5 mm; locality TU 1210. (Plate 2, fig. 5)
 Figured specimen, USNM 263974; height 5.5 mm, length 5.5 mm, diameter (immature left valve) 0.7 mm; locality TU 1210. (Plate 2, fig. 6)
 Figured topotype, *Dimya grandis* var. *divaricata*, USNM 263975; height 18.0 mm, length 22.8 mm, diameter (right valve) 4.5 mm; locality TU 1219. (Plate 2, fig. 7)

DIMYA FIMBRICOSTATA

H. E. Vokes, n. sp.

Plate 3, figures 1-7; Plate 4, figures 1-4

[?] *Ostrea borealis* ? Lamarck. GABB, 1881, Acad. Nat. Sci. Phila., Jour., (ser. 2) v. 8, p. 380.

Description: Shell relatively large for the genus, more or less irregular in shape, depend-

PLATE 3

Figures

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| 1-7. <i>Dimya fimbricostata</i> H. E. Vokes, n. sp. | 44 |
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| 3. Paratype I, USNM 263978 ($\times 2.8$); height 10.7 mm, length 12.6 mm, diameter (left valve) 2.5 mm. Locality TU 1240. | |
| 4. Paratype F, USNM 263979 ($\times 2.5$); height 20.4 mm, length 18.0 mm, diameter (left valve) 5.1 mm. Locality TU 954. | |
| 5. Paratype G, USNM 263980 ($\times 2$); height 20.1 mm, length 26.7 mm, diameter (right valve) 7.2 mm. Locality TU 954. | |
| 6. Paratype C, USNM 263981 ($\times 2$); height 22.6 mm, length 23.5 mm, diameter (right valve) 8.9 mm. Locality TU 954. | |
| 7. Paratype J, USNM 263982 ($\times 2$); height 21.4 mm, length 24.9 mm, diameter (left valve) 5.5 mm. Locality TU 1240. | |
| All specimens from Moín Formation, Pleistocene, Costa Rica. | |

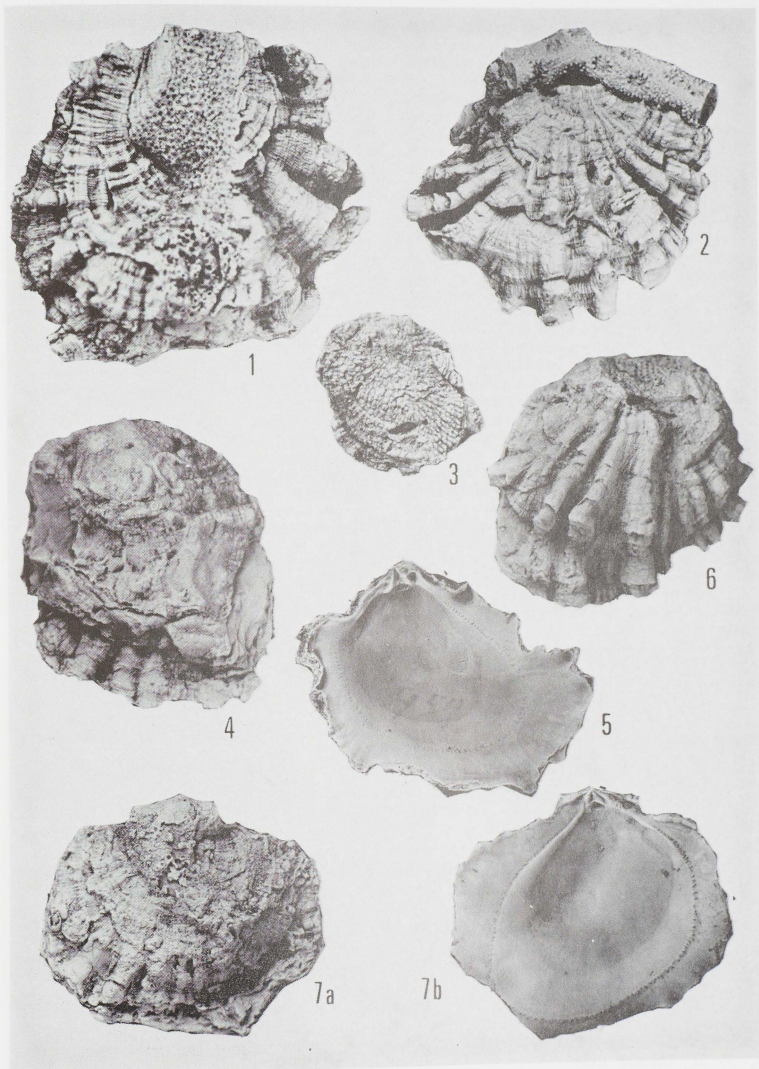


PLATE 3

ing upon the nature of the attachment area, but usually roundly ovate and tending to be slightly produced posteriorly. Right valve attached to substrate, slightly larger than the left valve that fits inside of its outer edge; exterior of both valves rugose, with strong costae developing marginally from the area of attachment on the right valve and from a corresponding medially irregular roughened area on the left. Both the costae, which tend to plicate the thinner valve margins slightly, and the interspaces ornamented with finer, irregular, more or less radial costellae, the whole being fimbriated by thin, raised, concentric growth lamellae and occasional rugosities from interruptions of growth. Hinge-line variable according to area of attachment, occasionally slightly auriculate on one side or the other, but never relatively long and straight as in *D. argentea* Dall or *D. tigrina* Bayer. Hinge-line in most specimens marked by a slight projection at the site of triangular capping of the small resilial socket; the outer edges of this capping on the right valve raised to form slender cardinal crura, which do not quite meet at the apex of the triangle. These crura fitting into narrow, relatively deep sockets that margin the capping of the resilifer in the left valve; elongate grooves laterally adjacent to the crura of the right valve receiving the apical ends of enlarged marginal ridges in the left valve, which are formed ventrally between the pallial line and the row of impressed pits at the outer limit of the visceral area. Inner margins of the valve of a rather micaceous appearance; smooth, except for the suggestion of plications developed by the strong surficial costae. Visceral area with a porcellaneous coating that appears to be most strongly developed in the area inside of the entire pallial line; the thinner, outer part of the

coating exterior to the pallial line margined, laterally, by a row of small pits or short, low, and narrow radial ridges, extending inwardly in many specimens to the pallial line as progressively weakened, inconspicuous and irregularly radial ridges. Muscle scars of the type characteristic of the genus. The anterior scar, closer to the hinge area than the doubled posterior one, appearing to straddle or terminate the pallial line, elliptical in shape and, especially on the right valve, deeply impressed. Posterior scars distinctly bilobed, located adjacent to but inside of the pallial line; the outer and larger lobe tending to be more impressed than the smaller inner one.

Type locality: TU 954, hill cut behind Standard Fruit Company's box factory, just west of cemetery at Pueblo Nuevo, about 2 km west of Puerto Limón, Costa Rica.

Occurrence: Moin Formation, lower and middle Pleistocene; Costa Rica.

Holotype, USNM 263976; height 23.6 mm, length 25.5 mm, diameter (paired valves) 10.5 mm; locality TU 954. (Plate 3, fig. 1)

Paratype A, USNM 263977; height 20.5 mm, length 23.4 mm, diameter (right valve) 5.5 mm; locality TU 954. (Plate 3, fig. 2)

Paratype B, USNM 263984; height 21.6 mm, length 23.0 mm, diameter (right valve) 9.6 mm; locality TU 954. (Plate 4, fig. 2)

Paratype C, USNM 263981; height 22.6 mm, length 23.5 mm, diameter (right valve) 8.9 mm; locality TU 954. (Plate 3, fig. 6)

Paratype D, USNM 263983; height 22.3 mm, length 25.9 mm, diameter (left valve) 4.5 mm; locality TU 954. (Plate 4, fig. 1)

Paratype E, USNM 263986; height 21.6 mm, length 17.3 mm, diameter (left valve) 4.1 mm; locality TU 954. (Plate 4, fig. 4)

PLATE 4

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1-4. <i>Dimya fimbriocostata</i> H. E. Vokes, n. sp. ($\times 2.5$)	44
1. Paratype D, USNM 263983; height 22.3 mm, length 25.9 mm, diameter (left valve) 4.5 mm. Locality TU 954.	
2. Paratype B, USNM 263984; height 21.6 mm, length 23.0 mm, diameter (right valve) 9.6 mm. Locality TU 954.	
3. Paratype H, USNM 263985; height 19.7 mm, length 16.6 mm, diameter (left valve) 4.0 mm. Locality TU 1240.	
4. Paratype E, USNM 263986; height 21.6 mm, length 17.3 mm, diameter (left valve) 4.1 mm. Locality TU 954.	
5-7. <i>Dimya tigrina</i> Bayer ($\times 8$)	48
5. USNM 263987; height 4.4 mm, length 5.2 mm (right valve). Locality TU 953.	
6. USNM 263988; height 6.3 mm, length (incomplete) 6.3 mm (right valve). Locality 953.	
7. USNM 263989; height 5.7 mm, length 6.6 mm (left valve). Locality TU 953.	

All specimens from Moin Formation, Pleistocene, Costa Rica.

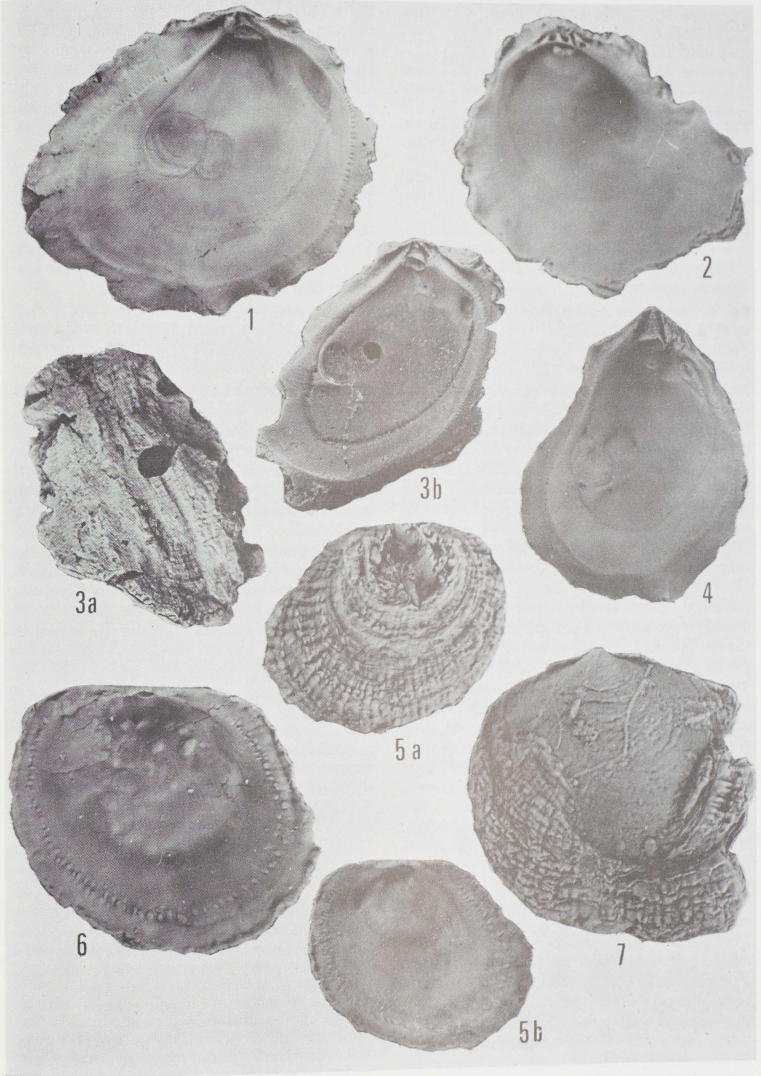


PLATE 4

Paratype F, USNM 263979; height 20.4 mm, length 18.0 mm, diameter (left valve) 5.1 mm; locality TU 954. (Plate 3, fig. 4)

Paratype G, USNM 263980; height 20.1 mm, length 26.7 mm, diameter (right valve) 7.2 mm; locality TU 954. (Plate 3, fig. 5)

Paratype H, USNM 263985; height 19.7 mm, length 16.6 mm, diameter (left valve) 4.0 mm; locality TU 1240. (Plate 4, fig. 3)

Paratype I, USNM 263978; height 10.7 mm, length 12.6 mm, diameter (left valve) 2.5 mm; locality TU 1240. (Plate 3, fig. 3)

Paratype J, USNM 263982; height 21.4 mm, length 24.9 mm, diameter (left valve) 5.5 mm; locality TU 1240. (Plate 3, fig. 7)

Remarks: The 404 specimens upon which the above description has been based reveal a wide variation in shape and form depending upon the nature of the area to which the right valve had been attached. Most of the specimens clearly were attached to branching corals (see pl. 3, figure 2). Others show surface scars that can only be attributed to bryozoans, which may have been coating the surfaces of corals or small molluscan shells. Some clearly were attached to each other and a few to gastropods (*Cypraea*, *Conus*, *Strombus*, etc.).

The strongly costate, rugose surface ornamentation is the most distinctive feature of this new species. Some of the more strongly ornamented specimens of *D. grandis divaricata* Dall are not unlike the more weakly ornamented forms of the present species, but none of the latter ever have the relatively smooth external surface that is characteristic of the majority of the specimens of *D. grandis*, nor do they reveal the peculiar "pinched in" condition of the marginal ridges just below the hinge line on the left valves that may be seen in the Dominican Miocene species.

Ninety of the specimens upon which this species is based were collected at TU locality 954 from strata exposed in the hill cut immediately behind the Standard Fruit Company's box factory just west of the cemetery at Pueblo Nuevo, a suburb of Puerto Limón, Costa Rica. The strata exposed here correlate with the Moín [Moen] Formation of Gabb, 1895, which he referred to as post-Pliocene in age; Akers (1972, p. 42) states that the planktonic foraminiferal fauna in TU 954 is indicative of Neogene zone 22 of Blow, 1969, and hence of a basal Pleistocene age. An additional 214 valves have been collected at TU 1240 and

109 from TU 1307, both localities being at the top of a ridge that is approximately 60 meters higher in altitude than TU 954. Here the planktonic foraminifera indicate a middle Pleistocene age.

Gabb (1881), described the "Moen" fauna and referred to "a small plicate oyster in the deposit," which he questionably identified as *Ostrea borealis* Lamarck. It seems most probable that this identification was based upon representatives of the present species; particularly since our extensive Tulane University collections from Moín and the outskirts of Limón contain no plicated ostreid species.

DIMYA TIGRINA Bayer

Plate 4, figures 5-7

Dimya tigrina BAYER, 1971, Bull. Marine Sci., v. 21, no. 1, p. 223, figs. 69 (three views), 71A ["off Punta Piedras, Colombia: 9°45.1'N, 76°09.1'W, 79-75 meters"].

Bayer described this, the second Recent species of *Dimya* to have been reported from the western Atlantic area, as follows:

"Shell attached by the right valve, obliquely ovate, broader posteriorly. The hinge line is not auriculate, rather long, about 0.5 of the length of the mantle cavity (defined by the extreme limits of the pallial impression), straight, flat, transversely grooved, narrower and faintly impressed beneath the umbo. The thin, linear external ligament is visible along the whole hinge line; a deep, ovate pit beneath the umbos, closer to the posterior than to the anterior, accommodates the internal ligament. Exterior of left valve dull, pale brown marked with narrow, irregular radial streaks of darker brown; umbonal and central area externally smooth, marginal area sculptured by low, irregular radial ribs and thin, slightly raised concentric growth lamellae, resulting in a delicately scaly or frilly surface showing only faint traces of nacreous iridescence; interior of left valve porcellaneous, translucent, allowing the nacreous layer to show through marginally and showing distinct radial streaks of reddish brown; surface glossy marginally but within the pallial line dull except for the glossy muscular impressions.

"Interior of attached valve cream white with conspicuous pattern of irregular radial streaks and spots of reddish brown most intense at the margins; surface marginally glossy, centrally dull except for the glossy muscular impressions; a wide band of irregular, narrow radial grooves and wrinkles lies within the pallial line, narrowing toward the hinge where the wrinkles break

up into granulations that merge with the cross-striated hinge line.

"Anterior muscular impression elliptical, near the end of the hinge line and closer to the umbo than is the posterior impression. Posterior muscular impression well removed from the end of the hinge line, distinctly double, that in the left valve more clearly bilobed than that in the right.

"The wide margin of the right valve is free of the substrate and flares broadly; its outer surface is marked with low, broad radials crossed with scaly concentrics resulting in an imbricated appearance.

"Measurements — Left valve, length 9.4 mm, height at umbo, 7.85 mm, right valve, length 9.4 mm, height at umbo 8.0 (holotype)."

Although not explicitly so stated, it appears that this description was based upon the single, paired-valve, holotype specimen. The twelve specimens of this species from the early Pleistocene, Moín Formation, at Moín Hill and near Puerto Limón, Costa Rica, reveal variation in some of the characters, especially in the nature of the hinge line. In most it is relatively elongate as described, but in one or two it is short to almost non-existent, with the site of the internal ligament being more or less at the apex of an angulate dorsal margin. Furthermore, the position of the internal ligament pit relative to the hinge line varies a great deal, one specimen having it at the extreme posterior end, while in some others it is anterior to the mid-line, the position apparently being affected by the nature of the attachment area of the right valve.

The characteristic color pattern is, of course, absent from the fossil specimens, but other factors, including the size, nature and position of the muscle scars, and the external ornament (compare pl. 4, figs. 5a, b, 7, with fig. 69 of Bayer, upper left and lower views) leave little doubt that these specimens represent the shallower water Recent species.

Six of the fossil specimens were collected at Tulane University locality TU 954 near Puerto Limón, Costa Rica, and six are from TU 953, in the railroad cut at Moín Hill, type locality for the Moín Formation of Gabb, 1895.

Figured specimen, USNM 263989; height 5.7 mm, length 6.6 mm, a left valve; locality TU 953. (Plate 4, fig. 7)

Figured specimen, USNM 263988; height 6.3 mm, length (incomplete) 6.3 mm, a right valve;

locality TU 953. (Plate 4, fig. 6)

Figured specimen, USNM 263987; height 4.4 mm, length 5.2 mm, a right valve; locality TU 953. (Plate 4, fig. 5)

DIMYA species Plate 1, figure 10

Three right valves of another species of *Dimya* are in the Tulane University collections from the well-known fossil locality at Bowden, Jamaica. Two are attached to a left valve of *Scapharca halidonta* Dall; one of these is very small and immature, the other (here figured), although attaining a height of 8.7 mm, and a length of 10.2 mm, is yet too thin and appressed to the irregular surface of the arcid valve to permit any observations of the positions of the adductor scars or other features that might serve to permit specific identification. The third specimen is fragmentary, having lost most of the dorsal area when broken free from the attachment surface, which is still present over most of the exterior of the valve; the small area exterior to this is marked by numerous exceedingly fine, hair-like radial riblets. These are rather similar to the fine radials that ornament the more coarse costae in *D. grandis divaricata* and, to a lesser extent, some specimens of *D. fimbriocostata*, n. sp., but there is no suggestion indicative of the presence of stronger primary ribbing on the Bowden specimens.

Figured specimen, USNM 263968; height 8.7 mm, length 10.2 mm; locality TU 705.

APPENDIX I: SPECIES REFERRED TO THE GENUS DIMYA

The following list includes those species known to the writer that have been, at one time or another, referred to the genus *Dimya*, either by their authors or by subsequent students.

- argentea* DALL, 1886, Bull. Harvard Mus. Comp. Zool., v. 12, no. 6, p. 228, pl. 4, figs. 5a, b. Recent, western Atlantic Ocean.
- bonneti* COSSMANN, 1902, Ann. Soc. Roy. Malac. Belgique, v. 36, p. 21, pl. 2, figs. 14, 15. Lutetian (middle Eocene), Saulxmarchais, France.
- california* BERRY, 1936, Proc. Malac. Soc. London, v. 22, no. 3, p. 126, pl. 13B, figs. 1-4. Recent, off Southern California.

- checchiai* SERRA, 1936, Bol. Soc. Geol. Ital., v. 55, no. 1, p. 125, pl. 3, figs. 7, 7a. Maestrichtian (Upper Cretaceous), Tripolitania, [Libya]. [?= *Dimyopsis*].
- coralliotis* BERRY, 1944, Proc. Malac. Soc. London, v. 26, no. 1, p. 25, figs. 1-4. Recent, off Southern California.
- corugata* HEDLEY, 1902, Mem. Australian Mus., v. 4, p. 308, text fig. 52. Recent, off New South Wales, Australia. (Type of *Dimyarina* Iredale, 1936).
- crearoi* OPPENHEIM, 1900, Palaeontographica, v. 47, p. 127, pl. 3, figs. 15-19. Priabonian (upper Eocene), north Italy.
- deshayesiana* ROUAULT, 1850, Mém. Soc. Géol. France, (ser. 2) v. 3, pt. 2, p. 471, pl. 15, figs. 3, 3a, 3b. Middle Eocene, Bos d'Arros, near Pau, southwestern France. Type of genus.
- dissimilis* TATE, 1886, Trans. Roy. Soc. South Australia, v. 8, p. 100, pl. 8, figs. 9a, b. Miocene, South Australia. [Figured as *Dimyodon dissimilis* by Bittner, 1895, pl. 23, figs. 33-37 (10 views)].
- extenuiplicata* SACCO, 1897, I Molluschi del terreni terziarii del Piemonte e della Liguria, pt. 23, Pelecypoda (Ostreidae, Anomiidae e Dimyidae), p. 42, new name for *Ostrea tenuiplicata* Seguenza, 1879, p. 123, pl. 12, fig. 1. Aquitanian (lower Miocene) to Astian (lower Pliocene), Calabria, southern Italy.
- filipina* BARTSCH, 1913, Proc. U.S. Natl. Mus., v. 45, no. 1983, p. 305, pl. 28, figs. 1-4. Recent, off Amina Sola Isl., Philippines.
- fragilis* VON KOENEN, 1893, Abh. Geolog. Spezialkarte v. Preussen u. Thüringischen Staat., v. 10, pt. 5, p. 1065, pl. 69, figs. 5a-c, 6a-c. Lattorfian (lower Oligocene), northern German.
- fragilis crassiplicata* SACCO, 1897, *supra*, p. 42. Tortonian (upper Miocene), northwestern Italy.
- fragilis miopliocenica* SACCO, 1897, *supra*, p. 41, pl. 11, figs. 41-57. Helvetian (middle Miocene) to Plaisancian (lower Pliocene), northwestern Italy.
- fragilis punctata* NOSZKY, 1939, Ann. Hist. Nat. Mus. Hungary, v. 32, (Min., Geol. & Paleont.), p. 87 [as "*Dymia*"]. Rupelian (middle Oligocene), Hungary.
- grandis* DALL in GUPPY and DALL, 1896, Proc. U.S. Natl. Mus., v. 19, no. 1110, p. 328; DALL 1898, Trans. Wagner Free Inst. Sci., v. 3, pt. 4, pl. 35, fig. 8. "Oligocene" [= upper Miocene], Dominican Republic.
- grandis divaricata* DALL in GUPPY and DALL, 1896, *ibid.*, p. 338. Occurs with *grandis* s. s., Dominican Republic.
- internostriatum* "Gumbel" FRAUSCHER, 1886, Denkschr. k. Akad. Wiss., Wien, Math. Naturw. Kl., v. 51, p. 36, pl. 3, figs. 11a-d, 12 [as *Cyclostreon*]. Lower Eocene, northern Alps.
- intusstriata* D'ARCHIAC, 1850, Mém. Soc. Géol. France, (ser. 2) v. 3, pt. 2, p. 441, pl. 13, figs. 9, 9a, 10, 10a, 11 [as *Anomia*]. Middle Eocene, southwestern France. [Many authors cite as "*intusstriata*"; has been reported from the lower and middle Eocene of France, Italy, Bavaria, Bulgaria, north Africa, the Crimea and Ukraina.]
- japonica* HABE, 1971, Veliger, v. 13, no. 4, p. 331, figs. 9-19. Recent, Japan. Identified as *D. lima* Bartsch, by Habe in several publications, 1958-1965.
- kaiparaensis* LAWS, 1944, Trans. Proc. Roy. Soc. New Zealand, v. 73, no. 4, p. 300, pl. 45, fig. 26. Lower Miocene, New Zealand.
- libyca* QUAAAS, 1902, Palaeontographica, v. 30, pt. 2, p. 180, pl. 21, figs. 3a-c. Upper Cretaceous, Libyan Desert. [Appears to be *Dimyopsis*.]
- lima* BARTSCH, 1913, Proc. U.S. Natl. Mus., v. 45, no. 1983, p. 306, pl. 27, 28, figs. 5, 6. Recent, Philippine Islands [reported from Arafura Sea by Prashad (1932, p. 118, pl. 3, figs. 21, 22)].
- maoria* POWELL, 1937, "Discovery" Repts., v. 15, p. 168, pl. 45, fig. 2 [as *Dimya (Dimyarina)*]. Recent, off Three Kings Islands, north-west of North Island, New Zealand.
- mimula* DALL, BARTSCH, and REHDER, 1938, Bernice P. Bishop Mus., Bull. 153, p. 78, pl. 19, figs. 1, 2. Recent, off south coast of Molokai, Hawaiian Islands.
- molokaia* DALL, BARTSCH, and REHDER, 1938, *ibid.*, p. 79, pl. 19, fig. 3. Recent, off north coast of Molokai, Hawaiian Islands.
- obliqua* SCHAFFAULT, 1863, Süd-Bayerns Lethaea Geognostica, p. 135, pl. 45-c, fig. 9 [as *Anomia*]. Eocene, Bavaria [cited as synonym of "*Deuteromya intusstriata* (Archiac)" by Zelinskaya *et al.* (1968, p. 53)].
- pamplonensis* CAREZ, 1881, Etude terrains Cretaces et Tertiaires du nord de l'Espagne, p. 310, pl. 8, figs. 2-5 [as *Plicatula*]. ["appears to be a *Dimya*" *fide* Eames, 1951, p. 354.]
- radiata* KURODA, 1928, Venus, v. 1, p. 14, pl. 1, fig. 11. Recent, Japan. [Synonym of *D. filipina* Bartsch, *fide* Habe, 1971, p. 330.]
- radiata takii* KURODA, 1933, Venus, v. 3, no. 3, App., p. 11, pl. 53, fig. 1. Recent, Japan. [Synonym of *D. filipina* Bartsch, *fide* Habe, 1971, p. 330.]
- raulini* COSSMANN and PEYROT, 1914, Conch. Néogénique de l'Aquitaine, v. 2, pt. 2, p. 409, pl. 22, figs. 12-15. Helvetian?, southwestern France [see p. 36].
- richei* DONCIEUX, 1911, Ann. Univ. Lyon, (n. s. 1) v. 30, p. 34, pl. 6, figs. 7a, b. Oligocene, southern France.
- sigillata* TATE, 1886, Trans. Roy. Soc. South Australia, v. 8, p. 100, pl. 8, figs. 8a, b. Upper Eocene, South Australia.
- spondyliiformis* EAMES, 1951, Philos. Trans.

- Roy. Soc., v. 235B (627), p. 354, pl. 12, figs. 51, 52a-d, 53 [as "*Dimya* ?"]. Eocene, western Punjab.
- subrotunda* FELIX, 1891, Palaeontographica, v. 37, p. 163, pl. 25, figs. 9, 9a. Neocomian (lower Cretaceous) Mexico [appears referable to *Dimyodon*, see p. 35].
- tabasaranica* (KOROBKOV, 19??), [original description not found; fig'd, as "*Deuteromya tabasaranica*" in Korobkov, 1954, Reference and Method. Guide to Tertiary Mollusca. Lamellibranchia, pl. 76, figs. 14-18, "upper Eocene, Kavkaz", Dagestana.]
- tigrina* BAYER, 1971, Bull. Marine Sci., v. 21, no. 1, p. 223, figs. 69 (3 views), 71A. Recent, Caribbean Sea.
- westonensis* MAXWELL, 1978, New Zealand Jour. Zool., v. 5, p. 15, figs. 1, 2. Upper Eocene, New Zealand.
- sp. ? VINCENT, 1930, Mus. Roy. Hist. Nat. Belg., Mém. 46, p. 76, pl. 4, fig. 6 [as *Dimya* ? sp. ?]. Paleocene, Poudingue de Ciply, Belgium.
- sp. ? GLIBERT and VAN DE POEL, 1973, Inst. Roy. Sci. Nat. Belg., Mém. 175, p. 16 [as "*Dimya* sp. ?"]. Paleocene, Calcaire de Mons, Belgium.
- northeastern Italy.
- schlumbergeri* "Munier-Chalmas" FISCHER, 1886, Man. de Conchyl. et de paléont. Conchyl., p. 936, text fig. 705. Bathonian, Jurassic, France. Type of genus.
- sigillina* WOODWARD, 1864, Geol. Mag., v. 1, p. 112, pl. 5, figs. 1-5 [as "*Plicatula*"]. Upper Cretaceous, England. Referred to *Dimyodon* by Woods, 1903, p. 225.
- similis* VON KOENEN, 1893, Abh. Geolog. Specialkarte v. Preussen u. Thüringischen Staat., v. 10, pt. 5, p. 1067, pl. 69, figs. 8a-c. Lattorfian (lower Oligocene), Germany and Ukraine (Sokolow, 1905, p. 48, pl. 12, figs. 14-16, pl. 13, fig. 3).
- similis interstricta* NOSZKY, 1939, Ann. Hist. Nat. Mus. Hungary, v. 32, p. 34. Rupelian (middle Oligocene), Hungary.
- storrsi* SMITH, 1927, U.S. Geol. Surv., Prof. Paper 141, p. 122, pl. 96, fig. 1. Upper Triassic, California [?, a *Dimyopsis*, see p. 35].
- woehrmani* BITTNER, 1895, Abh. k. k. geol. Reichsanst., Wien, v. 18, pt. 1, p. 219 [as "*wohrmanni*"], new name for "*Dimyodon intusstriatus* Emmer. spec. bei Baron Wöhrmann, Jahrb. d. geol. Reichsanstalt 1889, S. 209, Tab. VIII, Fig. 4, 5, 6 (excl. synonym!)" "*Carditaschichten*", Upper Triassic, Tyrol.

APPENDIX II: SPECIES REFERRED TO THE GENUS DIMYODON

- boehmi* STOLLEY, 1892, Mittheil. Min. Inst. Univ. Keil, v. 1, no. 7, p. 243, pl. 2, fig. 8 [as "*Böhmi*"]. Upper Cretaceous, Schleswig-Holstein, northwestern Germany; also reported from Denmark (Grönwall, 1900, p. 78) and the "Upper Chalk" of England (Grönwall, 1906, p. 203).
- costatus* GRÖNWALL, 1900, Meddel. Dansk. Geol. Forening, v. 1, no. 6, p. 77, pl. 2, figs. 4-7. Upper Cretaceous, Denmark, France.
- dissimilis* TATE, 1886 [see listing under genus *Dimya*].
- intusradiatum* "Gumbel" BÖHM 1891-92, Palaeontographica, v. 38, p. 88, pl. 4, figs. 2a-e. Upper Cretaceous.
- nilssoni* HAGENOW, 1842, Neues Jahrb. für Min., p. 546 [as "*Ostrea*"]. Upper Cretaceous. Reported by several writers from Germany, Denmark, Holland, France, and England. Trechmann (1935, p. 173) has cited it as possibly occurring ["cf."] in the Northern Range of Trinidad, the sole western Atlantic record.
- plicatuloides* "Leym." COQUAND, 1869, Mon. du genre *Ostrea*, p. 194 [as *Plicatula*]. [NOT *Ostrea plicatuloides* Leymerie, 1851, Mém. Soc. Géol. France, (ser. 2) v. 4, p. 195, pl. 9, figs. a-c; *fide* Grönwall, 1900, p. 74, and 79-80.]
- richthofeni* BITTNER, 1895, Abh. k. k. geol. Reichsanst., Wien, v. 18, pt. 1, p. 217, pl. 23, fig. 32 (3 views). Upper Triassic, St. Cassian,

VII. LOCALITY DATA

The following are Tulane University fossil collecting localities:

226. Red Bluff Clay, east bank Chickasawhay River, about one mile south of Hiwanee, 3.5 miles south of Shubuta (SW ¼ Sec. 28, T10N, R7W), Wayne Co., Mississippi.
642. Red Bluff Clay, east bank Chickasawhay River, bluff immediately west of Hiwanee (NE ¼ Sec. 28, T10N, R7W), Wayne Co., Mississippi.
705. Bowden Formation, roadcut at Bowden, east of Port Morant, Parish of St. Thomas, Jamaica.
953. Moin Formation, railroad cut and adjacent ditches on east side of road from Moin Junction to Sandoval, 4.5 km west of Puerto Limón, Costa Rica. [At Moin Hill, type locality of Moin Formation.]
954. Moin Formation, hill cut immediately behind the Standard Fruit Company's box factory, just west of cemetery at Pueblo Nuevo, about 2 km west of Puerto Limón, Costa Rica.
1209. Gurabo Formation, road cuts on both sides of Los Quemados — Sabaneta Road 2 kms west of Los Quemados and 0.6 km east of the crossing of the Rio Gurabo, Dominican Republic.
1210. Gurabo Formation, Rio Gurabo, east

- bank, first bluff downstream from bridge on Los Quemados — Sabaneta road, Dominican Republic [= USGS 8544; Maury's Zone "B"].
1211. Gurabo Formation, Rio Gurabo, west bank, second bluff downstream from bridge on Los Quemados — Sabaneta road, Dominican Republic [= USGS 8546].
1215. Gurabo Formation, Rio Gurabo, bluffs on both sides of river from bridge on Los Quemados — Sabaneta road to a point approximately 1 km upstream, Dominican Republic [= USGS 8539-8543; Maury's Zone "D"].
1219. Gurabo Formation, Rio Amina, bluffs on east side of river immediately upstream from ford that is 2 kms west of Potrero and about 3 kms downstream from "La Represa," Dominican Republic [= USGS 8516].
1225. Gurabo Formation, banks of large arroyo on west side of Rio Mao, upstream from Mao Adentro and downstream from Cercado de Mao; about 11 kms (by winding road) south of Mao, Dominican Republic.
1227. Gurabo Formation, deep arroyo that crosses under road to Jánico from Santiago de los Caballeros, 11 kms south of bridge over Rio Yaque del Norte at Santiago, Dominican Republic.
- 1227A. Gurabo Formation, turbidity flow lens (ca. 30' long, 6" thick) about two feet above base of outcrop at point approximately 75 feet downstream from highway bridge, Dominican Republic.
1240. Moin Formation, Barrio Los Corales, top of hill at end of road that passes Standard Fruit Company's box factory (see TU 954); locality is 1.8 kms north of main highway at Pueblo Nuevo, which is 2 kms west of Puerto Limón, Costa Rica.
1254. Gurabo Formation, roadcut at top of hill, 4 km west of Duarte Highway, on road to Presa Tabera; approximately 15 km south of Santiago de los Caballeros, Dominican Republic.
1277. Gurabo Formation, Rio Gurabo, upstream from horse-trail into canyon about 2 kms (air-line) upstream from bridge of Los Quemados-Sabaneta road (see Vaughan *et al.*, 1921, pl. 11), Dominican Republic.
1279. Gurabo Formation, or base of Mao Adentro Formation, cut on south side of Los Quemados-Sabaneta road 2.5 kms west of junction at Los Quemados and about 0.3 km east of bridge over Rio Gurabo, Dominican Republic.
1288. Red Bluff Clay, type locality, east bank Chickasawhay River, about 1.5 miles south of Shubuta (NE ¼ Sec. 16, T10N, R7W), Wayne Co., Mississippi.
1289. Red Bluff Clay, east bank Chickasawhay River, about ¾ mile south of Hiwanee (SW ¼ Sec. 28, T10N, R7W), Wayne Co., Mississippi.
1291. Red Bluff Clay, Sand Branch of "Carson Sand Creek," about 4 miles by country road east of Hiwanee, and about 100 yards downstream from road crossing (SE ¼ Sec. 24, T10N, R7W), Wayne Co., Mississippi.

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REVIEW

MESOZOIC PALYNOLOGY OF SVALBARD - I: The Rhaetian of Hopen, with a preliminary report on the Rhaetian and Jurassic of Kong Karls Land, by Tor Bjaerke and Svein B. Manum. Published by the Norsk Polarinstittutt, Oslo, 1977, 48 pp., 9 pls., \$6.00 (distributed in the United States by the Columbia University Press, New York).

Palynomorphs from thirteen workable samples are described and illustrated, twelve are from shale-silt lithologies and one is a coal sample. The beds on Hopen (an island on the southeastern corner of the Svalbard archipelago) were regarded as Lower Cretaceous until the seventies when a series of reports on the contained plant macrofossils resulted in dating these beds as Rhaetian to lowermost Jurassic in age. A report by Smith (1974) supported this dating, but the present study yields results which restrict these beds to the Rhaetian. This work is very well illustrated with nine excellent plates.

—H.C.S.