

CORALS AND MOLLUSKS FROM A MIOCENE CARBONATE-RICH DEPOSIT OF MADRUGA, WESTERN CUBA CORALES Y MOLUSCOS DE UN DEPÓSITO CALIZO DEL MIOCENO DE MADRUGA, OCCIDENTE DE CUBA

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ABSTRACT: Here is reported fauna from a Middle Miocene limestone deposit of the Cojímar Formation near the town of Aguacate in the Province of Mayabeque, western Cuba. The fossils are preserved only as internal or external molds, but we identified members of at least eight bivalves and six gastropod families and one solitary coral. The most common taxon is a lucinid bivalve probably belonging to the genus *Anodontia*, which may likely represent a new taxon. This species in particular, and the fauna and facies in general, suggest that the Aguacate limestone may represent an ancient seagrass meadow environment. The fauna of the Aguacate quarry shows biogeographic relationships mainly to the Miocene of Panama and Florida, but also some links to the subtropical Atlantic coast of North America, and the Miocene of northern Ecuador.

KEY WORDS: *Anodontia*, Bivalvia, Caribbean sea.

RESUMEN: Aquí se registra la fauna presente en un depósito de calizas del Mioceno Medio de la Formación Cojímar que afloran cerca del pueblo de Aguacate, en la provincia de Mayabeque, occidente de Cuba. Los fósiles se conservan solo como moldes internos o externos, pero identificamos miembros de al menos ocho familias de bivalvos y seis de gasterópodos, y un coral solitario. El taxón más común es un bivalvo lucínido que probablemente pertenezca al género *Anodontia*, y que pudiera representar un nuevo taxón para la ciencia. Esta especie en particular, y la fauna en general, sugieren que la caliza Aguacate puede representar un antiguo ambiente de pradera de pastos marinos. La fauna de la cantera de Aguacate muestra relaciones biogeográficas principalmente con el Mioceno de Panamá y Florida, pero también algunos vínculos con la costa atlántica subtropical de América del Norte y con el Mioceno del norte de Ecuador.

PALABRAS CLAVES: *Anodontia*, Bivalvia, Mar Caribe.

INTRODUCTION

During the early 1930s, the region of Madruga in the Province of Mayabeque, western Cuba, became the center of attention to several North American petroleum geologists. Their initial surveys revealed the presence of Cretaceous and Cenozoic outcrops within a complex geological setting (DeGolyer, 1918; Wright and Sweet, 1924; Chawner, 1932; Lewis, 1932;

Palmer, 1932; Palmer, 1938). In 1932, Chawner reported and mapped several fossil deposits within this geological complex, attracting the attention of Palmer, who revisited and resampled most of the outcrops available at the time (Palmer, 1948). Palmer's compilation included over 3217 localities of which at least 110 are today within the region of Madruga, several of which are sites of geological and paleontological interest.

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One of the most important Palmer's fossiliferous locality from Madruga is "Cantera Jene 2 km. S. Aguacate" (Loc. 766 in [Palmer, 1948: 321](#)), but this reference is ambiguous because there are various quarries about 2 km south of Aguacate. One of them is approximately 100 m along the west side of the highway, another is about 550 m to the east, following an old road. Palmer's locality likely denoted the first quarry, from which recently important fossil discoveries (e.g. shark teeth and turtles) have been made; most of which are as-yet-unpublished. Iturralde-Vinent and colleagues referred to this locality as "Havana Prov. Limestone quarry near the town of Aguacate" and briefly noted the occurrence of fossil sharks ([Iturralde-Vinent et al., 1996](#)). However, even though both quarries are richly fossiliferous, they are still poorly sampled and their fossil fauna remains unstudied.

Our short exploration of the Aguacate quarry revealed a rich mollusk fauna including chemosymbiotic bivalves of the family Lucinidae, as well as a few solitary corals. Because studies of Cuban Miocene bivalve faunas are rare ([Cooke, 1919](#); [Franco, 1983](#); [Kiel and Hansen, 2015](#)), we use this opportunity to provide an overview of the fossil fauna collected at the Aguacate quarry and put the fauna into a regional and paleoecological context.

MATERIALS AND METHODS

The material described here was collected during two visits to the Aguacate quarry (coordinates: 22°58'N, 81°49'W) ([Fig. 1](#)) in 2018 and 2020. The material is deposited and available at the local Madruga Museum with the catalog numbers MPAL-1050 to 1093, and at the Swedish Museum of Natural History in Stockholm (NRM).

GEOLOGICAL SETTING

Traditionally, the rocks of the Aguacate quarry have been informally referred to the Güines Formation (early-middle Miocene), but geological maps and lithology indicate that they belong to the Cojímar Formation (upper Lower Miocene-lower Middle Miocene). The Cojímar Formation (named by [Palmer \(1934\)](#)) lies concordantly over the Jaruco or Husillo formations on basin areas, and transitions in facies both laterally and vertically to the Güines Formation. In Madruga, the Cojímar Formation occurs roughly to the north of Sierra del Grillo and mainly includes calcareous and argillaceous marls and gray chalky limestones. In the Aguacate area, the formation crops out as limestones, similar to those of the Güines Formation, but with marls and intercalated limestones typical of Cojímar lithology and fauna ([Albear and Iturralde-Vinent, 1985](#)).

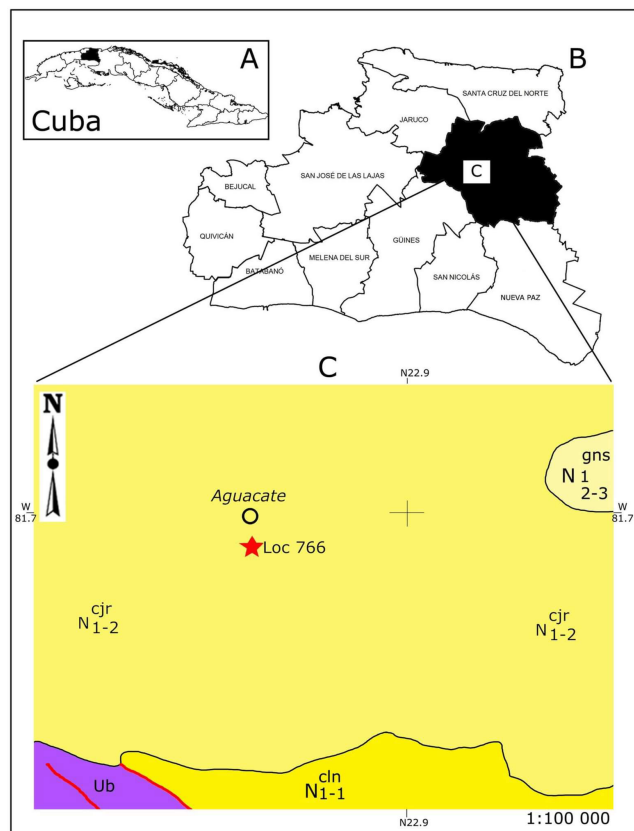


FIGURE 1. Locality map. Outline of Cuba with the Mayabeque province highlighted (A). The Mayabeque province with the Madruga area highlighted (B). Excerpt from the geological map of the area of the Aguacate quarry (C).

FIGURA 1. Mapa de la localidad. Esquema de Cuba con la provincia de Mayabeque resaltada (A). La provincia de Mayabeque con la zona de Madruga resaltada (B). Mapa geológico de la zona de la cantera de Aguacate (C).

The thickness of the Cojímar Formation is usually less than 390 m as estimated from drill cores ([Albear and Iturralde-Vinent, 1985](#); [Pardo, 2009](#)).

The Aguacate quarry exposes thickly bedded limestone with a fine to medium texture (calcareous) intercalated with marls ([Fig. 2](#)). The exposed surface is altered and covered with a light gray patina. The marls are usually more fossiliferous than the limestone. Along the northern portion of the quarry, there are Miocene outcrops with fissures filled with rendzina-like red paleosol.

The fossil fauna of the Cojímar Formation is diverse but has not been evaluated in detail ([Albear and Iturralde-Vinent, 1985](#)). So far, some of the benthic microfossils have been described by [Palmer \(1940-1941\)](#) and the planktonic by [Brönnimann and Rigassi \(1963\)](#), and [Iturralde-Vinent \(1969\)](#). Typically, it includes the following: *Orbulina universa*, *O. suturalis*, *Trilobatus immaturus*,

T. sacculifer, *T. trilobus*, *T. quadrilobatus*, *Globigerinoides ruber*, *Dentoglobigerina altispira*, *Globoquadrina dehiscens*, *Sphaeroidinella dehiscens*, *Globorotalia praemenardii*, *G. archeomenardii*, *Fohsella praefohsi*, *F. peripheroacuta*, *F. peripheroronda*, *Globigerinella obesa*, *G. siphonifera* (= *G. aequilateralis*), and '*Nummulites*' *cojimarensis* (Albear and Iturralde-Vinent, 1985; Pardo, 2009). Recently, thin sections from samples of the quarry confirm the occurrence of *Orbulina universa* (Gutiérrez-Domech, R., pers. comm., 2021). This thanatocoenosis indicates a Middle Miocene age around the Langhian-Serravallian transition [M7-M8, *Fohsella peripheroacuta* and *F. praefohsi* zones of Wade *et al.* (2011)] for these deposits. These rocks were deposited in bathyal to neritic conditions in water less than 300 m (1000 ft) deep (Albear and Iturralde-Vinent, 1985; Pardo, 2009).

RESULTS AND DISCUSSION

The fauna of the Aguacate quarry is preserved largely as internal or external molds, which makes it difficult to assign precise taxonomic identifications. We found several specimens of solitary corals, likely belonging to a single species ("*Caryophyllia*", Fig. 3A). Mollusks are common and diverse, with at least eight bivalve and six gastropod families being present. These include:

Nuculanidae. A single specimen showing the taxodont hinge (Fig. 3C).

Pectinidae. One specimen with sharp radial ribs and wide interspaces with fine commarginal lirae (Fig. 3D), resembling certain species of the genus *Chlamys*, and the species *Amusium mimicum*, described as having a ribbed umbonal area (Woodring, 1982: p. 587-588; pl. 122, fig. 2).

Glycymerididae. A few internal molds showing hinge teeth and a strongly ribbed inner ventral margin (Fig. 3E); similar species include *Glycymeris tumulus* from the Miocene of Virginia, USA (Gardner, 1943: pl. 1, fig. 6), *Glycymeris duplinensis* Dall (Gardner 1943: pl. 2, fig. 3) from Miocene and Pliocene of North Carolina, USA, and the Miocene to Recent *Glycymeris pectinata* (Gmelin) known from Central America and the Caribbean Sea, and extending as far north as North Carolina (Gardner, 1926: p. 38).

Thyasiridae. Several specimens of a subrectangular *Thyasira* reaching 12 mm in length, with sharp posterior ridge and groove, and a long, thin anterior adductor scar (Fig. 3F).

Lucinidae. There are two species: a single specimen probably belonging to *Lepilucina* aff. *gratis* (Olsson, 1964) is preserved as internal and external mold (Fig. 3G, H). This species has

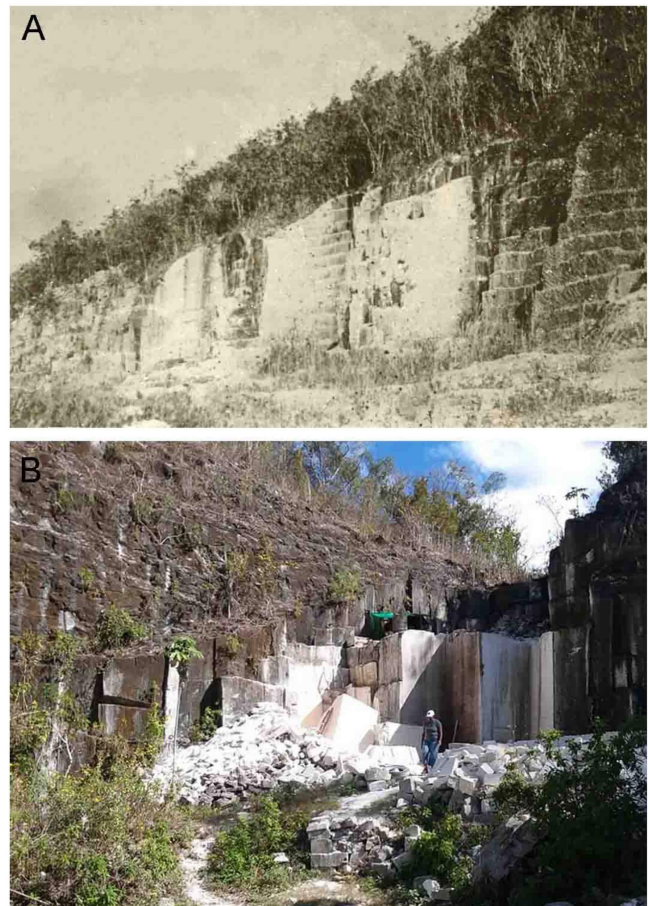


FIGURE 2. Historical and recent photographs of the Aguacate quarry in Madruga, western Cuba. Historical image (about 1930, Madruga Museum) (A). Photograph taken in 2020 showing a site of active quarrying (B).

FIGURA 2. Fotografías históricas y recientes de la cantera de Aguacate en Madruga, oeste de Cuba. Imagen histórica (alrededor de 1930, Museo de Madruga) (A). Fotografía tomada en 2020 que muestra un sitio de cantera activo (B).

previously been reported from the middle Miocene of Ecuador and Panama (Woodring, 1982). The other species (Figure 4) is the most common taxon at the Aguacate quarry; it is a very flat, medium-sized *Anodontia* (sensu lato) with an undulating pallial line and long, thin anterior adductor muscle scar, a narrow and edentulous hinge plate, and no lateral teeth. No external features are preserved. This species is very similar to the extant Caribbean type species *Anodontia alba* and the extant *A. edentuloides* (Verrill) from the Gulf of California (Taylor and Glover, 2005) except for its rather weak inflation, which is unusual for *Anodontia*. This species may represent a new taxon for Cuba, but we refrain from describing it until better specimen are available.

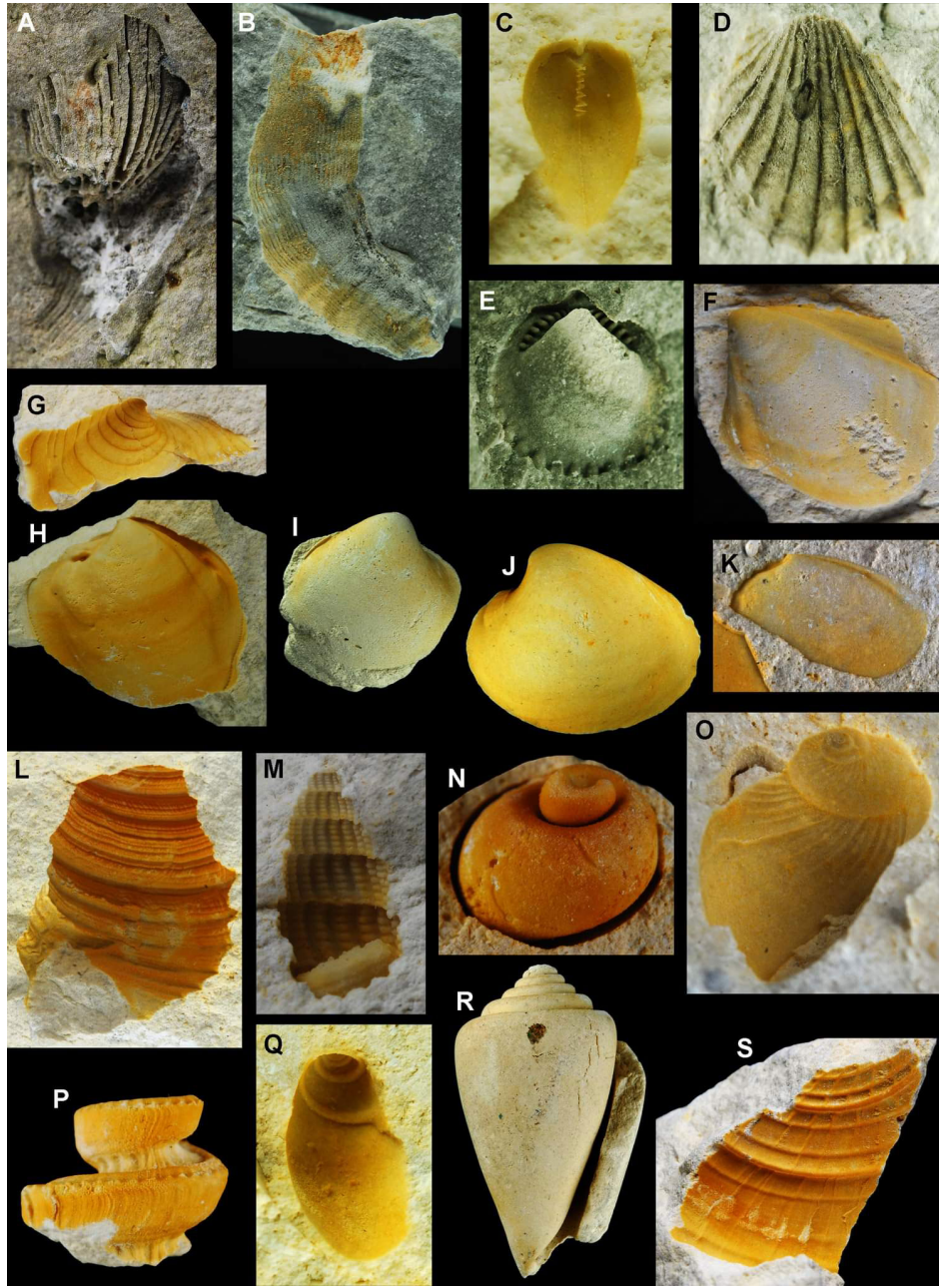


FIGURE 3. Corals and mollusks from the Miocene Aguacate quarry, Madruga, Cuba. the solitary coral "*Caryophyllia*", external molds (NRM Cn 75278, 75279) (A, B). Nuculanid bivalve, internal mold (NRM Mo 193060) (C). Pectinid bivalve, external mold (NRM Mo 193061) (D). Glycymeridid bivalve *Glycymeris* aff. *pectinata* (Gmelin), internal mold of left valve (NRM Mo 193062) (E). Thyasirid bivalve *Thyasira* sp., internal mold of left valve (NRM Mo 193063) (F). Lucinid bivalve *Lepilucina* aff. *gratis* (Olsson, 1964) (NRM Mo 193064). Venerid bivalves, internal molds (NRM Mo 193065, 193066) (I, J). Tellinid bivalve, internal mold of left valve (NRM Mo 193075) (K). Turritellid gastropod, external mold (NRM Mo 193067) (L). Cerithiid gastropod, external mold (NRM Mo 193068) (M). Naticid gastropods, internal and external molds (NRM Mo 193069, 193070) (N, O). Possible turrid gastropod, internal mold (NRM Mo 193071) (P). Olivid gastropod, external mold (NRM Mo 193072) (Q). Conid gastropod, internal mold (NRM Mo 193073) (R). Architectonicid gastropod *Architectonica* aff. *nobilis* Röding, fragmentary external mold (NRM Mo 193074) (S).

FIGURA 3. El coral solitario "*Caryophyllia*", moldes externos (NRM Cn 75278, 75279) (A, B). Bivalvo nuculanídeo, molde interno (NRM Mo 193060) (C). Bivalvo pectínido, molde externo (NRM Mo 193061) (D). Bivalvo glicimérico *Glycymeris* aff. *pectinata* (Gmelin, 1791), molde interno de la válvula izquierda (NRM Mo 193062) (E). Bivalvo Thyasirid *Thyasira* sp., molde interno de la válvula izquierda (NRM Mo 193063) (F). Bivalvo lucínido *Lepilucina* aff. *gratis* (Olsson, 1964) (NRM Mo 193064). Bivalvos venérídeos, moldes internos (NRM Mo 193065, 193066) (I, J). Bivalvo telínido, molde interno de la válvula izquierda (NRM Mo 193075) (K). Gasterópodo turritélido, molde externo (NRM Mo 193067) (L). Gasterópodo ceritícido, molde externo (NRM Mo 193068) (M). Gasterópodos nátidos, molde interno y externo (NRM Mo 193069, 193070) (N, O). Posible gasterópodo turrido, molde interno (NRM Mo 193071) (P). Gasterópodo oliváceo, molde externo (NRM Mo 193072) (Q). Gasterópodo conidio, molde interno (NRM Mo 193073) (R). Gasterópodo Architectonicid *Architectonica* aff. *nobilis* Röding, 1798, molde externo fragmentario (NRM Mo 193074) (S)

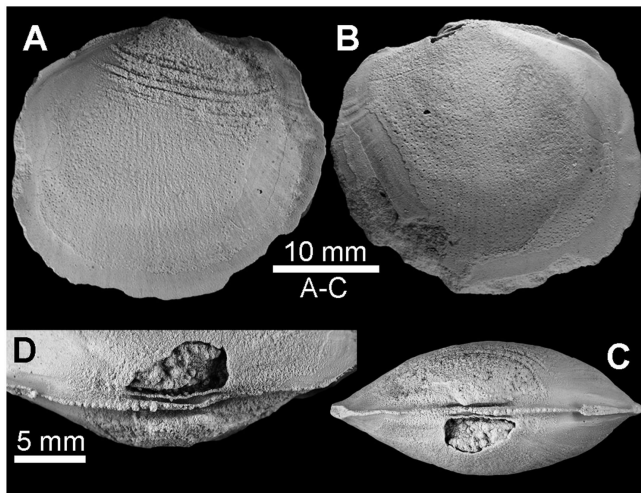


FIGURE 4. The most common fossil from the Miocene Aguacate quarry; the lucinid bivalve *Anodontia* (s.l.) sp. (NRM PAL Mo 193092). View on right valve (A). View on left valve (B). View on dorsal side (C). Close-up on edentulous hinge area (D). This species may represent a new fossil taxon for Cuba.

FIGURA 4. El fósil más común de la cantera del Mioceno de Aguacate; el bivalvo lucínido *Anodontia* (s.l.) sp. (NRM PAL Mo 193092). Vista de la valva derecha (A). Vista de la valva izquierda (B). Vista del lado dorsal (C). Detalle de la zona de la bisagra edéntula (D). Esta especie puede representar un nuevo taxón fósil para Cuba.

Coeval species from Florida include '*A. corpulenta*', '*A. santarosana*', and '*A. janus*' (cf. Bretsky, 1976), all of which are more inflated than the specimens from the Aguacate quarry. The latter species was also reported (as *Pegophysema janus*) from the Gatun Formation in Panama (Woodring, 1982, pl. 111, figs. 13, 15-17).

Veneridae.—Several specimens of general veneroid shape, reaching 30 mm in length and present as internal molds only, representing more than one species (Figs. 3I, J).

Tellinidae.—A small, elongate specimen of about 10 mm length (Fig. 3K); similar species are described as *Tellina* (*Moerella*) *piesa* and *T. (M.) ctenota* from the early and middle Miocene of the Alum Bluff Group in Florida (Gardner, 1928), and as *Tellina* (*Eurytellina*) *nitens* Adams, from the Gatun Formation in Panama (Woodring 1982: pl. 117:16, 17).

Turritellidae.—One large external mold of about 15 mm diameter, showing strong spiral ribs and angular whorl profile (Fig. 3L).

Cerithiidae.—A few small external molds showing strong axial ribs crossed by six spiral cords (Fig. 3M).

Naticidae.—A few internal and external molds of moderately high-spined specimens having fine opisthocline ribs on the upper half of the whorls (Figs. 3N, O); species with a similar sculpture on the spira include *Natica* (*Naticarius*) *stenopa* (Woodring, 1957: pl. 20, figs. 4-6), from the middle Miocene Gatun Formation in Panama and several species assigned to *Natica* (*Naticarius*) and *Stigmaulax* from the Neogene of northern Ecuador (Olsson, 1964).

Turridae.—A single internal mold showing a strongly constricted internal whorl (Fig. 3P) might belong to the Turridae.

Olividae.—A single external mold (Fig. 3Q).

Conidae.—A large internal mold having a moderately high spire (Fig. 3R).

Architectonicidae.—A large, fragmentary external mold (Fig. 3S) not unlike *Architectonica nobilis* Röding as illustrated from the middle Miocene Gatun Formation in Panama (Woodring, 1959: pl. 29: figs. 1-6, 10-12, 14-16).

The fauna of the Aguacate quarry consists of typical tropical, shallow marine corals and mollusks. The most common taxon is a very flat, medium-sized *Anodontia* (s.l.), which may likely represent a new taxon (Fig. 4). A lucinid with a similar outline, inflation, and edentulous hinge was reported as *Myrteopsis?* sp. from the early Miocene Cantera Portugalete in Cuba (Kiel and Hansen, 2015); but it has a much shorter anterior adductor scar than the *Anodontia* (s.l.) specimens from the Aguacate quarry and shows weak but distinctive commarginal sculpture. The abundance of the lucinid bivalve *Anodontia* (s.l.) suggests that these deposits may be interpreted as an ancient seagrass meadow. *Anodontia* species are often associated with seagrass beds (Taylor and Glover, 2005). For example, the extant *A. alba*, which resembles the Aguacate specimens regarding pallial line and adductor scar characters, was reported in very large numbers from a seagrass meadow in Biscayne Bay, Florida (Moore et al., 1968) and other places in the Caribbean regions (Jackson, 1973). However, the co-occurring and not uncommon medium-sized thyasirid bivalve is rather unusual for seagrass meadows, as they tend to prefer deeper and more dysoxic environments (Dando et al., 2004; Oliver, 2015). Biogeographically, the fauna of the Aguacate quarry shows links to other areas within the Caribbean region, to Florida and the tropical/subtropical Atlantic coast of North America, and the Miocene of northern Ecuador (Gardner, 1943; Olsson, 1964; Woodring, 1957, 1959, 1982; Moore et al., 1968; Jones and Portell, 1988).

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