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Artikel: Contribution to the geology and paleontology of the area of the city La Habana, Cuba, and its Surroundings
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larger Foraminifera from the *Lepidocyclina (Lepidocyclina)–Lepidocyclina (Eulepidina)* to the *Miogypsina* zone; and in terms of discoasters from the *Discoaster woodringi* to the *Discoaster deflandrei* zone.

Cojímar formation

The Cojímar formation is one of the best known lithostratigraphic units of the Habana area. It was proposed by R. H. PALMER (1934, p. 134) for a series of Oligocene (? Miocene) "soft white and tan marls" outcropping at different localities

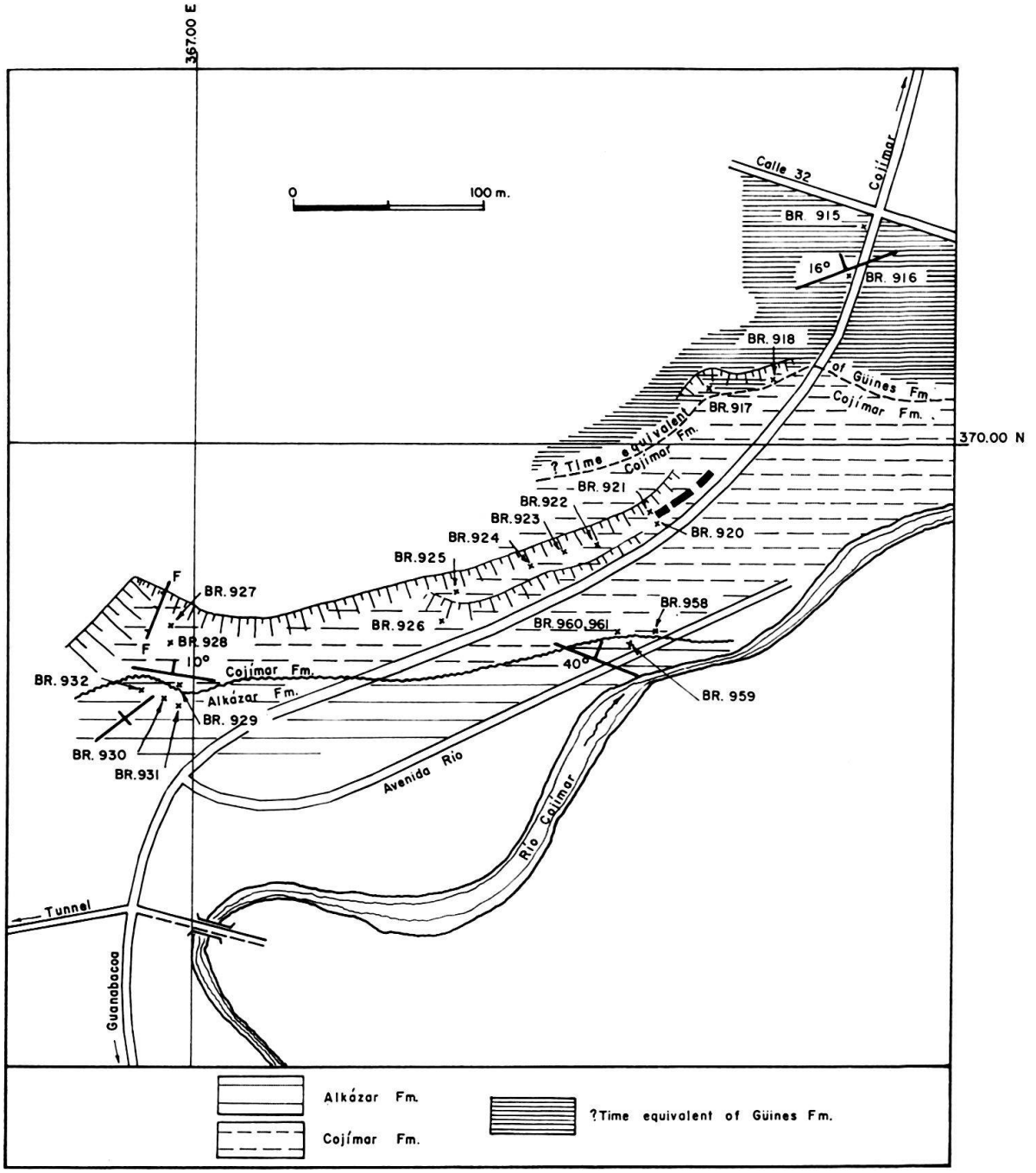

Fig. 73. Index map of the type locality of the Cojímar formation at the road from Guanabacoa to Cojímar.

along the northern rim-rock, especially at the south slope of the hill that extends from Morro Castle at the entrance to the Bahía de la Habana eastward toward the coastal town of Cojímar and beyond. The name of the formation is derived from the Cojímar river which cuts a gorge south of Cojímar between Loma de Urría in the west and Loma San Pedro in the east. In this general area, R. H. PALMER noticed that the Cojímar formation overlies unconformably Upper Cretaceous beds and underlies with transitional contact beds which he assigned to the Güines formation. No figures were given for the thickness of the Cojímar formation. Mrs. D. K. PALMER (1940, p. 19) described the lithology as a soft, light gray to cream marl, and defined as type locality the exposures along the west side of the road from Guanabacoa to Cojímar in the gorge of the Cojímar river, at the south edge of Cojímar about 6.5 km east of La Habana. After a careful analysis of the microfauna, Mrs. PALMER (1940–1941) assigned the Cojímar formation to the Upper Oligocene. The beds were reported to be tectonically so broken that no satisfactory information on thickness and attitude could be obtained. Three kilometers west of the type locality and approximately east of Casa Blanca, Mrs. PALMER found that the Cojímar formation is resting unconformably on the Lower Eocene Universidad formation, and that toward the top it is grading into the assumed Miocene Güines limestone, and is reaching a thickness of 550 feet. There, just east of the Hospital Naval, the Cojímar formation is exposed in a deep road cut. This outcrop is here designated cotype locality of the Cojímar formation.

In the following, revised descriptions are presented of the Cojímar formation as it could be studied at the type locality in the summers of 1958 and 1959 (index map, fig. 73). We did not find it difficult to distinguish the Cojímar lithologies from those of the Universidad and the Consuelo formations, although we admit that this problem might arise in small isolated outcrops (D. K. PALMER, 1940, p. 25). The base of the formation is exposed in the west–southwestern corner of the type section. Here the Cojímar beds are dipping 10° to the N 10° E and are unconformable on almost vertical southwest striking beds of the locally somewhat siliceous Alkázar formation. In the top beds of the Lower Eocene occur bore holes made by lithophagic organisms filled with limonitic granular Cojímar material. Above this distinct angular unconformity are about 30 to 35 m of typical Cojímar beds. They consist of alternating harder and softer chalky beds, predominantly yellowish orange and yellowish gray to whitish, occasionally with fine irregular limonitic striae, which were noticed also in other outcrops of the Cojímar formation and therefore seem to be one of its characteristic features. There are also some calcarenites and fragmental, porous and chalky limestones. The stratification is poor and in general no distinct bedding planes exist. The beds are somewhat thinner and better defined in the lower half of the formation. The boundaries between harder and softer beds are nowhere clearly defined. The harder beds often show a thinning–thickening aspect probably caused by differential compaction during diagenesis. Certain chalky beds have a granular surface due to the abundance of fragments of pelecypods, echinoderms, algae and Foraminifera, especially tests of globigerinids. Toward the top of the type section, the beds appear to be less fossiliferous than at the bottom. The planktonic microfossils are generally badly preserved and coated with country rock. For this reason, *Orbulina suturalis* BRÖNNIMANN and *Orbulina*

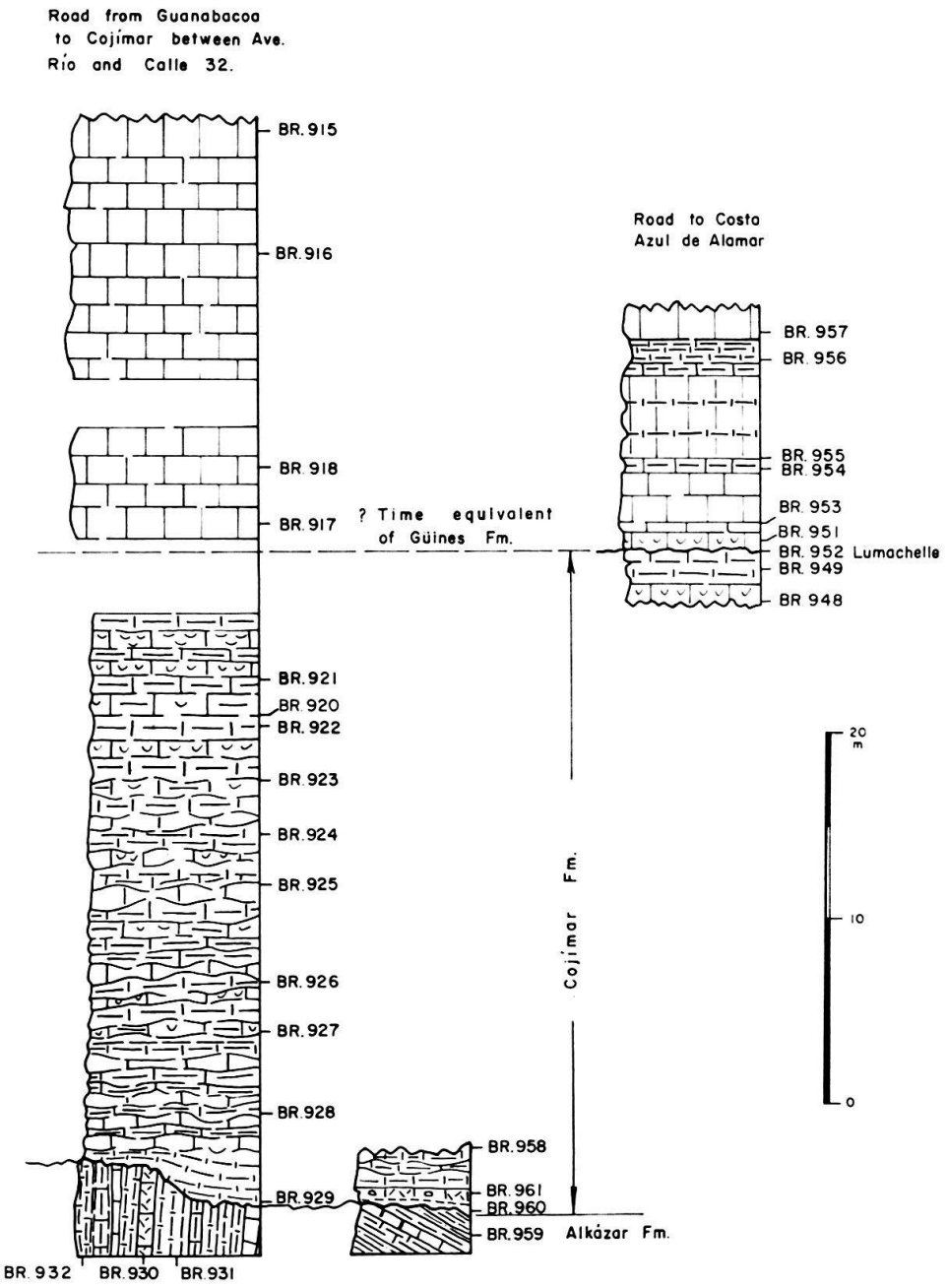

Fig. 74. Columnar sections of the type Cojímar formation, and of the contact Cojímar formation— ?equivalent of Güines formation at the road to Costa Azul de Alamar.

universa D'ORBIGNY could occasionally not be distinguished. The beds on top of the type section, where BR stations 915 to 918 are located, are formed by hard massive crystalline limestones which lack softer intercalations, and which either belong already to a new formation possibly a time equivalent of the Güines formation, or are the top beds of the Cojímar formation altered through accumulation of calcite and subsequent recrystallization. The contact between these upper beds and the typical Cojímar beds is not exposed at the type section. At other places it is of distinctly transitional nature. In the upper portion of the type section, the quality of the outcrops is poor and the country rock is masked locally by small

patches of light gray Quaternary terrace material of the Cojímar river as represented by BR station 919.

The stratigraphic sequence of the type samples is explained in the columnar section, fig. 74. They are listed from bottom to top from BR stations 920 to 929:

BR stations 930, 931

Described under Alkázar formation.

BR station 929

Lithology: Chalk, indurated, granular, pale yellowish orange.

Washed residue heterogeneous and similar to BR station 961 with

Globoquadrina dehiscens (CHAPMAN, PARR, and COLLINS)
Globorotalia fohsi barisanensis LEROY
Globorotalia fohsi fohsi CUSHMAN and ELLISOR
Globorotalia mayeri CUSHMAN and ELLISOR
Globorotalia scitula (BRADY)
Globigerinoides subquadratus BRÖNNIMANN
Globigerinoides trilobus (REUSS) group
Globorotaloides variabilis BOLLI
Globorotalia obesa BOLLI
"*Globigerina*" *juvenilis* BOLLI
Orbulina suturalis BRÖNNIMANN
Operculinoides cojimarensis PALMER (common)
Globorotalia aequa (CUSHMAN and RENZ) } reworked
Pseudohastigerina micra (COLE) } reworked
Pseudoguembelina excolata (CUSHMAN) } reworked

BR station 928

Lithology: Chalk, indurated, powdery, whitish to light grayish yellow.

Washed residue heterogeneous with

Globorotalia fohsi barisanensis LEROY
Globorotalia fohsi fohsi CUSHMAN and ELLISOR
Globorotalia mayeri CUSHMAN and ELLISOR
Globorotalia obesa BOLLI
Globorotalia praemenardii CUSHMAN and STAINFORTH
Globorotalia scitula (BRADY)
Globigerina foliata BOLLI
"*Globigerina*" *juvenilis* BOLLI
Globoquadrina dehiscens (CHAPMAN, PARR, and COLLINS)
Globigerinoides subquadratus BRÖNNIMANN
Globigerinoides trilobus (REUSS) group
Orbulina suturalis BRÖNNIMANN
Globorotaloides variabilis BOLLI
Pseudoguembelina excolata (CUSHMAN) (reworked).

BR station 927

Lithology: Chalk, indurated, powdery, light grayish yellow.

Washed residue with

Orbulina suturalis BRÖNNIMANN
Globorotaloides variabilis BOLLI
Globoquadrina dehiscens (CHAPMAN, PARR, and COLLINS)
Globorotalia fohsi fohsi CUSHMAN and ELLISOR
Globorotalia mayeri CUSHMAN and ELLISOR
Globorotalia obesa BOLLI
Globorotalia praemenardii CUSHMAN and STAINFORTH
Globigerinoides trilobus (REUSS) group
Globigerina foliata BLOLI
"*Globigerina*" *juvenilis* BOLLI

BR station 926

Lithology: Chalk, friable, powdery, whitish to light grayish yellow.

Washed residue slightly heterogeneous with

Globigerina foliata BOLLI
"*Globigerina*" *juvenilis* BOLLI
Globigerinoides trilobus (REUSS) group
Globorotalia fohsi fohsi CUSHMAN and ELLISOR
Globorotalia mayeri CUSHMAN and ELLISOR
Globorotalia obesa BOLLI
Globorotalia praemenardii CUSHMAN and STAINFORTH
Orbulina bilobata (D'ORBIGNY)
Orbulina suturalis BRÖNNIMANN
Globorotaloides variabilis BOLLI
Upper Cretaceous guembelinids (reworked).

BR station 925

Lithology: Limestone, chalky, friable, light grayish yellow.

Washed residue heterogeneous with

Orbulina suturalis BRÖNNIMANN
Globigerinoides trilobus (REUSS) group
Globorotalia fohsi barisanensis LEROY
Globorotalia fohsi fohsi CUSHMAN and ELLISOR
Globorotalia mayeri CUSHMAN and ELLISOR
Globorotalia obesa BOLLI
Globorotalia praemenardii CUSHMAN and STAINFORTH
Globoquadrina altispira (CUSHMAN and JARVIS) group
Globoquadrina dehiscens (CHAPMAN, PARR, and COLLINS)
Globoquadrina venezuelana (HEDBERG)
Globigerina foliata BOLLI
"*Globigerina*" *juvenilis* BOLLI
Globorotaloides variabilis BOLLI
Operculinoides cojimarensis (D. K. PALMER)
Globotruncana stuarti (DE LAPPARENT) (reworked).

BR stations 922, 923 and 924

Lithologies: Chalk, friable, powdery, grayish yellow to yellowish orange, (922, 924); limestone, chalky, whitish to grayish yellow (923).

Washed residues with

Globorotalia fohsi fohsi CUSHMAN and ELLISOR
Globorotalia mayeri CUSHMAN and ELLISOR
Globorotalia obesa BOLLI
Globorotalia praemenardii CUSHMAN and STAINFORTH
Globoquadrina dehiscens (CHAPMAN, PARR, and COLLINS)
Globigerina foliata BOLLI
"*Globigerina*" *juvenilis* BOLLI
Globorotaloides variabilis BOLLI
Globigerinoides trilobus (REUSS) group
Orbulina suturalis BRÖNNIMANN
Sphaeroidinella grimsdalei (KEIJZER).

From BR station 922 W. A. VAN DEN BOLD (letter 21. 3. 1963) identified the following ostracodes of about "Güines" age:

Aurila deformis (REUSS)
Bairdia sp.
Echinocythereis ? *jacksonensis* (HOWE and PYEATT)
Hermanites hutchisoni V. D. BOLD
Loxoconcha antillea V. D. BOLD
Pterygocythereis n. sp.
Quadracythere antillea (V. D. BOLD)

BR stations 920 and 921

Lithologies: Limestone, fragmental, porous, very pale orange.

Textures: Microcrystalline vacuolar groundmass with fragments of algae, mollusks, echinoderms and bryozoas. Common amphisteginas and globigerinas. Nannoplankton destroyed through recrystallization.

Assemblages: *Orbulina suturalis* BRÖNNIMANN
Globigerina spp.
Amphistegina spp.
Meandropsina sp.
Archaias cf. *operculiniformis* HENSON
Acervulina inhaerens SCHULTZE.

The following samples are from the questionable time equivalent of the Güines beds on top of the Cojímar type section. They probably represent a new formation different from the Güines formation.

BR station 918

Lithology: Limestone, hard, yellowish gray.

Texture: Microcrystalline groundmass with some fragments of echinoderms, algae and mollusks. Most microfossils destroyed through recrystallization.

BR stations 916 and 917
Lithologies: Limestone, hard, porous, whitish to yellowish gray, in part limonitic (916), chalky, porous, white (917).
Textures: Cryptocrystalline to microcrystalline groundmass, in part vacuolar, with abundant and rather large fragments of algae, echinoderms, encrusting Foraminifera, bryozoas, and mollusks. Common amphisteginas and some globigerinas.

Assemblages:
Orbulina suturalis BRÖNNIMANN
Globigerina spp.
Acervulina inhaerens SCHULTZE
Gypsina globulus REUSS
Sporadotrema cylindricum (CARTER)
Amphistegina spp.
Meandropsina sp.
Planorbulina mediterranensis D'ORBIGNY.

BR station 915
Lithology: Limestone, hard, porous, whitish to light yellowish gray.
Texture: Cryptocrystalline to microcrystalline groundmass, in part vacuolar, with fragments of algae, mollusks, encrusting Foraminifera, bryozoas and echinoderms. Common amphisteginas and globigerinas. The minute planktonic forms destroyed through recrystallization.

Assemblage:
Orbulina suturalis BRÖNNIMANN
Globigerina spp.
Amphistegina spp.
Acervulina inhaerens SCHULTZE
Planorbulina mediterranensis D'ORBIGNY
Sporadotrema sp.

BR station 919 (Quaternary terrace)
Lithology: Limestone, in places vacuolar, light gray.
Texture: Recrystallized calcite. Barren.

The pronounced angular unconformity between Cojímar and Lower Eocene beds is perfectly exposed at the bottom of the western flank of the Cojímar gorge along Avenida Río (index map, fig. 73; photographs of contact, figs. 29, 30). There, the yellowish in places silicified arenaceous Lower Eocene beds, BR station 959, are truncated by Cojímar beds. The basal Cojímar bed is an indurated calcarenaceous layer composed of organic fragments (BR station 960). It contains some igneous grains and is directly overlain by a softer sandy and conglomeratic chalk with some angular to subangular chert pebbles with reworked faunal elements of Lower Eocene and Upper Cretaceous age, BR station 961, and this by a thin, shaley lumachelle formed by fragments of pelecypods. Pectens, similar to *Lyropecten* (*Nodipecten*) *articulosus* (COOKE) were noticed in this bed. Mrs. PALMER (1940, p. 23) reported *Miogypsina* sp. from the basal strata of the Cojímar formation about 1 km east of Casa Blanca, and well preserved specimens of *Globotruncana* from 9 different localities of the Cojímar formation. These forms are unquestionably allochthonous (D. K. PALMER, 1940–1941, pp. 288–291). We also recorded globotruncanas and guembelinids in addition to keeled, truncate globorotalias in the

type samples of the Cojímar formation, which in this general area transgresses on the Vía Blanca, Alkázar, Universidad and Husillo formations. Then follow the typical Cojímar lithologies as described above with abundant small rounded and irregular knolls of encrusting algae and fragments of pelecypods. BR station 958 is from this algal bed, about 3.5 m above the unconformity.

BR station 959 (Alkázar formation)

Lithology: Chalk, indurated, powdery, granular appearance, yellowish orange. Washed residue heterogeneous with abundant Lower Eocene Radiolaria mixed by contamination from the overlying Cojímar beds with

Orbulina suturalis BRÖNNIMANN
Globoquadrina altispira (CUSHMAN and JARVIS)
Globoquadrina venezuelana (HEDBERG)
Globorotalia fohsi fohsi CUSHMAN and ELLISOR
Globorotalia mayeri CUSHMAN and ELLISOR
Sphaeroidinella grimsdalei (KEIJZER)
Globotruncana cf. *arca* (CUSHMAN) (reworked).

BR station 960

Lithology: Calcarenite, whitish to yellowish gray, with rare igneous grains.
Texture: Microcrystalline vacuolar groundmass with rather densely packed fragments of algae, echinoderms, bryozoas, encrusting Foraminifera, and mollusks. Abundant benthonic Foraminifera, in particular amphisteginas. Also some globigerinids.

Assemblage:

Amphistegina spp.
Gypsina globulus REUSS
Acervulina inhaerens SCHULTZE
Archaias sp. (fragments only)
Planorbulina mediterranensis D'ORBIGNY
Globotruncana lapparenti BROTZEN group
Globorotalia sp. (truncate form)
Lepidocyclina sp. (fragment)

} reworked

BR station 961

This assemblage shows strong reworking of Upper Cretaceous planktonic Foraminifera.
Lithology: Calcarenite, friable, pale yellowish orange.
Washed residue heterogeneous with

Globorotalia fohsi barisanensis LEROY
Globorotalia fohsi fohsi CUSHMAN and ELLISOR
Globorotalia mayeri CUSHMAN and ELLISOR
Globigerinoides trilobus (REUSS) group
Orbulina universa D'ORBIGNY
Globoquadrina altispira (CUSHMAN and JARVIS)
Sphaeroidinella grimsdalei (KEIJZER)
Globorotaloides variabilis BOLLI

Globorotalia spinuloinflata (BANDY)
Globorotalia sp. (truncate form)
Catapsydrax stainforthi BOLLI, Loeblich, and TAPPAN
Globotruncanella havanensis (VOORWIJK)
Globotruncana linneiana (D'ORBIGNY)
Pseudotextularia elegans (RZEHAK)
} reworked

BR station 958
Lithology: Limestone, fragmental, porous, with large algal remains, pale yellowish orange.
Texture: Cryptocrystalline to microcrystalline vacuolar groundmass with fragments of algae, encrusting Foraminifera, echinoderms, bryozoas and mollusks, common amphisteginas and some globigerinas. Algae and encrusting Foraminifera make up about 50 % of the area of the thin section.
Assemblage: *Sporadotrema* sp.
Amphistegina cf. *angulata* CUSHMAN
Acervulina inhaerens SCHULTZE
Globigerina spp.
Washed residue heterogeneous with
Orbulina suturalis BRÖNNIMANN
Globoquadrina altispira (CUSHMAN and JARVIS)
Globorotaloides variabilis BOLLI
Globorotalia fohsi barisanensis LEROY
Globorotalia fohsi fohsi CUSHMAN and ELLISOR
Globorotalia obesa BOLLI
Globorotalia mayeri CUSHMAN and ELLISOR
Globigerinoides trilobus (REUSS) group
Chiloguembelina cubensis (D. K. PALMER)
Globigerina ciperoensis angustiumbilicata BOLLI
Globorotalia cf. *wilcoxensis* CUSHMAN and PONTON
Globorotalia aequa CUSHMAN and RENZ
Rugoglobigerina rugosa (PLUMMER)
} reworked

Contact Cojímar formation—(?)time equivalent of the Güines formation in the Cojímar–Alamar area

Typical Cojímar beds are exposed at cuts of the road from Avenida Monumental along the southern slope of the gorge of Río Cojímar on the north flank of Loma San Pedro toward the Reparto Costa Azul de Alamar. The younger part of the section which crops out along the culminating portion of the road is formed by massive, hard, cavernous limestone which may be either altered Cojímar chalk or a new formation, ?time equivalent of the Güines formation as exposed in the Vento syncline and in the Güines area. The older part of the section is in typical Cojímar beds directly corresponding with those of the type locality. In these beds we collected large pectens identified by W. P. WOODRING (letter of October 7, 1959) as *Lyropecten* (*Nodipecten*) *articulosus* (COOKE). WOODRING remarks "that the

type lot of this species was collected at the "quarry near asylum, near Guajay (Wajay), 15 miles southwest of Habana" (COOKE, 1919, p. 136, pl. 7, figs. 7, 8). *Lyropecten (Nodipecten) articulosus* is closely related to *L. condylomatus* (DALL) from the late Miocene Chipola formation of Florida. The earliest species of *Lyropecten* appear according to WOODRING "in strata of late Oligocene age in the Canal Zone and in Trinidad. *L. articulosus*, however, is more closely related to *L. condylomatus* than to the late Oligocene forms. On the basis of this one species, it is more probable that the strata near Guajay and near Cojímar are of early Miocene age than that they are late Oligocene. . . ." Near the top of the typical Cojímar lithologies, represented by BR stations 948 and 949, occurs a 1 to 4 cm thick layer of greenish and limonitic clay with abundant flattened tests of pectens and other lamellibranchs. This bed is regarded as a beach lumachelle formed during a brief emergence. It is cutting the underlying beds somewhat irregularly and apparently disconformably. BR station 952 is from this lumachelle. The overlying beds where BR station 951 was taken, may be already the ?time equivalent of the Güines formation. It is a 1 m thick porous light yellowish or orange limestone with numerous mollusk remains, in general very similar to the top Cojímar beds, but somewhat harder. The conspicuous tests of *Operculinoides cojimarensis* (D. K. PALMER) were seen below and above the lumachelle. Above the questionable Güines time equivalent, the formation is a massive, hard crystalline limestone with a few thin interbeds of hard calcareous shale. This contact zone is illustrated by the columnar section, fig. 74, which explains the relative stratigraphic positions of the samples described below.

BR station 957
Lithology: Limestone, fragmental, hard, porous, whitish to grayish yellow.
Texture: As BR stations 951, 953–955.

Assemblage:
Planorbulina mediterranensis D'ORBIGNY
Amphistegina spp.
Sporadotrema cylindricum (CARTER)
Acervulina inhaerens SCHULTZE
Archaias sp.
Meandropsina sp.
Orbulina universa D'ORBIGNY
Globigerina spp.
Miogypsina sp. (reworked).

BR station 956
Lithology: Chalk, friable, powdery, whitish.
Washed residue with
Orbulina universa D'ORBIGNY
Globigerina spp., and
reworked Upper Cretaceous Foraminifera.

BR stations 953, 954, 955

These samples are lithologically and faunally very similar and are therefore summarized in a single description.

Lithologies: Limestone, fragmental, hard (953, 955), chalky (954), whitish to grayish yellow.
Textures: As station 951.
Assemblages: *Planorbulina mediterranensis* d'Orbigny
Amphistegina spp.
Acervulina inhaerens Schultze
Operculinoides cojimarensis (D. K. Palmer) (only in 953)
Archaias sp.
Meandropsina sp.
Gypsina globulus Reuss
Orbulina suturalis Brönnimann
Orbulina universa d'Orbigny
Globigerina spp.
Sporadotrema cylindricum (Carter).

BR station 951
Lithology: Limestone, fragmental, chalky, whitish to light pale yellowish orange.
Texture: Microcrystalline groundmass with minute fragments of mollusks and echinoderms and with larger discrete fragments of algae, corals, bryozoas, encrusting Foraminifera, echinoderms and mollusks. Common amphisteginas and globigerinids.
Assemblage: *Acervulina inhaerens* Schultze
Amphistegina sp.
Orbulina suturalis Brönnimann
Orbulina universa d'Orbigny
Archaias sp.
Meandropsina sp.
Globigerina spp.

BR station 952 (Lumachelle)
Lithology: Chalk, clayey with abundant mollusk fragments, whitish to greenish.
Washed residue with
Globorotalia obesa Bolli
Globorotalia mayeri Cushman and Ellisor
Orbulina suturalis Brönnimann
Globigerina foliata Bolli
"*Globigerina*" *juvenilis* Bolli
Globorotaloides variabilis Bolli
Sphaeroidinella grimsdalei (Keijzer)
Globigerinoides trilobus (Reuss) group.

BR stations 949 and 950
These two samples are lithologically and faunally almost identical and therefore described together.
Lithologies: Chalk, indurated, powdery, light yellowish orange.
Washed residue with
Globorotalia fohsi fohsi Cushman and Ellisor
Globorotalia mayeri Cushman and Ellisor

Orbulina bilobata (D'ORBIGNY)
Orbulina suturalis BRÖNNIMANN
Orbulina universa D'ORBIGNY
Globigerinoides trilobus (REUSS) group
Globorotaloides variabilis BOLLI
Globorotalia obesa BOLLI
Globorotalia praemenardii CUSHMAN and STAINFORTH
Globigerina foliata BOLLI
Globoquadrina altispira (CUSHMAN and JARVIS)
Operculinoides cojimarensis (D. K. PALMER).

BR station 948
Lithology: Chalk, indurated, granular, pale yellowish orange.
Washed residue with

Globorotalia obesa BOLLI
Globorotalia mayeri CUSHMAN and ELLISOR
Globorotaloides variabilis BOLLI
Orbulina universa D'ORBIGNY
Orbulina suturalis BRÖNNIMANN
Globigerinoides trilobus (REUSS) group
Operculinoides cojimarensis (D. K. PALMER).

At Avenida Monumental, just immediately west of the Urría type locality, coordinates 369.94 N and 366.22 E, about 5 m of the questionable time equivalent of the Güines formation are exposed. These strata, represented by BR stations 964 and 965, show the same lithology as at the culmination of the road toward Reparto Costa Azul de Alamar. The actual contact with the underlying Cojímar formation is masked by talus. At this locality, the Cojímar formation is only about 8 m thick, against 30 to 35 m at the type section, and overlies unconformably the Toledo member of the Universidad formation. As at Avenida Río, the basal 2 m of the Cojímar formation contain numerous isolated "nodules" of encrusting algae, BR station 963. The top of the algal bed is a thin pecten lumachelle with a clayey and limonitic matrix indicating a brief period of intraformational emergence.

BR station 963 (Cojímar formation)
Lithology: Limestone, hard, fragmental, granular in appearance, porous, white.
Texture: Cryptocrystalline to microcrystalline groundmass, vacuolar, with abundant small angular fragments of organic origin, in which are embedded discrete large fragments of algae (*Lithophyllum* sp.), encrusting Foraminifera, bryozoas, echinoderms and mollusks. Common amphisteginas and globigerinids and large arenaceous Foraminifera.
Assemblage:

Amphistegina spp.
Sporadotrema sp.
Acervulina inhaerens SCHULTZE
Orbulina suturalis BRÖNNIMANN
Orbulina universa D'ORBIGNY
Globigerina spp.

BR station 964
Lithology: Limestone, hard, chalky, whitish.
Texture: As BR station 963, but without large algal fragments and with only a few globigerinids.

Assemblage: *Amphistegina* sp.
Acervulina inhaerens SCHULTZE
Sporadotrema sp.
Globigerina spp.

BR station 965
Lithology: Limestone, hard, dense, whitish to yellowish gray, limonitic.
Texture: Microcrystalline groundmass with traces of microfossils.

Other outcrops of the Cojímar formation

Autopista del Mediodía

On the western side of the road cut at the Autopista del Mediodia we measured about 15 to 17 m of Cojímar formation (index map, fig. 45). The unconformable contact between the Toledo member of the Universidad formation and the Cojímar formation has already been described under Universidad formation (see p. 355 of this paper). The Cojímar lithology does not differ essentially from that of the type Cojímar but it lacks the coarser organic fragments which give a granular aspect to some beds and it also lacks the harder shell-bearing beds. As a whole, the color of the formation is lighter than that of the type beds. The very top of the formation is not exposed. In February 1958, a trench showed a conglomerate composed of large angular blocks of Cojímar material, BR station 423B, in a white powdery chalk matrix, BR station 423A, separated only by a small covered gap from the underlying Cojímar formation. The matrix of this conglomerate appears to be already of post-*Globorotalia fohsi* age. The actual contact may be unconformable. The section along the eastern side of the road cut at the Autopista del Mediodía differs from that of the western side by the preservation of the 5 lowest meters of Príncipe member below the Cojímar formation. This contact has previously been described in the chapter on the Universidad formation. Neither the top of the Cojímar formation nor the younger beds can be seen at this locality.

BR station 423A (matrix of conglomerate)
Lithology: Chalk, friable, powdery, white.
Washed residue with
Globigerinoides trilobus (REUSS) group
Orbulina bilobata (D'ORBIGNY)
Orbulina suturalis BRÖNNIMANN
Globigerina foliata BOLLI
Globorotalia mayeri CUSHMAN and ELLISOR.

BR station 423B (components of conglomerate)
Lithology: Chalk, indurated, powdery, white.
Texture: Cryptocrystalline to microcrystalline with planktonic microfossils. Minute microfossils generally destroyed through recrystallization.

Assemblage: *Globigerina* spp.
Orbulina suturalis BRÖNNIMANN
Coccoliths.

Washed residue with
Globorotalia fohsi fohsi CUSHMAN and ELLISOR
Globigerinoides trilobus (REUSS).

BR station 419
Lithologies: Chalk, grayish yellow.

Washed residues heterogeneous with reworked Lower Eocene Radiolaria and with
Globigerinoides trilobus (REUSS) group
"*Globigerina*" *juvenilis* BOLLI
Globoquadrina altispira (CUSHMAN and JARVIS)
Globoquadrina dehiscens (CHAPMAN, PARR, and COLLINS)
Globorotalia fohsi fohsi CUSHMAN and ELLISOR
Globorotalia obesa BOLLI
Globorotalia mayeri CUSHMAN and ELLISOR
Globigerina soldadoensis BRÖNNIMANN (reworked).

Pebbles of Toledo limestone at the base of the Cojímar chalks collected in BR station 419:
Lithology: Limestone, silicified, laminated, light yellowish brown to yellowish orange.
Texture: Silicified groundmass with abundant Radiolaria.

Assemblage: Radiolaria
Discoaster lodoensis BRAMLETTE and RIEDEL (common)
Discoaster aster BRAMLETTE and RIEDEL
Discoaster barbadiensis TAN
Thoracosphaera sp.
Coccoliths.

BR stations 420, 421 and 422

Lithologies and microfaunas from these stations are practically identical and therefore reported in a single description.
Lithologies: Limestone, chalky, white.
Textures: Microcrystalline groundmass with planktonic microfossils. The minute components of the planktonic assemblages are destroyed through recrystallization.

Assemblages: *Orbulina bilobata* (D'ORBIGNY)
Orbulina suturalis BRÖNNIMANN
Orbulina universa (D'ORBIGNY)
Globigerina spp.

Washed residue with
Globigerinoides subquadratus BRÖNNIMANN
Globigerinoides trilobus (REUSS) group
Globorotalia fohsi fohsi CUSHMAN and ELLISOR
Globorotalia mayeri CUSHMAN and ELLISOR
Globorotalia obesa BOLLI

Globorotalia praemenardii CUSHMAN and STAINFORTH
Globigerina foliata BOLLI
Orbulina suturalis BRÖNNIMANN
Orbulina universa D'ORBIGNY
Globoquadrina altispira (CUSHMAN and JARVIS).

BR station 546
Lithology: Chalk, friable, pale yellowish orange.
Washed residue with

Globorotalia fohsi fohsi CUSHMAN and ELLISOR
Globorotalia mayeri CUSHMAN and ELLISOR
Globigerinoides trilobus (REUSS) group
Orbulina suturalis BRÖNNIMANN
Sphaeroidinella grimsdalei (KEIJZER).

BR stations 547 and 549 (basal Cojímar, western cut)
Lithologies: Limestone, silicified, dark yellowish orange (547 pebble from Toledo member), chalk, friable, light grayish yellow (549).
Texture: Cryptocrystalline to microcrystalline limonitic groundmass with abundant planktonic microfossils (547).
Assemblages:

Globorotalia spp. (truncate forms)
Globigerina senni (BECKMANN)
Coccoliths (abundant)
Braarudosphaera bigelowi (GRAN and BRAARUD)
Braarudosphaera discula BRAMLETTE and RIEDEL (common)
Discoaster aster BRAMLETTE and RIEDEL
Discoaster barbadiensis TAN
Discoaster lodoensis BRAMLETTE and RIEDEL
Forms intermediate between *D. barbadiensis* and *D. aster*
Thoracosphaera spp.

Washed residue of BR station 549 with

Globorotalia fohsi fohsi CUSHMAN and ELLISOR
Globorotalia fohsi lobata BERMÚDEZ
Globorotalia mayeri CUSHMAN and ELLISOR
Globorotalia praemenardii CUSHMAN and STAINFORTH
Globorotalia obesa BOLLI
Globigerinoides trilobus (REUSS) group
Orbulina universa D'ORBIGNY
Orbulina bilobata (D'ORBIGNY)
Sphaeroidinella grimsdalei (KEIJZER)
Globoquadrina altispira (CUSHMAN and JARVIS)
Globoquadrina dehiscens (CHAPMAN, PARR, and COLLINS).

BR station 455 (top Universidad, eastern cut)
Lithology: Limestone, hard, pale yellowish orange.
Texture: Cryptocrystalline to microcrystalline groundmass with abundant planktonic microfossils.

Assemblage: *Globigerinatheka barri* BRÖNNIMANN
Truncorotaloides topilensis (CUSHMAN)
Globigerapsis sp.
Globigerina senni (BECKMANN)
Coccoliths
Tremalithus eopelagicus BRAMLETTE and RIEDEL
Braarudosphaera discula BRAMLETTE and RIEDEL (abundant)
Discoaster barbadiensis TAN (common)
Micrantholithus cf. *M. vesper* DEFLANDRE (rare)
Thoracosphaera sp.
Intermediate forms between *D. aster* and *D. barbadiensis.*

The absence of *D. lodoensis* suggests a late Middle Eocene age for this assemblage.

New reparto in former quarry northwest of Pogolotti, Marianao

Between Calzada Real and coordinates 362.52 N and 355.20 E, the Cojímar formation is exposed over a distance of more than 200 m along a northwest trending cliff. The beds dip from 8° to 16° to the northwest. The total thickness is 40 to 45 m. The basal beds are more indurated than the younger ones, which show the typical Cojímar lithology, in particular the fine irregular orange striae. But, as at the cut at the Autopista del Mediodia, the coarser granular beds are lacking. The contacts with the underlying Husillo formation and the overlying (?)time equivalent of the Güines formation are not exposed. The samples from the cliffs listed below are from bottom to top:

Northeastern portion of cliff

BR stations 904 (bottom) and 905

The samples from these stations are lithologically and faunally virtually identical and therefore recorded in a single description.

Lithologies: Limestone, fragmental to calcarenaceous, pale yellowish orange to yellowish gray.

Textures: Cryptocrystalline to microcrystalline groundmass, dense to vacuolar, with fragments of mollusks, echinoderms, algae, encrusting Foraminifera and bryozoas. Common amphisteginas and globigerinids.

Assemblages: *Orbulina suturalis* BRÖNNIMANN
Orbulina universa D'ORBIGNY
Globoquadrina cf. *dehiscens* (CHAPMAN, PARR, and COLLINS)
Globigerina spp.
Amphistegina spp.
Operculinoides cojimarensis (D. K. PALMER)
Archaias sp.
Meandropsina sp.
Acervulina inhaerens SCHULTZE
Gypsina globulus REUSS
Planorbulina mediterranensis D'ORBIGNY
Miogypsina sp. (fragment, reworked)
Sporadotrema sp.

Washed residue (905) with

Globigerinoides trilobus (REUSS) group
Orbulina suturalis BRÖNNIMANN
Orbulina universa D'ORBIGNY
Globoquadrina altispira (CUSHMAN and JARVIS)
Globorotalia obesa BOLLI
Amphistegina spp.
Operculinoides cojimarensis (D. K. PALMER).

BR station 906

Lithology: Limestone, fragmental to calcarenaceous, yellowish gray.

Texture: Microcrystalline groundmass, vacuolar, with densely packed minute fragments of mainly echinoderms, mollusks and algae. Also larger fragments of echinoderms, and algae. Common amphisteginas, and some globigerinids.

Assemblage: *Amphistegina* spp.
Archaias sp.
Acervulina inhaerens SCHULTZE
Orbulina universa D'ORBIGNY
Sporadotrema sp.
Globigerina spp.

Southwestern portion of cliff

BR station 909

Lithology: Chalk, indurated, with yellowish orange striae. Whitish, to very pale orange overall color.

Washed residue with

Globorotalia fohsi fohsi CUSHMAN and ELLISOR
Globorotalia fohsi barisanensis LEROY
Globorotalia mayeri CUSHMAN and ELLISOR
Globorotalia obesa BOLLI
Globorotalia scitula (BRADY)
Globigerinoides trilobus (REUSS) group
Orbulina suturalis BRÖNNIMANN
Orbulina universa D'ORBIGNY

BR stations 907 (top) and 908

These samples are lithologically and faunally similar and therefore described together.

Lithologies: Limestone, chalky, whitish (907), chalk, friable, powdery (908).

Textures: Microcrystalline, extremely vacuolar groundmass with irregularly distributed organic derived minute fragments and planktonic Foraminifera.

Assemblages: *Orbulina suturalis* BRÖNNIMANN
Orbulina universa D'ORBIGNY
Globigerina spp.

Washed residues with

Orbulina bilobata (D'ORBIGNY)
Orbulina suturalis BRÖNNIMANN

Orbulina universa D'ORBIGNY
Globorotalia fohsi fohsi CUSHMAN and ELLISOR
Globorotalia fohsi lobata BERMÚDEZ
Globorotalia mayeri CUSHMAN and ELLISOR
Globorotalia obesa BOLLI
Globorotaloides variabilis BOLLI
Globigerina foliata BOLLI
"*Globigerina*" *juvenilis* BOLLI
Globoquadrina altispira (CUSHMAN and JARVIS)
Globoquadrina dehiscens (CHAPMAN, PARR, and COLLINS)
Globigerinoides subquadratus BRÖNNIMANN
Globigerinoides trilobus (REUSS) group
Globigerinoides mitra TODD
Sphaeroidinella grimsdalei (KEIJZER)

Tejar Andrade

The geographic location of Tejar Andrade, Marianao, has been explained under Husillo formation. Reference is made to the index map, fig. 71, and to the cross sections, fig. 72. The quarry is divided in two sections by Arroyo Bañabuey. In the southeastern section, only pre-Cojímar formations are exposed. In the northwestern section of the quarry, reduced outcrops of the Príncipe member of the Universidad formation are found (BR station 858). Reefal limestones of the Husillo formation overlie also at this locality unconformably the Universidad formation (BR station 859). Husillo bioherms form the central part of this portion of the quarry. In the northeastern section of the quarry, very hard, massive reefal limestones, documented by BR stations 862, 909A, 911, 913, are at the base of the exposed section which is normally overlain by typical Cojímar beds (BR stations 860, 861, 910, 912, 914). The surface on top of the reefs is smooth and hard and apparently represents the original surface. The reefal limestones are also here attributed to the Husillo formation. The contact between the Husillo reefs and the Cojímar formation is very irregular. Apparently the growth of the reefs was interrupted by a sudden subsidence which initiated over this area the relatively deeper water conditions of Cojímar time. This interpretation of the contact is supported by the lack of limonitic residues at the top of the bioherms. The Cojímar formation is typically developed but, as at the Autopista del Mediodía and the Reparto northwest of Pogolotti, Marianao, it lacks the granular beds.

The following samples from the Cojímar formation were taken at random:

BR stations 860 and 861

They are lithologically and faunally very similar and therefore described together.

Lithologies: Chalk, friable, powdery, granular, very pale orange to pale yellowish orange (860), chalk, white (861).

Washed residues with

Globorotalia fohsi fohsi CUSHMAN and ELLISOR
Globorotalia mayeri CUSHMAN and ELLISOR
Globorotalia obesa BOLLI

Globorotalia praemenardii CUSHMAN and STAINFORTH
Orbulina bilobata (D'ORBIGNY)
Orbulina suturalis BRÖNNIMANN
Orbulina universa D'ORBIGNY
Globigerinoides trilobus (REUSS) group.

BR stations 910 and 912

These samples are faunally and lithologically practically identical and therefore reported together.

Lithologies: Chalk, friable, powdery, whitish.

Washed residue with

Operculinoides cojimarensis (D. K. PALMER)
Globoquadrina altispira (CUSHMAN and JARVIS)
Globigerinoides trilobus (REUSS) group
Globorotalia fohsi fohsi CUSHMAN and ELLISOR
Globorotalia mayeri CUSHMAN and ELLISOR
Globorotalia obesa BOLLI
Orbulina suturalis BRÖNNIMANN
Orbulina universa D'ORBIGNY
Globigerina foliata BOLLI.

BR station 914

Lithology: Chalk, friable, powdery, white.

Washed residue with

Globorotalia mayeri CUSHMAN and ELLISOR
Globigerinoides trilobus (REUSS) group
Orbulina sp.
Globorotalia fohsi fohsi CUSHMAN and ELLISOR.

Environment and age

At the type section of the Cojímar formation and at Loma Urría and Loma San Pedro, we observed the following principal lithologies, arranged below in order of significance.

a) Chalks and chalky limestones

Thin sections of the indurated chalks or chalky limestones show a microcrystalline groundmass with common to abundant planktonic Foraminifera. The minute planktonic microfossils such as discoasters and coccoliths are usually destroyed through recrystallization. The friable powdery chalks contain rich *Globigerina–Globorotalia* faunas. Associated with the planktonic assemblages we encountered occasionally *Operculinoides cojimarensis* (D. K. PALMER).

Environment: Relatively deep water.

b) Fragmental limestones

The next common lithology of the Cojímar type section are fragmental limestones. They appear mainly toward the top of the formation. In thin sections, the groundmass of these limestones is cryptocrystalline to microcrystalline with

abundant and usually rather densely packed minute subangular to angular, organic derived fragments. The minute fragments and the cryptocrystalline to microcrystalline groundmass are so finely mixed that a secondary groundmass is formed in which are embedded larger and isolated fragments of algae, encrusting and other benthonic Foraminifera, echinoderms, mollusks and bryozoas and whole tests of benthonic Foraminifera, in particular amphisteginas. Planktonic Foraminifera are common. The nannoplankton seems to be destroyed through recrystallization.
Environment: Intermediate between reefal complex and deeper water.

c) Calcarenites

Calcarenites are a minor lithologic constituent of the basal portion of the type section. Exceptionally they also occur interbedded with the above described fragmental limestones of type (b). The groundmass of the calcarenites is microcrystalline, vacuolar, with more or less densely packed comminuted fragments of algae, echinoderms, bryozoas, mollusks and encrusting and other benthonic Foraminifera. Algae and encrusting Foraminifera are occasionally the dominant components. Whole tests of amphisteginas and other rotaliids are common. *Operculinoides cojimarensis* (D. K. PALMER) was noticed. Peneroplids such as *Archaias* cf. *operculiniformis* HENSON and *Meandropsina* sp. are usually present as fragments. Planktonic Foraminifera are scarce. As in the chalks and chalky limestones of type (a) the minute planktonic microfossils, if originally present, appear to be destroyed through recrystallization.
Environment: Reefal complex.

Two of the above described lithologic types, i.e. chalks and chalky limestones (a) and calcarenites (c), are very similar to those reported from the Husillo formation and suggest similar depositional environments. The calcarenites of the Cojímar formation are derived from a reef and probably were deposited in the fore-reefal area. No isolated bioherms were encountered in the Cojímar beds. The fragmental limestones of lithologic type (b) with the abundant minute organic components and the larger discrete organic inclusions, occasionally with many planktonic Foraminifera, are believed to have been formed in an intermediate area between deeper water and reefal complex. These limestones differ from the fragmental limestones of the Husillo formation, which are, at least in part, of biohermal origin. The limestones following on top of the Cojímar type section and referred to the questionable time equivalent of the Güines formation are fragmental limestones of the type (b). They are well developed in the Alamar section, from BR station 951 at the base to BR station 957 at the top, and they differ considerably from the Güines formation as developed in the south of the Habana area which is clearly a back-reef deposit. They contain *Operculinoides cojimarensis* (D. K. PALMER) and *Cuneolinella cojimarensis* (D. K. PALMER, 1940–1941, pp. 26, 122). The lumachelle at BR station 952 is interpreted as having been formed during a brief emergence. The chalks and chalky limestones with the common to abundant planktonic Foraminifera of the lithologic type (a) were laid down under relatively deeper water conditions, similar to the chalks interbedded in the Husillo type section. In the washed residues from the chalky beds of the Cojímar type section, it was found

that the ratio of planktonic and benthonic Foraminifera decreases from the bottom to the top of the section from about 50 to 90 % in BR stations 929 and 961, to about 50 % in BR stations 924, 928, and to about 40 % and less in BR stations 920 to 922. Applying the results of GRIMSDALE and VAN MORKHOVEN (1955), the estimated depth of the chalky sediments of the Cojímar beds is interpreted to decrease during geological time from about 600 to 1200 m for BR stations 929 and 961, near the base of the formation, to about 600 m for the stations with an approximate ratio of planktonic and benthonic forms of about 50 %, and to about 100 to 600 m, or less, for the stations near the top of the formation. The fragmental limestones and the lumachelle referred to the questionable time equivalent of the Güines formation, overlying in the Cojímar–Alamar area the Cojímar formation, would also be relatively shallow-water deposits, close to a reefal complex as indicated by the combination of planktonic and benthonic microfossils and reefal derived material. In contrast to the Husillo beds as exposed in the Husillo quarry, the facies of the Cojímar formation does not change rapidly from deeper to shallow-water conditions and back to deeper water, but gradually from deeper to shallower water. The older Cojímar chalks are the last deep water deposits in the stratigraphic sequence of the Habana area, and as such comparable with the chalks of the Universidad and Punta Brava formations. The post-Cojímar beds of the Habana area, represented by the questionable time equivalent of the Güines limestones in the Cojímar–Alamar area, by the restricted shallow-water limestones and dolomites of the Güines formation sensu stricto, by the marls of the Rosario formation with oysters and peneroplids of late Miocene age, by the reefal Vedado and Morro formations, by the Pleistocene Biltmore shell bed, and finally by the cross-bedded calcarenites of the Pleistocene Casa Blanca, Jaimanitas and Santa Fé formations, all indicate distinctly very shallow marine environments.

Mrs. PALMER (1940–1941, pp. 22–27) published a table with the percentages of species of each foraminiferal family found in the Cojímar formation and compared them with those compiled by NORTON (1930) for the Recent foraminiferal fauna of the Caribbean sea. Although the percentages of the Cojímar fauna correspond fairly well with Norton's zone from 500 to 825 fathoms, Mrs. PALMER concluded after a discussion of the depth ranges of *Gypsina discus* (GOËS), *Gypsina globulus* REUSS, *Orbulina bilobata* (D'ORBIGNY), *Amphistegina*, *Sporadotrema* and *Sorites* that the probable depth of the Cojímar sea was approximately 200 fathoms. In order of magnitude this result does not conflict strongly with our depth estimate of about 600 m for the middle and major portion of the type section based on the method developed by GRIMSDALE and VAN MORKHOVEN.

Reworking of older faunal and lithologic elements is conspicuous in the lower Cojímar beds. Usually one finds Upper Cretaceous and Eocene planktonic Foraminifera and occasionally even some igneous grains, probably derived from the clastics of the Habana group. This is explained by the overlap of the Cojímar beds in the type area on the Upper Cretaceous Vía Blanca formation and on the Lower Eocene Alkázar and Universidad formations.

Not much has been published on the megafossils of the Cojímar formation, although well-preserved specimens of lamellibranchs, corals, echinids and algae were noticed in the type Cojímar beds.

The following echinids were described by SÁNCHEZ ROIG (1949) from beds outcropping in the Cojímar and Marianao areas and assigned by this author to the Upper Oligocene. Only those forms are here listed, which in our opinion are most probably from the Cojímar formation. Of 17 species cited 14 are from Finca La Noria, located on the south side of the Loma San Pedro which is wholly in Cojímar beds. Those indicated by * are indigenous to Cuba.

Antillaster elegans JACKSON, Finca La Noria, Cojímar
**Amblypneustes corrali* LAMBERT and SÁNCHEZ ROIG, Finca La Noria, Cojímar
**Aplolampas* sp., Finca La Noria, Cojímar
Agassizia clevei COTTEAU, Finca La Noria, Cojímar
**Neopasagus sanchezi* (LAMBERT), Finca La Noria, Cojímar
Brissoma antillarum COTTEAU, Finca La Noria, Cojímar
**Brissoma habanensis* SÁNCHEZ ROIG, Río Cojímar and quarries at the entrance of Cojímar
**Echinolampas cojimarensis* SÁNCHEZ ROIG, Finca La Noria, Cojímar
Echinolampas anguillae COTTEAU, Finca La Noria, Cojímar
**Hebertia jacksoni* LAMBERT, Finca La Noria, Cojímar
**Leiocidaris cojimarensis* LAMBERT and SÁNCHEZ ROIG, Finca La Noria, Cojímar
**Pericosmus roigi* LAMBERT, Estación de Ceiba, F. C. de Marianao
**Progonolampas sanchezi* LAMBERT, Finca La Noria, Cojímar
**Schizaster habanensis* SÁNCHEZ ROIG, Asilo Nacional de Ancianos, Casa Blanca
**Schizaster cojimarensis* SÁNCHEZ ROIG, Finca La Noria, Cojímar
Schizobrisus antillarum COTTEAU, Finca La Noria, Cojímar
Schizobrisus clevei COTTEAU, Finca La Noria, Cojímar

We do not know of any other records of megafossils from the Cojímar formation of the Habana area. The large pecten identified by WOODRING as *Lyropecten (Nodipecten) articulosus* (COOKE) is from the Cojímar beds of the north cliff of Loma San Pedro. The type of this species was collected by BARNUM BROWN and is from disintegrated limestones encountered in a quarry near "asylum near Guajay [=Wajay], 15 miles southwest of Habana." There are many quarries in the general area between the highway to Rancho Boyeros and the village of Wajay and it is almost impossible to locate Barnum Brown's outcrop with any degree of certainty. The same is true with the other fossil localities listed by COOKE (1919, p. 109) in the vicinity of Habana as:

Vento, Province of Habana, with *Cyprea* sp., *Pecten ventonensis* COOKE n. sp., *Teredo* sp., *Panope* sp., *Metis trinitaria* DALL, and *Lucina* sp.

Calabazar, Province of Habana, with *Scaphander* sp., *Cassidea sulcifera* (SOWERBY)?, *Cypracea* sp., *Lucania* sp.

Near E.C.A.?, Cuba (within 10 miles of Habana) with *Malea camura* GUPPY and *Lucina* sp.

Quarry near asylum near Guajay, 15 miles southwest of Habana, with *Ostrea haitensis* SOWERBY, *Pecten decorus* COOKE, n. sp. and *Pecten articulosus* COOKE, n. sp. COOKE regarded the small collections from Calabazar and Wajay to be probably of Oligocene age, and the one from "Near E.C.A." may be somewhat

younger than the others, although the evidence is inconclusive. SÁNCHEZ ROIG (1949, p. 246) recorded *Ostrea haitensis* SOWERBY from a cut at the railroad from Habana to Marianao, Estación de Ceiba. This is the same locality from which this author described *Pericosmus roigi* LAMBERT.

As pointed out earlier, discoasters and coccoliths so common in the older Tertiary appear to be destroyed through recrystallization in all of the Cojímar samples examined by us. The planktonic Foraminifera, however, indicate that the Cojímar formation is part of the *Globorotalia fohsi* zone which overlies the *Globigerinatella insueta* zone and underlies the *Globorotalia mayeri* zone. Not all of the subzones of the *Globorotalia fohsi* zone were recognized. The type section of the Cojímar formation is within the *Globorotalia fohsi fohsi* subzone, and only three samples, one from the Cojímar beds at the road cut at the Autopista del Mediodía, BR station 549, and the others from the Marianao area, BR stations 907 and 908, are from the younger *Globorotalia fohsi lobata* subzone. The *Globorotalia fohsi robusta* subzone, the youngest of the subzones of the *Globorotalia fohsi* zone was not recognized, either because it is not represented, or because, and from the field evidence this seems to be more probable, a distinct facies change occurs from the chalky deeper water beds to the hard fragmental limestones of relatively shallow-water character from which globorotalias either could not be isolated or where they are practically absent. In terms of larger Foraminifera, the Cojímar formation is part of the *Operculinoides* zone, which is extended from the *Globorotalia fohsi* zone to the end of the Miocene.

TECTONICS OF THE HABANA AREA

The over 80 km long east–west trending Habana–Matanzas uplift or anticlinorium plunges near Matanzas axially eastward into the sea. Southwest of Habana it sharply turns toward the west-southwest and also shows a distinct axial plunge. Pre-Capdevila beds are not exposed between the highway from Habana to Rancho Boyeros and the Guanajay–Mariel uplift immediately to the west of the mapped area. Approximately halfway between Habana and Matanzas, in the vicinity of Central Hershey, a northwest trending saddle filled with Oligocene and younger sediments covers the steeply folded and broken core of the anticlinorium. This saddle is possibly caused by a fault trend in older sediments.

To the south of the Habana anticlinorium lies the also east–west trending relatively flat Vento syncline with beds of Miocene and ?younger age. Farther south follows the Bejucal uplift with a core of steeply folded Lower Eocene beds, probably Apolo, Alkàzar and Capdevila formations. Between the Bejucal uplift and the Caribbean sea to the south, the Miocene to younger beds are gently dipping southward. The flattening of the dips in the southernmost exposures of this area is suggestive of a third apparently less pronounced east–west trending uplift located off-shore.

The northern rim-rock od the Habana anticlinorium

The entrance to the Bahía de la Habana is dividing the northern rim-rock into two segments. The west-southwestern segment, made up mainly of post-Capdevila beds, dips throughout Vedado and Marianao toward the northwest, and toward the