LATE JURASSIC FOSSILS FROM CUBA AND THEIR ECONOMIC SIGNIFICANCE

BY RALPH W. IMLAY

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(1417)
ABSTRACT

The Viñales limestone fauna is correlated with the upper Portlandian on the basis of the ranges of its normally coiled ammonites and their similarity with species in the upper Portlandian of Mexico and Argentina. Genera not known below the upper Portlandian include Coronoceras, Microcanthoceras, Durangites, Lytoholites, and Parodontoceras. Genera not known above the Portlandian include Metakaploceras, Phyllochoceras, and Durangites. Genera not known above the lower Tithonian include Coronoceras and Lytoholites.

Previous correlation with the Lower Cretaceous was based mainly on identity of apertures and similarity of uncoiled ammonites to species in the Lower Cretaceous of southern Europe. Association of these forms with normal ammonites permits no doubt as to their Portlandian age and suggests that apertures must be used with caution in detailed stratigraphic work. Nothing in the fauna suggests the Kimmeridgian or Tithonian stages. The much younger age of the fauna than that of the Argovian-lower Kimmeridgian ammonites, described by Sanchez Roig and Marjorie O'Connell, shows that the older fossils are from the San Cayetano formation beneath the Viñales limestone, and that these formations are separated by an unconformity involving parts of the Kimmeridgian and Portlandian.

Furthermore, the study shows that undoubted Lower Cretaceous rocks have yet been found in the West Indies, that metamorphic rocks elsewhere in the West Indies may be Jurassic, and that the regions bordering the Gulf of Mexico have a similar Jurassic history. It suggests that the Palaeozoic disturbance is late Jurassic.

Application of these conclusions toward forming a clearer picture of events in Jurassic and Lower Cretaceous times should aid in showing the time of origin and possible distribution of mineral deposits and should be particularly useful in explorations for petroleum in the deeply buried rocks of the Gulf region.

INTRODUCTION

The present study was begun with a fair degree of confidence that the Viñales limestone fauna was early Lower Cretaceous. Interest was first aroused by examining a small collection of ammonites and apertures from Camagüey Province. Fossils from the Viñales limestone have been received periodically by the Geological Survey since 1929 and have usually been identified as probably Lower Cretaceous. This age assignment seemed reasonable on the basis of the similarities of the uncoiled ammonites and the apertures to Lower Cretaceous Eurasian fossils and the rarity of uncoiled ammonites in the Upper Jurassic. Further confirmation of Lower Cretaceous age was furnished by several recently published statements, although nowhere had undoubted proof been published of rocks of Lower Cretaceous age in Cuba or in any other of the West Indian islands. A Lower Cretaceous age was apparently contradicted, however, by the supposed occurrence in the Viñales limestone of ammonites of Argovian-lower Kimmeridgian age described by Sanchez Roig and Marjorie O'Connell in 1920 and 1921. Subsequently, Dickerson and Butt (1935), on the basis of considerable field work, claimed that these Jurassic fossils actually were derived from the phyllites of the San Cayetano formation but were mixed locally with float from the overlying Viñales limestone. Furthermore, they contended that the Viñales lime-
FOSSILS FROM CUBA

INTRODUCTION

The fossils were collected almost entirely by Roy E. Dickerson, R. H. Palmer, W. H. Butt, Emilio Alemán, Antonio Martínez, and N. E. Weisbord, during the years 1929 and 1934 while in the employ of the Atlantic Refining Company. Most of the collections from Santa Clara Province were made by Palmer, and most of those from Pinar del Río Province by Dickerson. One locality in northern Santa Clara Province was recollected by Emilio Alemán, D. W. Gravell, and John Klecker in 1941. A small but important collection from Camagüey Province was made by Thomas P. Thayer of the Federal Geological Survey in 1941. Particular thanks are due Doctor Dickerson for obtaining permission from the Atlantic Refining Company of Cuba to study their extensive collections, and for his careful checking of locality and stratigraphic data. The splendid co-operation shown by petroleum geologists in this, as in past studies, is deeply appreciated.

VIÑALES LIMESTONE

DISTRIBUTION AND THICKNESS

The surface extent of the Viñales limestone is shown on a generalized geologic map of Cuba compiled by Lewis (1932, opposite p. 534), and on more detailed maps prepared by members of an expedition from the University of Utrecht (Rutten, 1936, p. 1-59, 3 pls.; Thiadens, 1937, p. 1-69, 3 pls.; Vermunt, 1937, p. 1-60, 3 pls.; MacGillavry, 1937, 169 p.). The formation extends (Palmer, 1938, p. 20) about 375 miles from westernmost Pinar del Río Province to eastern Camagüey Province and crops out mainly in the northern part of the Island. Dickerson (1937, p. 418) notes that the formation:

"is exposed in the Organ Mountains, Pinar del Río Province; in several small outcrops in northern Matanzas Province; in a worn-down cordillera 120 miles long in northern Santa Clara Province and westernmost Camagüey Province; and in a small area in northeastern Camagüey Province."—and—"probably underlies northern Havana Province as well."
The subsurface extent of the Viñales limestone toward the south is unknown, but Dickerson (personal communication) thinks that it is probably absent in southern Cuba as indicated: (1) by its absence on the Isle of Pines; and (2) the lack of seepages in the southern part of Cuba.

The thickness of the Viñales limestone has been variously estimated. Palmer (1938, p. 20) says it ranges from 1700 to at least 5000 feet. For Pinar del Río Province the thickness has been estimated by De Golyer (1918, p. 139) as at least 2500 feet, by Lewis (1932, p. 556-538) as about 2000 feet, and by Dickerson (1937, p. 418) as 1000 to 1500 feet. For Santa Clara Province, Dickerson reports a continuous section of 1300 feet in the low hills northwest of Sagua la Grande. Rutten (1936, p. 29) refrains from estimating the thickness of the aptychi-bearing Viñales limestone of northern Santa Clara Province because of the lack of index horizons and the presence of complicated structures, but his sections show that the limestone is very thick.

LITHOLOGIC FEATURES

The Viñales limestone (Aptychus formation of some authors) was defined by De Golyer (1918, p. 139) as including the hard, blue, massive-appearing limestone forming the central portions of the Sierras Rosario and Organos in Pinar del Río Province. Subsequently, it has been discussed briefly by many writers either in connection with the petroleum possibilities of Cuba, or the age of the formation, or the regional geology of Cuba. These discussions, already sufficiently summarized by Schuchert (1936, p. 514-521), show that the Viñales limestone consists mainly of dark-gray to black, fairly thin-bedded limestone but includes considerable amounts of dark shale and chert. The limestone is compact, generally not visibly crystalline, cut by a fine network of calcite veins, hollowed by many caverns and solution cavities, and weathers bluish or whitish. The chert is black, brownish red, or purple and is generally much fractured. Biologically, the formation is characterized by many aptychi, rare and generally poorly preserved ammonites, abundant Radiolaria, and some plant material. Topographically, it weathers into vertical-walled masses, called mogotes, that rise abruptly to considerable heights above relatively flat-floored valleys underlain by schists and phyllites of the so-called San Cayetano formation. These limestone mogotes, according to Meyerhoff (1938, pp. 280-284), characterize the advanced stages of development of karst topography.

Generalized sections of the Viñales limestone of the various provinces show that the formation remains remarkably uniform lithologically. In the mountains north of Candelaria in Pinar del Río Province, the “top of
mestone toward the south (communication) thinks that it is
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tone mogotes, according to
the advanced stages of de-
}

the Jurassic section is formed by sheer cliffs of hard gray and gray-black,
thin-bedded limestones interbedded with thin seams of brownish shale,
which weathers white. Some iron is disseminated through the strata and
there are occasional lenses of chalcedony” (Brown and O’Connell, 1922,
p. 645).

In a company report of October 1933, Butt describes the Viñales limestones
of Pinar del Río Province as follows:

“They are dark gray to black in color and occur in beds ranging from one inch
to three feet in thickness. Interbedded with them in some places are one to three
layers of black chert. Locally they are somewhat crystalline but generally
they are not, nor do they show evidence of having been subjected to the meta-
norphosing agencies which have affected the [underlying] San Cayetano formation.”

The Viñales limestone of Matanzas Province has been described by W. D. Chawner in a company report as being thin-bedded to massive,
riable, locally oolithi and fragmental, and containing much organic shale
and some dark chert.

In northern Santa Clara Province the Viñales limestone contains oolithes.
According to Rutten (1936, p. 10), it

is built up largely by limestones and, to a much smaller extent, by cherts, whereas,
locally, marls and sandstones or intercalated layers of tuff occur. The limestones
are monotonous, dull, grey or grayish-blue, sometimes reddish, dense, and well to
fossilly bedded. Intercalated are layers and lenses of dark dense cherts. In some
localities occur grey-brown, fine-grained, sandstones—-—

In Camagüey Province the Viñales limestones, according to Mac-
Gillavry (1937, p. 7),

are rather monotonous and lithologically much the same as those of northern
Santa Clara and of Pinar del Río Province. They are buff to greyish blue, fine-
gained, compact and generally thin-bedded; they are mostly full of Radiolaria and
a certain amount of asphalt seems to be always present. Other members are cherts
and radiolarites.”

STRATIGRAPHIC BOUNDARIES

The Viñales limestone is overlain with apparent conformity by tuffaceous
beds of great thickness containing intercalations of limestone, chert,
and shale that become less common toward the top and are probably of
early Upper Cretaceous age (Rutter, 1936, p. 7; Vermunt, 1937, p. 15;
MaceGillavry, 1937, p. 10-12; Thiadens, 1937, p. 11, 12). Judging from
formational distribution, Dickerson (1937, p. 419) considers that the
Upper Cretaceous beds probably lie unconformably on the Viñales lime-
stone.

The relationship of the Viñales limestone to the underlying group of
highly folded, metamorphosed formations, generally referred to as the
San Cayetano formation, has been a subject of considerable dispute.
Some writers (De Golyer, 1918, p. 140) have insisted that the San Caye-
tano formation overlies the Viñales limestone, and others (Metcalf, in Lewis, 1932, p. 553; Vermunt, 1937, p. 5-8) have insisted that the Viñales limestone is a facies within the San Cayetano formation, but the opinion of geologists (Lewis, 1932, p. 553; Dickerson and Butt, 1936, p. 116-118) who have done the greatest amount of field work in Cuba, is that the Viñales limestone overlies the San Cayetano formation with angular unconformity. The superposition of the Viñales limestone is shown likewise by the topographic relationship of the limestone to the San Cayetano shales and phylmites (Meyerhoff, 1938, p. 281) and by its fauna being younger than that of the San Cayetano formation.

Evidence for an angular unconformity between these formations consists of differences in degree of metamorphism and folding, and the absence of certain faunas normally present in a complete sequence. Most writers (Brown and O'Connell, 1922, p. 644, 654; Lewis, 1932, p. 554-556; Dickerson and Butt, 1935, p. 116) agree that the San Cayetano schists, phylmites, quartzitic sandstones, and marbles are much more metamorphosed and strongly folded than the Viñales limestone, although Vermunt (1937, p. 5-10) does not believe that the two formations can be separated.

One of the clearest statements on the subject was made by Butt in a company report of October 1933, as follows:

"I am still of the opinion that the Viñales limestones lie upon the San Cayetano formation with probable angular unconformity. Throughout the Organos Mountains from Guane to San Diego de los Baños the San Cayetano formation is very complexly folded and its members have been considerably metamorphosed. Its sandstone members have become quartzitic and its shale members phyllitic, as a result of the deformatinal movements to which they have been subjected. The Viñales limestones, in contrast, while considerably faulted, are neither as complexly folded nor do they have the crystalline nature they would undoubtedly show had they the same history as the members of the San Cayetano formation. This difference in complexity of folding and in degree of metamorphism between these two formations cannot be explained, in my opinion, by greater competency on the part of the Viñales formation for there are many sandstone members in the San Cayetano formation which are equally as competent as the thin Viñales limestones."

Likewise bearing on differences in degree of metamorphism is a significant statement by Dickerson (1937, p. 419) as follows:

"—Jurassic fossils of Oxfordian age have been found in place in limy concretions embedded in phylmites in Pinar del Río Province. At one such locality, La Jaguey Vinja, bitumens were picked from the center of a large ammonite collected from a concretion in place. Upon analysis, the fixed carbon was 79.4 per cent, calculated on an ash-free, water-free basis. Mario Sanchez Roig has published two other analyses of bitumens directly associated with Jurassic fossils. Of these, sample No. 1 gives a carbon ratio of 83.4 per cent, and sample No. 2 [of] 57.5 per cent. These carbon ratios are notably high when compared with those obtained from analyses of bitumens probably yielded by Viñales limestone—. A bitumen collected from a locality near Baracoa gave a carbon ratio of 29 per cent; another from Loma Zambumbia, Santa Clara Province, had a coke residue of 30 per cent. This residue possibly contained 5 per cent ash. The difference between the two sets of carbon ratios and fixed carbon gives a measure of the comparative metamorphism of San Cayetano formation and the Viñales limestone."
Fossil evidence of an angular unconformity between the San Cayetano and Viñales formations, based on the absence of certain faunas that should normally be present if the sequence were complete, was first presented by Dickerson and Butt (1935, p. 116-118). They showed that the previously described Argovian-lower Kimmeridgian fossils, supposedly from the Viñales limestone, actually were derived from the San Cayetano formation but had been mixed in places with float from the overlying Viñales limestone. They claimed that the fossils of the Viñales limestone are of much younger early Lower Cretaceous age, thereby indicating that much of the Upper Jurassic is not represented by sediments in Cuba. The present work substantiates their main contentions, although placing the entire Viñales limestone in the Portlandian stage of the late Jurassic.

**Origin**

The Viñales limestone was "deposited in quiet waters on the continental shelf" (Schuchert, 1935, p. 514). This is indicated by distinct and generally thin bedding, included plant debris, high bituminous content, and the general absence of structure and texture suggestive of deposition in agitated waters. Deposition was probably in the deeper part of the neritic zone as indicated by the rarity of bottom-living mollusks, by the relatively much greater abundance of ammonites, by the scarcity of sandstones, and perhaps by the presence of layers of Radiolaria-bearing chert. Local shallows subjected to considerable wave action are suggested by the presence of oolites in northern Camagüey and Santa Clara provinces. Deposition must have been fairly rapid considering the great thickness of sediments that accumulated during a minor fraction of the Upper Jurassic.

**Fossils**

**Localities**

The fossils examined are from 45 localities of which 11 are in Pinar del Río Province, 29 in Santa Clara Province, and 5 in Camagüey Province. Most of the fossils, including all from Pinar del Río and Santa Clara provinces, were collected by geologists of the Atlantic Refining Company of Cuba; only a few fossils from four localities in Camagüey Province were collected by others. Therefore, it is considered practical and of possible future utility to use the company's laboratory numbers on index maps and fossil lists. The company's collections given to the Geological Survey have received a second set of numbers that will be included in the locality descriptions for purposes of cross reference. The general position of each locality is shown on Figures 1 to 4. Detailed descriptions of localities are given in Table 1:
<table>
<thead>
<tr>
<th>Atlantic Refining Company localities</th>
<th>U. S. G. S. Mesozoic localities</th>
<th>Description of locality, collector, and date</th>
</tr>
</thead>
<tbody>
<tr>
<td>11285</td>
<td>On farm of Ismael Hernandez, about 1 mile SW. of Minas on railroad between Camagüey and Nuevitas, Camagüey Province. F. L. Wilde, 1922.</td>
<td></td>
</tr>
<tr>
<td>60</td>
<td>On north side of main road, between Santa Clara and Camajuani, 5 km. W. of crossing of main road in Camajuani with the Ferrocarril Central, Santa Clara Province. Roy E. Dickerson, 1928.</td>
<td></td>
</tr>
<tr>
<td>105</td>
<td>Cantera, 1 km. N. of Zulueta, Santa Clara Province. R. H. Palmer, 1929.</td>
<td></td>
</tr>
<tr>
<td>127</td>
<td>Cut, 1 km. from station of Central Carmita, Santa Clara Province. R. H. Palmer, 1929.</td>
<td></td>
</tr>
<tr>
<td>184</td>
<td>Hill about 1 km. S. of Sitio Grande and on west side of road, Santa Clara Province. R. H. Palmer, 1929.</td>
<td></td>
</tr>
<tr>
<td>205</td>
<td>One-half km. NW. of Rancho Velo on south side of road, Santa Clara Province. R. H. Palmer, 1929.</td>
<td></td>
</tr>
<tr>
<td>211</td>
<td>San Rafael, 4 miles SW. of Cifuentes, Santa Clara Province. R. H. Palmer, 1929.</td>
<td></td>
</tr>
<tr>
<td>220, 221</td>
<td>Three and one-half miles NE. of Cifuentes and 1 km. N. of Central Unidad station at Los Angeles, between Cifuentes and Mata, Santa Clara Province. R. H. Palmer, 1929.</td>
<td></td>
</tr>
<tr>
<td>234</td>
<td>Alacranes, 3 km. W. of Central Santa Teresa which is 4½ miles S. of Sagua la Grande, Santa Clara Province. R. H. Palmer, 1929.</td>
<td></td>
</tr>
</tbody>
</table>
### Table 1. Fossil localities in the Viñales limestone—Continued

<table>
<thead>
<tr>
<th>Locality</th>
<th>Coordinates</th>
<th>Description of locality, collector, and date</th>
</tr>
</thead>
<tbody>
<tr>
<td>246</td>
<td>15357</td>
<td>Colonia Guinês, 13 miles NW of Sagua la Grande on road to San Ramón, Santa Clara Province. R.H. Palmer, 1929.</td>
</tr>
<tr>
<td>249</td>
<td>15359</td>
<td>One km E. of Hojalata which is 3.7 km NE of Quemado de Guines, Santa Clara Province. R.H. Palmer, 1929.</td>
</tr>
<tr>
<td>250</td>
<td>15358</td>
<td>Santa Rita, 5 miles S of Cifuentes, Santa Clara Province. R.H. Palmer, 1929.</td>
</tr>
<tr>
<td>251</td>
<td>15359</td>
<td>Railway cut between O'Reilly and San Francisco, on north end of Loma San Francisco, 16 miles W and 5 miles N of Sagua la Grande, Santa Clara Province. R.H. Palmer, 1929.</td>
</tr>
<tr>
<td>252</td>
<td>15360</td>
<td>One km N. of Plantas, Santa Clara Province. R.H. Palmer, 1929.</td>
</tr>
<tr>
<td>257</td>
<td>15357</td>
<td>Loma Carmita near Central Carmita which is 12 miles NE of Santa Clara and 2½ miles SE of Vega Alta, Santa Clara Province. R.H. Palmer, 1929.</td>
</tr>
<tr>
<td>259</td>
<td>15362</td>
<td>Small hill on north side of Arroyo Canas, 1½ miles NW of Vega Alta, Santa Clara Province. R.H. Palmer, 1929.</td>
</tr>
<tr>
<td>269</td>
<td>15363</td>
<td>West slope of Loma Sabanilla, 2½ miles N of Central Ramona, Santa Clara Province. Same beds as at locality 268. R.H. Palmer, 1929.</td>
</tr>
<tr>
<td>272</td>
<td>15362</td>
<td>Sierra Canaján, 2.8 kilometers northeast of main road between Minas and Camaguey, about 2 km W of Plazolita (known also as Magdalena and Yaguaraj), Camaguey Province. Roy E. Dickerson and N.E. Weisbord.</td>
</tr>
<tr>
<td>5138</td>
<td>16712</td>
<td>Hill 1200 to 1400 meters N. 50° W of Puerta del Ancón, Pinar del Río Province. R.E. Dickerson, Emilio Alemán, Antonio Martínez, W.H. Butt, 1933.</td>
</tr>
<tr>
<td>5165</td>
<td></td>
<td>Puerta del Ancón, float in field on west side, 100 feet south of highest point on road over pass, Pinar del Río Province. R.E. Dickerson, Emilio Alemán, and Antonio Martínez. 1933.</td>
</tr>
<tr>
<td>5211</td>
<td></td>
<td>On El Toro trail, about 400 meters from end, Pinar del Río Province. R.E. Dickerson and Emilio Alemán, 1934.</td>
</tr>
<tr>
<td>5216</td>
<td>16714</td>
<td>Just northwest of La Catalina, a small village about 8 km. NW of San Diego de los Bajos, Pinar del Río Province. Fossils collected not more than 50' feet above base of Viñales limestone, according to Dickerson. R.E. Dickerson, Emilio Alemán, W.H. But. 1934.</td>
</tr>
<tr>
<td>Atlantic Refining Company localities</td>
<td>U. S. G. S. Mesozoic localities</td>
<td>Description of locality, collector, and date</td>
</tr>
<tr>
<td>-----------------------------------</td>
<td>-------------------------------</td>
<td>---------------------------------------------</td>
</tr>
<tr>
<td>5229</td>
<td>On trail 500 meters E. of Hoyo El Rosario and 5 km. N. of Puerta La Murala which is a place on the mountain front 5 km. N. 70° W. of San Cristóbal, Pinar del Río Province. Roy E. Dickerson and Emilio Alemán, 1934.</td>
<td></td>
</tr>
<tr>
<td>5230</td>
<td>In field east of trail on northeast side of Hoyo El Rosario and 700 meters NW. of locality 5229, Pinar del Río Province. Roy E. Dickerson and Emilio Alemán, 1934.</td>
<td></td>
</tr>
<tr>
<td>5231</td>
<td>On trail to Hoyo El Rosario on west side of Río San Francisco and 1 km. N. of Puerta La Murala which is a small place 5 km. N. 70° W. of San Cristóbal, Pinar del Río Province. Roy E. Dickerson and Emilio Alemán, 1934.</td>
<td></td>
</tr>
<tr>
<td>5246</td>
<td>Five hundred feet above small tributary to the Río Honda on finca (estate) of Rafael Begoa, Pinar del Río Province. Roy E. Dickerson, 1934.</td>
<td></td>
</tr>
<tr>
<td>5256</td>
<td>About 120 meters S. of mountain front and 1000 meters N. 80° E. of house of Mamerto Paz which is 600 meters N. 20° W. of Ginebra, a small store 6 km. N. of Candelaria, Pinar del Río Province. Roy E. Dickerson and Emilio Alemán, 1934.</td>
<td></td>
</tr>
<tr>
<td>5264</td>
<td>West side of Canyon of Río Santa Cruz, about 200 feet above river, and 3 km. W. of Ginebra, a small store 6 km. N. of Candelaria, Pinar del Río Province. Roy E. Dickerson and Emilio Alemán, 1934.</td>
<td></td>
</tr>
<tr>
<td>7539</td>
<td>Northwest slope of Loma Sabanilla, 2½ miles N. of Central Ramona, Santa Clara Province. About same locality as 269. D. W. Gravell, John Klecker, and Emilio Alemán, 1941.</td>
<td></td>
</tr>
<tr>
<td>18579</td>
<td>Near shafts sunk for oil on southern slope of a hill on the Regla Finca, 3 to 4 km. W. of Minas on the Camaguey-Nuevitas branch of the Cuban railroad, Camaguey Province. Fossils from conglomerate zone in limestone. Thomas P. Thayer, 1941.</td>
<td></td>
</tr>
<tr>
<td>18580</td>
<td>Five hundred feet away from locality 18579. Thomas P. Thayer, 1941.</td>
<td></td>
</tr>
<tr>
<td>18581</td>
<td>Just inside boundary of Regla Finca on north slope of low hill about three-fourths of a mile E. of locality 18579. Thomas P. Thayer, 1941.</td>
<td></td>
</tr>
<tr>
<td>3083</td>
<td>Baños de Soros, about 5 miles NW. of Candelaria, Pinar del Río Province. Probably collected by N. E. Weisbord.</td>
<td></td>
</tr>
</tbody>
</table>
FOSSILS FROM CUBA

Les limestone—Continued

Locality, collector, and date

Hoyo El Rosario and 5 km. N. of it is a place on the mountain front of Cristóbal, Pinar del Río Province, niño Alemán, 1934.

The east side of Hoyo El Rosario and vicinity 5229, Pinar del Río Province, niño Alemán, 1934.

On west side of Río San Francisco, La Muralla which is a small place Cristóbal, Pinar del Río Province, niño Alemán, 1934.

On tributary to the Río Honda on Vega, Pinar del Río Province. Roy E. Dickerson and

Tain front and 1000 meters N. 80° E. which is 500 meters N. 20° W. of M. N. of Candeleria, Pinar del Río Province and Emilio Aleman, 1934.

Santa Cruz, about 200 feet above sea level, a small store 4 km. N. of Province. Roy E. Dickerson and

E. of chimney of Central Carmita at railroad between Santa Clara and Province. Roy E. Dickerson, 1934.

Chimney of Central Carmita, Santa Dickerson, 1934.

Monte la Vaquilla, 2½ miles N. of Central Province. About same locality as 239, Roy E., and Emilio Alemán, 1941.

Southern slope of a hill on the Regla Minas on the Camagüey-Nueva road, Camagüey Province. Fossils in limestone. Thomas P. Thayer,

from locality 18579. Thomas P.

Pina on north slope of low hill E. of locality 18579. Thomas P.

Hoyo de NW. of Candeleria, Pinar del collecting by N. E. Weisbord.
<table>
<thead>
<tr>
<th>Cuban Provinces</th>
<th>Santa Clara</th>
<th>Pinar del Rio</th>
<th>Camaguey</th>
</tr>
</thead>
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**Table 2. Geographic distribution of the late Jurassic fossils of the Viñales limestone of Cuba**

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FOSSILS

STATE OF PRESERVATION

The fossils of the Viñales limestone consist mainly of poorly preserved, distorted, internal molds retaining some shell material. A few silicified fossils are fairly well preserved, although having porous surfaces that do not permit magnification. Suture lines generally cannot be traced. Specifically determinable fossils available for the present study include about 400 normal ammonites, 150 uncoiled ammonites, and 65 aptechy.

ANALYSIS OF FAUNA

The Viñales limestone fauna discussed herein (Table 2) includes 23 species of normally coiled ammonites, 4 of uncoiled ammonites, 7 of aptechy, and 1 cephalopod beak. The gastropods, pelagypods, brachiopods, echinoids, corals, and sponges are represented by a few fragmentary specimens not worth description. The cephalopods are distributed among 22 genera of which one is new. Of the ammonites, 11 species are new, 5 are identical or closely comparable with Mexican species, 1 is compared with an Argentinian species, 2 are compared with Alpine-Mediterranean species, and 8 are not specifically determinable. Most of the aptechy are identical with species from southern Europe. The affinities of the normal ammonites are predominantly with the late Jurassic ammonites of Mexico and Argentina and to a lesser extent with those of the Alpine-Mediterranean and Indian provinces. The affinities of the uncoiled ammonites and aptechy are predominantly with the early Lower Cretaceous faunas of the Alpine-Mediterranean province and slightly with any known late Jurassic faunas.
The Phylloceratidae are represented by one species of *Phylloceras*; the Oppelidae by two species of *Metahaploceras*; the Haploceratidae by two species of *Hildoglochiceras* and one of *Pseudolissoceras*; the Aspidoceratidae by a few immature or fragmentary specimens of *Simoceras*.

![Map of fossil localities in Santa Clara Province](image)

*Figure 3.—Map of fossil localities in Santa Clara Province*

All numbers represent localities of the Atlantic Refining Company of Cuba.

*Virgatosimoceras*, *Aspidoceras*, and *Physodoceras*; and the Perisphinctidae by two species of *Virgatosphinctes*. The Berriasellidae are well represented by seven genera and nine species. *Corongoceras* is well known from Argentina, Algeria, and southern Europe but has not been recorded previously from North America. *Dickersonia*, n. gen., includes two species whose inner whorls are similar to *Corongoceras* but whose outer whorls develop simple *Berriasella*-like ribbing and appear to be most similar to forms from the latest Jurassic of India. *Micractanoceras* is represented by only a few immature forms. *Durangites* includes two species closely related to or identical with Mexican species. The genus has not been recorded previously outside Mexico. *Lytokohites* is referred to the Berriasellidae rather than the Neocomitidae, because of its rounded whorl section and the persistence of its ventral groove. Its occurrence in Cuba is of unusual interest, as it has been recorded previously only from Argentina, where it is confined to a narrow zone at the
one species of *Phylloceras*; the
as; the Haploceratidae by two
*Pseudolissoceras*; the Aspidi-
tary specimens of *Simoceras*,

Portlandian-Tithonian boundary. *Parodontoceras* includes two species
characterized by unbranched ribs in the adult and comparable with
species from the Tithonian of Mexico and the Berriasian of France.
*Berriasella* is doubtfully represented by one species. The Olocostephanidae
are represented by one specimen doubtfully referred to *Spiticeras*.

---

**FIGURE 4.—Map of fossil localities in Camagüey Province**

Only number 2372 represents a locality of the Atlantic Refining Company of Cuba. The
remaining numbers represent localities for the U. S. Geological Survey.

The family relationships of the uncoiled ammonites are highly uncer-
tain, but provisionally the Cuban species referred to *Leptoceras* may be
assigned to the Ancylloceratidae, and the species referred to *Hamulina*
and *Ptychoceras* may be assigned to the Lytoceratidae.

All the aptychi in the Cuban collections belong to the form genus
*Lamelloptychius* Trauth. The single cephalopod beak is identified with
*Hadrocheilus* Till.
Table 3—Similar Jurassic species in Cuba, Mexico, Argentina, and Eurasia

<table>
<thead>
<tr>
<th>Species from the Viñales limestone of Cuba</th>
<th>Similar species</th>
<th>Occurrence of similar species</th>
<th>Age of similar species</th>
</tr>
</thead>
<tbody>
<tr>
<td><em>Phylloceras pinarensae</em> Imlay</td>
<td><em>P. serus</em> (Oppel)</td>
<td>Southern Europe</td>
<td>Late Jurassic</td>
</tr>
<tr>
<td><em>Metaaploceras cf. M. mazapilense</em> (Burchhardt)</td>
<td><em>M. mazapilense</em> (Burchhardt)</td>
<td>Zacatecas, Mexico</td>
<td>Portlandian</td>
</tr>
<tr>
<td><em>Hildoglochiceras cf. H. grossicostatum</em> Imlay</td>
<td><em>H. grossicostatum</em> Imlay</td>
<td>Coahuila, Mexico</td>
<td>Upper Portlandian</td>
</tr>
<tr>
<td><em>H. cf. H. alamense</em> Imlay</td>
<td><em>H. alamense</em> Imlay</td>
<td>Coahuila, Mexico</td>
<td>Tithonian</td>
</tr>
<tr>
<td><em>Pseudoliosoceras cf. P. zitteli</em> (Burchhardt)</td>
<td><em>P. zitteli</em> (Burchhardt)</td>
<td>Argentina</td>
<td>Lower Portlandian</td>
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<tr>
<td><em>Simoceras cf. S. volanense</em> (Oppel)</td>
<td><em>S. volanense</em> (Oppel)</td>
<td>Southern Europe</td>
<td>Portlandian</td>
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<tr>
<td><em>Virgatoxiphites cristobalensis</em> Imlay</td>
<td><em>V. freques</em> (Oppel)</td>
<td>India</td>
<td>Portlandian</td>
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<tr>
<td><em>V. aff. V. rotundidoma</em> Uhlig</td>
<td><em>V. rotundidoma</em> Uhlig</td>
<td>India</td>
<td>Portlandian</td>
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<tr>
<td><em>Coronoceras filicostatum</em> Imlay</td>
<td><em>C. alternans</em> (Gerth)</td>
<td>Argentina</td>
<td>Lower Tithonian</td>
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<tr>
<td><em>Duranitites</em> cf. <em>D. acanthicus</em> Burchhardt</td>
<td><em>D. acanthicus</em> Burchhardt</td>
<td>Durango, Mexico</td>
<td>Upper Portlandian</td>
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<tr>
<td><em>D. vulgaris</em> Burchhardt</td>
<td><em>D. vulgaris</em> Burchhardt</td>
<td>Durango, Mexico</td>
<td>Upper Portlandian</td>
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<tr>
<td><em>Lithoaplices caribbeans</em> Imlay</td>
<td><em>L. vestutoides</em> (Burchhardt)</td>
<td>Argentina</td>
<td>Upper Portlandian</td>
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<tr>
<td><em>Pareodontoceras butti</em> Imlay</td>
<td><em>P. simpliciocostatum</em> (Mazenot)</td>
<td>France</td>
<td>Berrissian</td>
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<tr>
<td><em>P. antilleanum</em> Imlay</td>
<td><em>P. cf. P. calistoides</em> (Behrendsen)</td>
<td>Zacatecas, Mexico</td>
<td>Tithonian</td>
</tr>
<tr>
<td><em>Leptoceras? hondense</em> Imlay</td>
<td><em>L. gracile</em> (Oppel)</td>
<td>Southern Europe</td>
<td>Portlandian</td>
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<tr>
<td><em>L.? catalinensis</em> Imlay</td>
<td><em>L. sp. ind. Mazenot</em></td>
<td>France</td>
<td>Berrissian</td>
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**FOSSILS FROM CUBA**

<table>
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<tr>
<th>FOSSILS</th>
<th>CORRELATION</th>
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<tr>
<td>Lower ( \text{Portlandian} )</td>
<td>The Viñasles limestone fauna is correlated with the upper part of the Portlandian stage of the late Jurassic on the basis of the known ranges of its normally coiled ammonite genera and the similarity, or identity, of some of its species with upper Portlandian species of Mexico and Argentina. The ranges of some of the genera are as follows:</td>
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<tr>
<td>Upper ( \text{Portlandian} )</td>
<td>*Melococloceras*, Kimeridgian and Portlandian.</td>
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<tr>
<td>Upper ( \text{Berrisanian} )</td>
<td>*Hildoplacochiceras*, upper Kimeridgian?, Portlandian, and Tithonian.</td>
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<tr>
<td>Upper ( \text{Portlandian} )</td>
<td>*Pseudolissoceras*, Portlandian.</td>
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<tr>
<td>Upper ( \text{Berrisanian} )</td>
<td>*Simoceras*, Portlandian and Tithonian.</td>
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<tr>
<td>Upper ( \text{Berrisanian} )</td>
<td>*Physodoceras*, Kimeridgian to Portlandian.</td>
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<tr>
<td>Upper ( \text{Berrisanian} )</td>
<td>*Virgatosphinctes*, upper Kimeridgian to Tithonian.</td>
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<tr>
<td>Upper ( \text{Berrisanian} )</td>
<td>*Corongoceras*, upper Portlandian and lower Tithonian.</td>
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<tr>
<td>Upper ( \text{Berrisanian} )</td>
<td>*Micranthoceras*, upper Portlandian and Tithonian.</td>
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<tr>
<td>Upper ( \text{Berrisanian} )</td>
<td>*Durangites*, upper Portlandian.</td>
</tr>
<tr>
<td>Upper ( \text{Berrisanian} )</td>
<td>*Lytopholites*, upper Portlandian and lower Tithonian.</td>
</tr>
<tr>
<td>Upper ( \text{Berrisanian} )</td>
<td>*Parodontoceras*, upper Portlandian to Berrisanian.</td>
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The Portlandian age of the above assemblage is indisputable, although genera, such as \*Pseudolissoceras*, \*Corongoceras*, and \*Lytopholites*, known from only a few species, may have longer ranges than indicated. \*Melococloceras* is common in the Kimeridgian and rare in Portlandian. \*Hildoplacochiceras* is common in the Portlandian, rare in the Tithonian, and questionably present in the Kimeridgian. \*Pseudolissoceras* is associated with \*Subplanites* and \*Virgatosphinctes* in the lower Portlandian of Argentina and Mexico, but in Europe it appears to range through the Portlandian. \*Simoceras* is apparently most common in the Tithonian. \*Physodoceras* is a characteristic late Upper Jurassic genus. \*Physodoceras* is rare above the Kimeridgian. \*Virgatosphinctes* is rare below the Portlandian. \*Corongoceras* in Argentina ranges from just above the beds with \*Pseudolissoceras* to the lowest beds with \*Substeueroceras*. \*Durangites* has been found at many places in Mexico, either associated with \*Kossmatia*, or just below beds containing \*Substeueroceras*. Its presence in Cuba is considered very strong evidence of the upper Portlandian age of the beds in which it occurs. \*Lytopholites* has been reported previously only from Argentina, where it occurs in the lowest bed containing \*Substeueroceras* and \*Protacanthodiscus* as well as in the underlying bed. \*Parodontoceras* in Mexico is not known below the Tithonian but in Argentina is reported also in the upper Portlandian just above beds containing \*Pseudolissoceras*. 

Further evidence of a Portlandian age is furnished by comparisons of the Cuban species with the most similar species of Mexico, Argentina, and Eurasia, as shown in Table 3.
An upper rather than lower Portlandian age for the Viñales limestone is indicated by the ranges of the ammonite genera and of the similar species. *Corongoceras, Micrancanthoceras, Durangites, Lytohoplites, and Parodontoceras* are not known below the upper Portlandian. *Meta-
kaploceras, Physodoceras*, and *Durangites* are not known above the Portlandian. *Corongoceras* and *Lytohoplites* are not known above the basal beds of Tithonian age in Argentina. Most of the similar species are upper Portlandian or younger. The only suggestion of a lower Portlandian age for the Viñales limestone is furnished by specimens of *Pseudolissoceras* comparable with species from Argentina and Mexico, where the genus is known only from the lower Portlandian. However, in Europe *Pseudolissoceras* is not so narrowly restricted, and in Cuba specimens showing the simple sutures characteristic of the genus were obtained at localities 5216 and 7539 in association with other genera not known below the upper Portlandian.

The fossil assemblage at locality 5216, near La Catalina in Pinar del Río Province, is of particular stratigraphic importance, as it was obtained according to Roy E. Dickerson (personal communication), only a few feet above the base of the Viñales limestone. Most of the species at locality 5216 occur likewise in the same region at localities 5231 and 5229 which Dickerson considers are some hundreds of feet higher stratigraphically. Furthermore, all other fossil localities of the Viñales limestone of Cuba show a community of species with the localities mentioned above. Most of them are definitely upper Portlandian, and none indicates lower Portlandian. Therefore, it may be doubted whether any part of the Viñales limestone is lower Portlandian.

Nothing in the fauna of the Viñales limestone suggests the Kimmeridgian stage. Even the long-ranging species of aptchi are entirely unlike the aptchi in the *Mazapilites* and *Idoceras* beds of the Kimmeridgian of Mexico, judging by about 25 specimens in the collections of the University of Michigan. Likewise, nothing in the fauna suggests the Tithonian stage of latest Jurassic, which is represented in Mexico and Argentina by beds containing many species of *Substeuerooceras*. Considering the reported great thickness of the Viñales limestone, its restriction to the upper Portlandian is surprising, although in the Placer de Guadalupe District of Chihuahua, Mexico, the Portlandian is represented by a similar great thickness. However, the presence of late Upper Jurassic rocks in Cuba is not surprising as rocks of that age are known from Trinidad (Speth, 1939, p. 187-189) and from the Gulf region of Mexico (Breckhardt, 1930, p. 94-96, 266; Muir, 1936, p. 11-17; Kellum, 1937, p. 39, 40, 69-71, 86-91, Pl. 9, figs. 1-6, 12).
an age for the Viñales limestone onite genera and of the similar s, Durangites, Lytopholites, and the upper Portlandian. Meta-
ites are not known above the pites are not known above the
n. Most of the similar species the only suggestion of a lower one is furnished by specimens of s from Argentina and Mexico, a lower Portlandian. However, narrowly restricted, and in Cuba characteristic of the genus were association with other genera not

near La Catalina in Pinar del Río, as it was obtained (oral communication), only a few.
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localities of the Viñales lime-
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be doubted whether any part

Limestone suggests the Kim-
species of aptychi are entirely Idoceras beds of the Kim-
specimens in the collections of thing in the fauna suggests the is represented in Mexico and species of Substeueroaceras. Con-
Viñales limestone, its restric-
ing, although in the Placer de the Portlandian is represented presence of late Upper Jurassic of that age are known from the Gulf region of Mexico 1930, p. 11-17; Kellum, 1937,

Previous correlations (Schuchert, 1935, p. 514-516; Dickerson and Butt, 1935, p. 116-118; Trauth, 1936, p. 66-68; Rutten, 1936, p. 10; Vermunt, 1937, p. 5, 8, 12; MacGillavry, 1937, p. 7, 8) with the Lower Cretaceous were based mainly on the identity of the aptychi and the similarity of the uncoiled ammonites to species in the early Lower Cretaceous deposits of the Alpine-Mediterranean region. Among the six identical species and varieties of aptychi, three have not been reported previously from beds older than the Lower Cretaceous. The richness in form and number of uncoiled ammonites in the Viñales limestone of Cuba contrasts markedly with the scarcity of uncoiled ammonites in Upper Jurassic deposits of other parts of the world but compares favorably with their abundance in the Lower Cretaceous. Association of the aptychi and uncoiled am-
monites with normally coiled ammonites in the same beds of the Viñales limestone permits no doubt as to their Portlandian age and suggests that aptychi must be used with caution in detailed stratigraphic work. This unusual association in Cuba probably explains the perplexities of some geologists (O’Connell, 1921, p. 1; Lewis, 1932, p. 943, 944; Vermunt, 1937, p. 5-12) who found limestones containing supposed Cretaceous aptychi intercalated with shales containing Upper Jurassic ammonites.

Further confusion and controversy concerning the age of the Viñales limestone has resulted from the assumption by collectors that the Argovian-lower Kimmeridgian ammonites described by Sanchez Roig (1920) and O’Connell (1920) were obtained from the Viñales limestone or from its float. This assumption was based on the fact that most of the fossils were found on the slopes bordering the vertical-walled hills of Viñales limestone. It was corrected by Dickerson and Butt (1935, p. 116-118) who, on the basis of considerable field work, determined that the ammonites actually occur in the phyllites of the San Cayetano formation but have been mixed locally with float from the overlying Viñales limestone. At many places, they collected older Jurassic (Argovian-lower Kimmeridgian) ammonites from concretions in the San Cayetano formation. Nowhere did they observe similar concretions in the Viñales limestone. Their observations and contentions are substantiated by the present study which shows that the Viñales limestone is not older than the Portlandian, is probably not older at its base than the upper Portlandian, and is decidedly younger than the Argovian-lower Kimmeridgian fossils previously described.

The ammonites of the San Cayetano formation, described in part by Sanchez Roig and O’Connell, have been discussed by Burekhardt (1930, p. 61, 62), Spath (1931, p. 400, 592, 593), and Arkell (1939, p. LXIV) and have been studied considerably in both Europe and America. The fossils of Sanchez Roig have been examined and commented on independently.
<table>
<thead>
<tr>
<th>European stages</th>
<th>Mexico</th>
<th>Argentina</th>
<th>Cuba</th>
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<tr>
<td><strong>Tithonian</strong></td>
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<tr>
<td>Upper</td>
<td>Substearoceras and Proniceras</td>
<td>Substearoceras</td>
<td>Not known</td>
</tr>
<tr>
<td></td>
<td>Kossnatica and Durangites</td>
<td>Lyhotopilites, Kossnatica, and Corongoceras</td>
<td>Durangites, Corongoceras</td>
</tr>
<tr>
<td></td>
<td>Micranthoceras-Hildolichoceras</td>
<td>Micranthoceras, Paracoceras</td>
<td>Lyhotopilites, Hildolichoceras, Pseudolissoceras, Micranthoceras</td>
</tr>
<tr>
<td><strong>Portlandian</strong></td>
<td>Subplanites and Pseudolissoceras</td>
<td>Pseudolissoceras and Subplanites</td>
<td>Probably absent</td>
</tr>
<tr>
<td>Lower</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Bononian</td>
<td>Mazapilites</td>
<td>Not known</td>
<td>Not known</td>
</tr>
<tr>
<td></td>
<td>Waagenia</td>
<td>or</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Glochiceras fialar and Idoceras group of durangense</td>
<td>doubtfully</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Idoceras group of balderus</td>
<td>represented</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Sutneria group of platynota</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Kimmeridgian</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Oxfordian</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Argovian</td>
<td>Dichotomosphenctes</td>
<td></td>
<td>Atasioceras</td>
</tr>
<tr>
<td>Divesian</td>
<td>Indosphinctes?</td>
<td></td>
<td>Dichotomosphenctes, Biplices, and Kranosphenctes</td>
</tr>
<tr>
<td>Callovian</td>
<td>Pelloceras</td>
<td>Pelloceras and Neugoniceras</td>
<td>Not known</td>
</tr>
</tbody>
</table>
by Burckhardt and Spath, who seem to agree as to their age. Concerning these fossils Burckhardt says (translation):

"An examination of this material shows at once that many determinations by M. Sanchez Roig should be rectified. Thus Perisphinctes lagunitasensis (pl. I, fig. 1, c) does not belong to that species, but to the group of P. promiscus Buk.; P. durangensis (I, 2) does not belong to that species, P. durangensis (II, 4) belongs to the group of P. polyplacous Rein., P. aff. variaeformis (III, 6; VI, 1) belongs to the group of P. lictor Font.; P. delgadoi (IV, 2) belongs to the group of P. frequens Oppel; P. aff. elizabethae (IV, 3) is near to P. frequens Oppel, P. cf. biplaxes (V, 3-4) is closely related to P. triplacous albus Qust. The Simbirekites (IX, I-4) are Perisphinctes, in part (2, 4) of the group of P. virgalatus Qust.; Kosmatoia (X, 1-1a) and Idoceras (X, 6-7; XI, 1-5) do not belong to these genera but are true Perisphinctes; Jodoceras aiguilites (X, 6) belongs to the group of Perisphinctes polyplacous Rein., Berriasella aff. oppeli (XI, 1, 1a-b) is a Perisphinctes equal to the group of P. polyplacous, Haploceras faler (XIV, 3-5) belongs to the group of Oppelina virgalata Qust., Nebrodites (XIV, 1-2) and the Aucellites are doubtful; possibly Perisphinctes virgalatus (VII, 4-5) is related to P. frequens Oppel.

"After these rectifications, the existence of the middle and upper Kimmeridgian and of the Portlandian at Vinales has not been proven as yet. On the other hand the ammonites examined by me indicate with certainty the presence of the zone of pointoceras bimaminatsum (Perisphinctes cf. inconstans Choffat, P. aff. biplaxes rotundus Qust., P. aff. virgalatus Qust., P. aff. triplacous albus Qust. in Engell) and of the zone of Perisphinctes polyplacous (P. aff. capillaceus Font. [pl. IX, 4, 1 c], P. gr. lictor Font., P. aff. frequens Oppel, P. aff. polyplacous Rein.)."

Some of the names used by Sanchez Roig have been corrected by Spath (1931, p. 400, 592, 593) as follows:

**Correction by Spath**

<table>
<thead>
<tr>
<th>Fossils used by Spath</th>
<th>Usage by Sanchez Roig</th>
</tr>
</thead>
<tbody>
<tr>
<td><em>Vinalesphinctes rotgi</em> Spath</td>
<td><em>Aspidoceras</em>, sp. 30, Pl. 12, fig. 2</td>
</tr>
<tr>
<td><em>Vinalesphinctes nigri</em> Spath</td>
<td><em>Aspidoceras</em>, sp. 30, Pl. 12, fig. 2</td>
</tr>
<tr>
<td><em>Prospnichites</em> n. sp.</td>
<td><em>Nebrodites</em> aff. aegyptius E. Fauré, sp. 31, Pl. 14, figs. 2, 2a</td>
</tr>
<tr>
<td><em>Prospnichites</em> n. sp.</td>
<td><em>Kosmatoia</em> sacatecana Burckhardt, p. 44, Pl. 10, figs. 1, 1a</td>
</tr>
<tr>
<td><em>Prospnichites subconsecutus</em> Spath</td>
<td><em>Perisphinctes</em>, sp. 23, Pl. 7, figs. 3, 3a</td>
</tr>
<tr>
<td><em>Biplicites</em> sp.</td>
<td><em>Perisphinctes lagunitasensis</em> Burckhardt, p. 12, Pl. 1, figs. 1, 1a</td>
</tr>
<tr>
<td><em>Bispidoceras</em> vinalescens Spath</td>
<td><em>Aspidoceras</em> sp. 29, Pl. 13, fig. 2</td>
</tr>
<tr>
<td><em>Aspidoceras o'connelli</em> (Sanchez Roig)</td>
<td><em>Aspidoceras o'connelli</em> Sanchez Roig, sp. 30, Pl. 13, figs. 1, 1a</td>
</tr>
</tbody>
</table>

The groups of perisphinctidids mentioned by Burckhardt in the above quotation have been discussed in considerable detail by Spath (1931, p. 397-403, 443-446) and by Arkell (1936, p. XXXIII-XLVI; 1937, p. XLVII-LIV; 1939, p. LV-LXIV; 1940, p. LXV) and have been placed in various genera and subgenera. The group of Perisphinctes promiscus Bukowski has been placed in *Biplicites* by Spath and in *Kraniaoplicites* by Arkell. The group of *P. polyplacous* (Reinecke) has been placed in *Planites* by Spath and in *Biplicites* by Arkell, who rejects Planites as an invalid name. The groups of *P. polyplacous* (Reinecke) and *P. lictor* (Fontannes) belong to *Ataxioceras*. The group of *P. virgalatus* (Quenstedt) belongs to *Discosphinctes*. The forms that Burckhardt referred to the group of *P. frequens* Oppel (i.e., *Virgatosphinctes*) are certainly
### Table 8—Correlation of the Upper Jurassic rocks of Cuba

<table>
<thead>
<tr>
<th>European stages</th>
<th>English formations (after Askoll, 1933)</th>
<th>Northern Mexico (After Inlay, 1950)</th>
<th>Southern Mexico (Taken from Burnhardt, 1930)</th>
<th>Arkansas, Louisiana, and eastern Texas (After Inlay, 1941)</th>
<th>Cuba</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tithonian</td>
<td>Purbeck beds</td>
<td>La Casita sandstones, shales, marls, coal, and gypsum</td>
<td>Limestone, marls, and shales in Vera Cruz, Puebla, Chiapas, and Oaxaca</td>
<td>Cotton Valley shales and sandstones</td>
<td>Not known</td>
</tr>
<tr>
<td>Portlandian</td>
<td>Portland beds</td>
<td></td>
<td></td>
<td></td>
<td>Viñales limestone</td>
</tr>
<tr>
<td>Kimmeridgian</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Basal conglomerate</td>
</tr>
<tr>
<td></td>
<td>Bononian</td>
<td>Kimmeridge clay</td>
<td>(La Caja marls and limestone offshore)</td>
<td>Locally conglomerates or thick masses of gypsum at base</td>
<td>Buckner red beds and anhydrite</td>
</tr>
<tr>
<td></td>
<td>Havrian</td>
<td></td>
<td></td>
<td>Locally basal conglomerates and sandstones</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Sequanian</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Oxfordian</td>
<td>Argovian</td>
<td></td>
<td></td>
<td></td>
<td>?</td>
</tr>
<tr>
<td></td>
<td>Divesian</td>
<td>Corallian beds</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Oxford clay</td>
<td>La Gloria sandstones and limestones</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Callovian</td>
<td>Kellaways beds</td>
<td></td>
<td>Salt and red beds in Chiapas, Vera Cruz and Oaxaca</td>
<td>Eagle Mills red beds and salt</td>
<td>?</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Lower limit not known</td>
<td></td>
<td></td>
<td>Not known</td>
</tr>
</tbody>
</table>

B. W. Inlay—Upper Jurassic Fossils from Cuba
incorrectly referred and probably belong to *Dichotomosphinctes* or *Discosphinctes*. The forms described by O'Connell (1920, p. 648-680, Pls. 34-36 in part) as *Perisphinctes cubanensis*, *P. delatori*, and *P. plicatiloides* should probably be referred to *Dichotomosphinctes* rather than *Biplices* as indicated by the forward curvature of their secondary ribs.

All these perisphinctid genera occur in the upper Oxfordian (Argovian) stage, and most of them do not range above it. However, *Ataxioceras* and *Discosphinctes* attain their greatest development in the lower Kimmeridgian. Whether Kimmeridgian is represented in the fauna of the San Cayetano formation will have to be determined by detailed study, but certainly none of the described species suggests an age as young as the zone of *Idoceras balderus* of late lower Kimmeridgian.

Comparisons of the Upper Jurassic faunas of Cuba with equivalent faunas of Mexico and Argentina (Table 4) indicate that the Cuban section is much less complete than sections in other regions bordering the Gulf of Mexico (Table 5) and that the unconformity between the San Cayetano and Viñales formations involves parts of the Kimmeridgian and Portlandian stages. Possibly future fossil discoveries will show that the Cuban Jurassic includes beds of other ages than now recognized, but present evidence shows that the Kimmeridgian was a time of uplift in Cuba, as in many parts of North America.

Thus the Nevadian orogeny of the west coast, according to Reed (1941, p. 106) and Talieferro (1941, p. 125, 134, 151), occurred after the deposition of the Mariposa slate containing Kimmeridgian fossils and before the deposition of the Knoxville formation containing Portlandian fossils. The Mariposa slate includes Kimmeridgian species of *Ameboiceras*, which, according to Spath (1933, p. 864; 1935, p. 72), ranges from the middle part of the upper Oxfordian (Argovian) to the lower part of the middle Kimmeridgian. The presence of this ammonite indicates that the Nevadian orogeny did not reach its greatest intensity until late Kimmeridgian time.

Likewise, in the western interior the Kimmeridgian was a time of uplift marking the beginning of deposition of terrestrial deposits of the Morrison formation (Baker, Dane, and Reeside, 1936, p. 9, 58-63). It is extremely doubtful whether any of the underlying marine deposits are as young as Kimmeridgian.

In Mexico marked changes in the characteristics of the sediments occurred in late Oxfordian or early Kimmeridgian time. The light-gray, thick-bedded limestone and yellowish sandstone of Oxfordian age were overlain by large amounts of dark shale, marl, sandstone, and locally gypsiferous and carbonaceous deposits that probably reflected topographic and climatic changes on the land masses surrounding the Mexican sea.
(Imlay, 1940b, p. 393-396). An unconformity in the marginal areas of the Mexican geosyncline during earliest Kimmeridgian time is suggested by thick masses of gypsum in the Sierra Madre Oriental, by conglomerates in the southern Coahuila, and by the apparent absence in northern Mexico of beds containing *Sutneria* of the group of *S. platynota* Reinecke.

In the Gulf region of the United States the unconformity at the base of the Cotton Valley formation was probably developed during late Oxfordian or early Kimmeridgian time, judging by the fossils obtained from the underlying Smackover limestone. The large quantities of gravel throughout the lower part of the Cotton Valley formation imply much higher bordering land masses than during the deposition of the Smackover limestone (Imlay, 1940a, p. 16-27; 1941, p. 256-261). Furthermore, the coarsening of these formations toward the north and east indicates the source of the sediments (Imlay, 1940a, p. 15, 21, 27) and suggests that the region of the present Southern Appalachian Mountains was a highland during Upper Jurassic time. Possibly the Palisade disturbance, which formed block mountains in eastern North America from Nova Scotia to the Carolinas, occurred during the Upper Jurassic. At present, it is dated as being younger than the Newark group of Upper Triassic age and older than the Potomac group of early Lower Cretaceous age. However, the evidence of: (1) a pronounced unconformity in the middle of the Upper Jurassic sequence of Cuba and of the Gulf region of the United States and (2) highlands east and north of the Gulf Coast Jurassic sea suggest a late rather than early Jurassic age for the disturbance. There was ample time during latest Upper Jurassic and Lower Cretaceous for peneplanation of the highlands before marine transgression across the Atlantic Coast in the early Upper Cretaceous.

**ECONOMIC SIGNIFICANCE**

Study of the fossils of the Viñales limestone of Cuba has led to conclusions of potential economic significance: (1) The oil-bearing Viñales limestone is of late Upper Jurassic age; (2) part of the underlying metamorphosed San Cayetano formation is of early Upper Jurassic age; (3) an unconformity is present between these formations and is of Kimmeridgian-lower Portlandian age, corresponding roughly with the unconformity developed during the Nevadan orogeny of the Pacific Coast region; (4) no undoubted Lower Cretaceous has yet been discovered in the West Indies; and (5) the Jurassic history of Cuba is similar in major features to that of other regions bordering the Gulf of Mexico. Application of these conclusions toward forming a clearer picture of Jurassic and Lower Cretaceous events should aid in the search for mineral deposits by showing their time of origin and possible distribution. Recognition of an
important unconformity in the middle of the petroliferous Upper Jurassic sequence should be of particular value in explorations for petroleum in the deeply buried rocks of the lands bordering the Gulf of Mexico. The metamorphosed Viñales limestone is a potential source of commercial petroleum.

In Cuba these conclusions will be useful in dating the intrusions of metaliferous serpentines and granitoid rocks and thereby defining the areas in which ore deposits may be found. Knowledge of the age of igneous intrusions in structurally complex areas will help the petroleum geologist to determine the kind and throw of faults and the probable depth at which the petroliferous Viñales limestones may be encountered. The position of the Viñales limestone is of prime importance in considering the possible presence of oil in reservoir rocks of Upper Cretaceous or Tertiary age. Confirmation of the occurrence of unconformities both above and below the Viñales limestone may likewise have a bearing on oil exploration.

The Upper Jurassic rocks of the Gulf region of the United States have furnished large quantities of petroleum only in southern Arkansas and northern Louisiana but are possible sources of petroleum in an arco-naut belt extending from Del Río, Texas, northeastward to Arkansas and from there southeastern to southwestern Alabama. The probability of finding suitable reservoir beds throughout this area is increased by the recognition of pronounced orogenic movements during the Upper Jurassic in the lands bordering the Gulf region. Judging from the Upper Jurassic section of Arkansas and Louisiana, a considerable depression of the Gulf of Mexico occurred during the same time as uplift in the surrounding land masses and permitted the accumulation of a great thickness of sediments. Although the Upper Jurassic orogeny may have been greatest in Cuba, its effects from the viewpoint of petroleum accumulation may be greater elsewhere.

The Upper Jurassic rocks of the Gulf region of Mexico are petroliferous but have not been adequately tested for oil production. The sequence of formations is remarkably similar to that of Arkansas and Louisiana, and the geologic history must likewise have been very similar. Of particular interest is the marked change in conditions of sedimentation at the end of Oxfordian time, or the beginning of Kimmeridgian time, which resulted in thick-bedded limestones being overlain by coarse clastic sediments that include gypsum and coal in their basal part. The change appears to coincide with the development of the disconformity between the Smokeyover limestone and the Cotton Valley formation of Arkansas and to be distant relatively to the middle Upper Jurassic orogeny of Cuba. Detailed studies of the Jurassic rocks exposed in the mountains of eastern
Mexico would be very valuable to geologists interested in petroleum possibilities of the deeply buried Jurassic rocks of the Gulf region.

**SYSTEMATIC DESCRIPTIONS**

*Genus Phylloceras* Suess, 1865

*Phylloceras pinarense* Imlay, n. sp.

(Plate 1, figures 1-9)

This species is represented in the collections by about 100 specimens and is the most common of the normally coiled ammonites. Form discoidal, compressed. Whorls elongate-ovate, higher than wide, becoming relatively higher during growth, thickest on lower fourth of flanks, embracing preceding whorls almost completely. Flanks broad, gently convex. Venter narrowly rounded, becoming narrower during growth. Umbilicus narrow, becoming wider during growth, wall steeply inclined, rounding rather abruptly into flanks.

The inner whorls (Pl. 1, figs. 1-4) are ornamented with fine, closely-spaced ribs that cross the flanks nearly radially and are strongest on the venter. These ribs become fainter anteriorly and are not visible on the lower part of the flanks at diameters greater than about 25 mm. They persist on the venter and on the upper part of the flanks at greater diameters but gradually change to striae that tend to be bundled and are rather strongly inclined forward. No radial swelling or furrows present at any growth stage.

Accurate dimensions are difficult to obtain, because many of the specimens have been compressed, and most of them have been much weathered on one side. The specimen shown on Figures 6-9 of Plate 1 appears to be nearly undeformed. At a diameter of 78 mm, its whorl height is 44 mm, its whorl thickness is 27 mm, and its umbilical width on the left side is 13 mm.

This species is unlike any described species from North or South America. It shows considerable resemblance to *Phylloceras varius* (Oppel) (in Zittel, 1868, p. 66, Pl. 7, figs. 5a-c, 6a-c) from the late Jurassic of southern Europe, but the adult has a wider umbilicus, a more narrowly rounded venter, and weaker ribbing. The wider umbilicus is probably due, in part, to the absence of shell material. *Phylloceras tethys* D'Orbigny (1841, p. 174, Pl. 53, figs. 7-9, Pl. 41, figs. 3, 4; Pictet and Loriol, 1858, p. 17, Pl. 3, figs. 1a, b) from the Neocomian of southern Europe is likewise very similar but apparently has stronger ribbing and a more evenly rounded venter on the adult whorls.


**Occurrence:** Viñales limestone. Atlantic Refining Company of Cuba locality 5216.

*Genus Metahaploceras* Spath, 1925

*Metahaploceras* cf. *M. mazapilense* (Burckhardt)

(Plate 2, figures 11-13)

One internal mold is tentatively referred to *Metahaploceras*. Whorls elongate-ovate in section, much higher than wide, thickest in the lower third of the flanks, embracing preceding whorls almost completely; flanks broad and nearly flat; venter narrowly rounded. Umbilicus very narrow, wall low and vertical.

The ribbing is falciform but poorly preserved and is visible only at the anterior
SSILS FROM CUBA

interested in petroleum pos.
of the Gulf region.

PTIONS

? 1865

3y, n. sp.

about 100 specimens and is the
most abundant. Form discoidal, compressed, axis;
relatively higher during growth,
where there are almost completely
inverted, becoming narrower during
the later growth, wall steeply inclined,
and fine, closely-spaced ribs on the venter. These ribs
on the lower part of the flanks at
axis on the venter on and the venter;
then gradually change to sutured
forward. No radial swelling or

mexicanum (Oppel) (in Zittel, 1866, p. 68
from Europe, but the adult has a
and weaker ribs. The wider
the shell material. Phylloceras
Pl. 41, figs. 3, 4; Pictet and
from southern Europe is
278; 3 figured paratypes, U. S.
Species, U. S. National Museum
Refining Company of Cuba locality

1925

6 (Burchhardt)

tahaploceras. Whorls elongate;
the lower third of the flanks,
are broad and nearly flat; venter
and vertical.

is visible only at the anterior

end of the mold. The lower parts of the flanks are ornamented with fine riblets and
sutures which curve forward to the middle of the flanks, recurve sharply backward just
above the middle, and then curve forward again. On the ventrolateral margins
appear closely spaced, widely spaced folds which curve strongly forward but do
not cross the venter.
The figured specimen at a diameter of 26 mm. has a whorl height of 19.5 mm., a
whorl thickness of 11 mm., and an umbilical width of 6 mm.

As far as preservation permits comparisons, this specimen seems to belong to
Phylloceras mazapilense Burchhardt (1906, p. 125, Pl. 34, figs. 1-7, 19; 1930, Table
4, p. 50, 52, 69, 70) from the lower and upper Pliocene beds of the Mazapil region
of Zacatecas, Mexico.


OCURRENCE: Viñales limestone. Atlantic Refining Company of Cuba locality

Metahaploceras? sp.

(Plate 4, figures 8-10)

One silicified internal mold is placed provisionally in Metahaploceras rather than
Haploceras or Neochonetoceras, because its ribbing develops indistinct branching
on the upper part of the flanks and is only gently falciform. It has a high and
narrow whorl section, flattened flanks, narrowly rounded venter, and extremely
narrow umbilicus. The indistinct prorsiradiate riblets and sutured of the lower part
of the flanks recurve gently backward just above the middle of the flanks
and merge into numerous, stronger ribs that curve forward rather strongly on
the upper part of the flanks and on the venter. The ribs attain their greatest
strength on the ventrolateral shoulders, are nearly as wide as the interspaces, and
tend to bifurcate on the upper third of the flanks.
The figured specimen, at a diameter of 32 mm., has a whorl height of 17.5 mm.,
a whorl thickness of 10 mm., and an umbilical width of 3 mm.

This species is much like Metahaploceras mazapilense (Burchhardt) (1906, p.
125, Pl. 34, figs. 1-7, 19) in whorl section but has a narrower umbilicus and does
not develop widely spaced, prominent folds on the ventrolateral margins. Its
ornamentation considerably resembles some of the coarser-ribbed species of Hap-
loceras, such as Haploceras costatum Burchhardt (1906, p. 56, Pl. 25, figs. 1-10), but
it is distinguished by the presence of rib-branching and a different whorl shape. On
most species of Haploceras the venter is more broadly rounded, the ribbing is more
falciform, and the place of greatest forward curvature of the ribs is lower on the
venter.


OCURRENCE: Viñales limestone. Atlantic Refining Company of Cuba locality

7539.

Genus Pseudolissoceras Spath, 1925

Pseudolissoceras ci. P. zittelii (Burchhardt)

(Plate 4, figures 1-4, 7, 8, 11, 12)

This species is represented by more than 45 specimens, of which most are frag-
mentary, calcareous, internal molds. However, 18 specimens from Loma Sanafi in
Santa Clara Province are silicified. Form discoidal, compressed. Whorls sub-
round in section, higher than wide, thickest a little above the middle of the flanks,
embracing about three fourths; flanks broad and nearly flat; venter evenly rounded
on inner whorls, narrowly rounded on outer whorls. Umbilicus narrow, becoming
wider during growth; wall low, vertical, rounding abruptly into flanks on outer whorls.

The whorls are marked with faint, gently saddleform riblets and striae that are inflected forward most strongly near the middle of the flanks.

Dimensions in mm. are as follows:

<table>
<thead>
<tr>
<th>Specimen</th>
<th>Greatest diameter</th>
<th>Whorl height</th>
<th>Whorl thickness</th>
<th>Umbilical width</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pl. 4, figs. 1-3</td>
<td>17</td>
<td>8.5</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pl. 4, figs. 7, 8</td>
<td>16</td>
<td>8</td>
<td>6</td>
<td>2.5</td>
</tr>
<tr>
<td>Pl. 4, figs. 11, 12</td>
<td>16</td>
<td>8</td>
<td>6</td>
<td>2.5</td>
</tr>
</tbody>
</table>

Some fragments show that the species attains a diameter of several inches.

The simple suture line is characteristic of *Pseudolithoceras* and contrasts markedly with the much more complicated suture line of *Haploceras*. The first lateral lobe is about twice as long as the siphonal lobe, is very broad, and bears a number of short, nearly equal-sized branches. The second lateral lobe is very short and small. Several auxiliary lobes are visible. Siphonal saddle broad, asymmetrically divided by a secondary lobe into two branches, of which the outer is higher. First lateral saddle about half the size of the siphonal saddles, asymmetrically divided.

The Cuban specimens are considered to represent a single species, although they vary somewhat in the relation of whorl height to thickness, in the degree of rounding of the upper part of the umbilical wall, and in the umbilical width. Similar variations noted in the described species of *Pseudolithoceras* have not been considered as worthy of varietal names. Most of the Cuban specimens correspond so closely with the figures of the Argentinian *P. zitteli* (Burchhardt) (1895, p. 55, Pl. 10, figs. 1-3; Haupt, 1907, p. 200, Pl. 4, figs. 3a, b, 4a-e; Krantz, 1928, p. 18, Pl. 1, fig. 6) that separation as a variety does not seem advisable. However, one of the specimens (Pl. 4, figs. 1-3) has a wider umbilicus than the others and possibly should be compared with *P. subsulcalis* (Burchhardt) (1906, p. 127, Pl. 34, figs. 8-14), from the lower Portlandian of Mexico, or to *P. sulcalis* (Oettinger) (in Zittel, 1870, p. 173, Pl. 28, figs. 2, 3a-c), from the Portlandian of southern Europe. The Cuban specimens of *Pseudolithoceras* are associated with other ammonites of definite upper Portlandian age. In Mexico and Argentina the genus is known only from the lower Portlandian. European records indicate that the genus ranges through the Portlandian.

**Figured Specimens:** U. S. National Museum 103393a, b, 103394a, b; 8 nonfigured specimens, U. S. National Museum 103385, 103386a-c, 103445a-d.

**Occurrence:** Viñales limestone. Atlantic Refining Company of Cuba localities 208, 5216, 5220, 5231, 7539.

**Genus Hildaglochiceras** Spath, 1924

*Hildaglochiceras* cf. *H. grossicotatum* Imlay

(Plate 2, figures 2-4)

Two fragmentary internal molds retaining some shell material show the characteristic ornamentation of *Hildaglochiceras*. Whorls ovate in section, much higher than wide, thickest near middle of flanks, embracing most of preceding whorls; flanks broad and nearly flat, rounding evenly into venter, sloping gently toward umbilicus; venter narrowly rounded and keeled.
The whorls are ornamented with a prominent, narrowly rounded keel, sickle-like ribs and striae, and a weak spiral groove. The striae curve forward on the lower half of the flanks to the spiral groove, then backward to the upper third of the flanks, and then strongly forward. On the ventrolateral margins they pass into low, falcoid ribs which approach the keel at a sharp angle but generally flatten out before reaching it. The spiral groove is broad and shallow, occurs slightly above the middle of the flanks, and is bounded dorsally by a faint swelling.

This species is more like *Hildoglochloras grossicostatum* Inlay (1929, p. 27, Pl. 2, figs. 5-11; Pl. 3, figs. 1-7, 9-11) than any other described species but has slightly finer ribbing. All the Indian species with similar ribbing are much less involute. Of these, *H. coele* Spaul (1921, Pl. 29, fig. 6; Pl. 68, fig. 8, pl. 81, figs. 4a, b; Pl. 82, fig. 4) is the most similar.

**Formed Specimens**: U. S. National Museum 103387a, b.

**Occurrence**: Viñales limestone. Atlantic Refining Company of Cuba locality 5138.

*Hildoglochloras* cf. *H. alamanes* Inlay

(Plate 2, figures 1, 2, 6, 7)

Two specimens are probably identical specifically with *Hildoglochloras alamanes* Inlay (1929, p. 30, Pl. 4, figs. 6-9, 11, 12). The whorls are much higher than wide, the flanks are flattened, and the umbilicus is very narrow. The smaller specimen retains the shell and shows fine striae curved in the sigmoidal manner characteristic of the genus. Its venter is merely sharpened posteriorly but develops a low, rounded keel anteriorly. The larger specimen, preserved mainly as an internal mold, shows a well-developed spiral groove and traces of forwardly inclined ribbing on the venter. As the specimen is poorly preserved, the venter in most places appears to be merely sharpened, but there are indications that the shell bore a keel.

Dimensions in mm. are as follows:

<table>
<thead>
<tr>
<th>Specimen</th>
<th>Greatest diameter</th>
<th>Whorl height</th>
<th>Whorl thickness</th>
<th>Umbilical width</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pl. 2, figs. 6, 7</td>
<td>22</td>
<td>11.5</td>
<td>5.5</td>
<td>2.5</td>
</tr>
<tr>
<td>Pl. 2, figs. 1, 2</td>
<td>43</td>
<td>23</td>
<td>12 (7)</td>
<td>6.5</td>
</tr>
</tbody>
</table>

**Figured Specimens**: U. S. National Museum 103388a, b.

**Occurrence**: Viñales limestone. Atlantic Refining Company of Cuba locality 5138.

**Genus Simoceras** Zittel, 1870

*Simoceras* sp. juv. cf. *S. volanense* (Oppel)

(Plate 3, figure 2, 3)

One small, silicified specimen is the sole representative of *Simoceras*. Whorls subquadrate in section, slightly wider than high, thickest near middle of flanks, barely embracing; flanks gently convex, becoming flatter anteriorly; venter flat and shouldered. Umbilicus very wide and shallow; wall very low, rounding evenly into flanks, becoming steeper anteriorly.

The ribs are broad, prominent, begin at the line of involutions, incline forward gently on the flanks, and terminate in prominent tuberules on the ventrolateral shoulders. The ventral tuberules are connected by broad, weak ribs. The midventral line is nearly smooth.
At a diameter of 11 mm., the whorl height and thickness are each about 3 mm., and the umbilical width is 6 mm.

This specimen appears to be similar to the European *Simoceras volanense* (Oppel) (1863, p. 231, Pl. 58, figs. 2a, b; Zittel, 1870, p. 213, Pl. 32, figs. 7-9), as well as the South American form *S.* aff. *S. volanense* (Oppel) described by Krantz (1928, p. 13, Pl. 3, fig. 7).

**Figured Specimen:** U. S. National Museum 103339.

**Occurrence:** Viñales limestone. Atlantic Refining Company of Cuba locality 268.

**Genus Virgatosimoceras** Spath, 1925

*Virgatosimoceras* sp.

(Plate 5, figures 8-10)

One large fragment of an outer whorl retains considerable shell material. Whorl subquadrate in section, as wide as high, thickest below middle, barely embracing; flanks gently convex; venter broadly rounded; umbilical wall low, steeply inclined, rounding rather abruptly into flanks.

The shell is ornamented with strong ribs and minute radial striae. The ribs curve backward on the upper part of the umbilical wall, recurve rather abruptly low on the flanks, incline forward slightly on the flanks, and cross the venter transversely or with a gentle forward arching. They are broad at their base, rounded or sharp-topped, of varying prominence, are weakest on the venter, and are widely but variably spaced. Some ribs remain simple, but most of them bifurcate on the upper third or fourth of the flanks. One rib bifurcates on the lower fourth of the flank, and both branches bifurcate again on the upper fourth. The thickness of the shell on the venter is about 5 mm.

The figured specimen at its anterior end has a whorl height and thickness of about 43 mm.

No described species of the *Simocentinae* is very similar. *Virgatosimoceras albertinus* (Catullo) (in Zittel, 1870, p. 222, Pl. 24, figs. 1a-d) at a comparable size has a broader venter and stronger ribs of which all bifurcate low on the flanks. *Virgatosimoceras rathpleisi* (Schneid) (115, p. 88, Pl. 4, figs. 1-1c; Pl. 7, figs. 2, 3-3b) has a similar whorl shape and type of rib branching, but its ribs are stronger and more widely spaced.

**Figured Specimen:** U. S. National Museum 103390.

**Occurrence:** Viñales limestone. Atlantic Refining Company of Cuba locality 5216.

**Genus Aspidoceras** Zittel, 1868

*Aspidoceras* spp.

(Plate 3, figures 4, 12, 13)

Two specimens from the Viñales limestone definitely belong to this genus. The larger specimen, preserved as a calcareous internal mold, has a depressed whorl section, a broad, gently rounded venter, and two closely associated rows of prominent spines. The outer and larger row of spines marks the place of greatest whorl thickness. The spines of the inner row are generally paired with those of the outer row and are on the upper margin of the umbilical wall. There is a suggestion of broad, ventral undulations connecting the spines.

The smaller specimen is only 9.5 mm. in diameter, but it agrees in general form and ornamentation with the larger. As a result of silification the spines are
excellently preserved and project nearly a mm. from the shell. At its anterior end
the whorl height is 4 mm., and the whorl thickness is 8.5 mm., exclusive of the spines.
The larger specimen is comparable to the immature forms of the European Aspi-
doceras rousiniciense (Zeuschner) (in Zittel, 1868, p. 116, Pl. 24, figs. 4, 5-5d), although
in spines are a little more closely spaced, and its ventral undulations are not nearly
as strongly developed. The Mexican species, A. alamitocenesis Castillo and Aguillera
(1898, p. 46, Pl. 22, fig. 6; Pi. 23), is likewise very similar but probably has fewer
spines per whorl.

**Figured Specimens:** U. S. National Museum 103391, 103392.

**Occurrence:** Viñales limestone. Atlantic Refining Company of Cuba localities 268,
3510.

**Genus Physodoceras Hyatt, 1900**

*Physodoceras* sp.

(Plate 4, figure 11)

One fragment shows a form with a narrow umbilicus, a steep umbilical wall, 
with rounded flanks, several radially elongate umbilical tubercules, and extremely
fine, closely spaced striae. The striae trend forward on the umbilical wall and on
the lower part of the flanks but recurve near the middle of the flanks and are radial
or subradiate on their upper part. The surface is slightly undulated but not ribbed.
The narrow umbilicus and single row of umbilical tubercules show that this species
belongs in *Physodoceras* rather than *Aspidoceras*. *Physodoceras* is common in the
Kimmeridgian and rare in the Portlandian. However, *P. cycloitus* (Oppel) (in
Zittel, 1879, p. 201, Pl. 30, figs. 2-5) is known from the Portlandian of Europe and
a similar species (Krantz, 1925, p. 10, Pl. 1, fig. 1) from the Portlandian of South
America.

**Figured Specimen:** U. S. National Museum 103393.

**Occurrence:** Viñales limestone. Atlantic Refining Company of Cuba locality
626.

**Genus Virgatosphinxes Uhlig, 1910**

*Virgatosphinxes cristóbalensis* Imray, n. sp.

(Plate 4, figure 13)

The species is represented definitely only by the type but probably includes several
associated fragments of immature forms as well as a small specimen not from the
type locality.

The outer whorl of the type has been smashed, but the penultimate whorl that
appears to be undeformed is higher than wide, subquadrate in section, and thickest
on the lower part of the flanks. The amount of involution is about two fifths.
Flanks flattened, rounding rather abruptly into the moderately wide, flattened
venter. Umbilicus moderate in width; wall low, vertical at base, rounding abruptly
into flanks.

The ribbing of the inner whorls of the type specimen agrees, as far as observation
permits, with that of the small specimen shown by Figures 5 and 6 of Plate 4. On
the latter, the ribs are narrowed and rather closely spaced. They begin at the
line of involution, curve backward on the umbilical wall, incline forward strongly
on the flanks, and cross the venter transversely without diminution in strength.
Most of the ribs bifurcate on the upper third of the flank, but a few trifurcate, and
a few remain simple. There are 5 or 6 narrow constrictions on each whorl. The
constrictions are generally preceded by a trifurcating or virgatomoous rib and
succeeded by a simple rib.
On the type specimen the ribbing of the penultimate whorl is like that just described, but the furcation points are a little lower. On the outer whorl the primary ribs become more widely spaced and are swollen on the umbilical shoulder into prominent bulges from which pass bundles of virgatous ribs with as many as 8 ribs in each bundle. Branching occurs at various heights from the lower third to the upper third of the flanks. A constriction is followed by a simple rib, but all the other ribs are virgatous. The suture line is not preserved.

The penultimate whorl of the holotype has a whorl height of 28 mm., and a whorl thickness of 20 mm. The small figured specimen (Pl. 4, figs. 5, 6), at a diameter of 44 mm., has a whorl height of 16 mm., a whorl thickness of 13 mm., and an umbilical width of 16 mm.

This species has remarkably similar ornamentation to that of V. frequens (Oppel) (1885, p. 295, Pl. 87; Uhlig, 1910, p. 325, Pl. 69, figs. 1a-c; 2, 3a-c; Pl. 75, figs. 1a-c; Pl. 75a, figs. 1a-c) but is less involute, has a more compressed whorl section, and develops thickened primary ribs at a much smaller size. A fragmentary specimen from the lower Portlandian of the Mazapil region of Mexico was described by Burchardt (1908, p. 118, Pl. 32, fig. 2) as Virgatites sp. ind., but it is certainly a Virgatosphinctes similar to the Cuban species and to V. frequens (Oppel).


Virgatosphinctes aff. V. rotundidoma Uhlig
(Plate 3, figure 14)

About 20 poorly preserved specimens represent an evolute, widely umbilicated species whose ribs are rather low, narrowly rounded, closely spaced, inclined slightly forward, and of which a little more than half bifurcate above the middle of the flanks. This species in form and ornamentation is similar to V. rotundidoma Uhlig (1910, p. 818, Pl. 52, figs. 1a-c; Pl. 53, fig. 1) but on the largest whorl has a greater frequency of single ribs and more ventrad furcation points. Virgatosphinctes denseplicatus (Waagen) (1875, p. 201, Pl. 46, figs. 3a-b; Pl. 55, figs. 1a, b; Spath, 1931, p. 532, Pl. 77, figs. 3a-c; Pl. 90, fig. 1, Pl. 96, figs. 3a, b; Pl. 102, fig. 4) has similarly dense ribbing in its inner whorls but develops thickened, distant primary ribs at an early stage and is less evolute.


Genus Corongoceras Spath, 1925
Corongoceras filicostatum Inlay, n. sp.
(Plate 5, figures 1-16)

The species is represented by 35 silicified specimens of which most are fragments of inner whorls. Whorls subhexagonal in section, wider than high in early growth stage, becoming higher than wide in mature growth stages, thickest on lower part of flanks, embracing to the lateral tubercles, or about two fifths of the preceding volutions; flanks evenly rounded in early stages, flattened in later stages; venter flattened and fairly narrow. Umbilicus fairly wide and shallow; wall low and rounding evenly into flanks.
The ornamentation consists of ribs and of lateral and ventral tubercles. The ribs begin at the line of involution, curve backward on the umbilical wall, incline forward moderately on the lower part of the flanks, recurve slightly on the upper part of the flanks, and cross the venter transversely. They are triangular in section, threadlike on the flanks but become broader above and are fairly coarse on the venter. On the innermost whorls to a diameter of about 15 mm., most of the ribs are simple. At greater diameters most of the ribs bifurcate or trifurcate a little above the middle of the flanks. Both simple and forked ribs bear lateral and ventral tubercles at diameters greater than about 5 mm. The lateral tubercles are small, acute, variable in size, and occur along a well-defined zone on the upper two fifths of the flanks. The ventral tubercles at all growth stages are larger and longer than the lateral tubercles and project laterally and outwardly. The ribs connecting the lateral with the ventral tubercles are commonly arranged in a zigzag fashion, but in places a pair of ribs issuing from a lateral tubercle terminate in a single ventral tubercle. Constrictions are pronounced on inner whorls.

The holotype (Pl. 5, figs. 12, 14, 15) at a diameter of 52 mm. has a whorl height of 19 mm., an estimated whorl thickness of 15 mm., and an umbilical width of 20 mm. The corresponding measurements of the paratype shown by Figures 5-7 of Plate 5 are 30 mm., 11 mm., and 12 mm. One specimen (Pl. 12, fig. 2) probably belonging to this species has a diameter three times greater than the holotype.

This species is placed in Coronoceras rather than Protacanthoceras Spath (1923, p. 305): (1) because of the appearance of tubercles at an early age, (2) the uniform strength of the tubercles and their presence on all ribs, (3) the ribs branching high in the flanks, and (4) the absence of a smooth band on the venter.

*Coronoceras* filicosatum closely resembles *C. alternans* (Gerth) (1925, p. 89, Pl. 6, figs. 3, 3a) from the lower Tithonian of Argentina but may be distinguished by the greater regularity in strength of its ribs and tubercles. *Coronoceras mendozanum* (Behrendsen) (1891, p. 300, Pl. 25, figs. 2a-c), from slightly older beds, has coarser ribs and weaker tubercles. *Coronoceras loteniense* Spath (1925, p. 144); Haupt, 1907, p. 201, Pl. 9, figs. 7a-e) has wider-spaced ribbing and a broader venter, but the sculpture of its inner whorls is very similar.

**Types:** Holotype, U. S. National Museum 103307; 8 figured paratypes 103398, 103399, 103401a-f; 11 unfigured paratypes 103402.

**Occurrence:** Viñales limestone. Atlantic Refining Company of Cuba localities 248, 208, 5229, 7539.

*Dickersonia* Imlay, n. gen.

This genus has strongly tuberculate inner whorls that are nearly identical with those of *Coronoceras*, but its outermost whorl completely lacks tubercles and is ornamented only by bipartite ribbing similar to that of *Barriasella*. It is easily distinguished from *Barriasella* by its lack of umbilical tubercles at any stage of growth, by the presence of prominent lateral tubercles on the inner and intermediate whorls, and by the rather widely spaced rows of prominent ventral tubercles on the immature whorls. The simplification of the ornamentation during growth is exactly the opposite of that of *Bianjordiceras*, although the inner whorls of the two genera are somewhat similar in lateral aspect. *Protacanthoceras* is distinguished from *Dickersonia* by the presence of umbilical tubercles, by the irregular occurrence of lateral tubercles, and by the increasing complexity of the ornamentation during growth.
Dickersonia is represented in the Cuban collections by two species, of which D. sabanillensis Inlay is designated as the genotype. Form discoidal, compressed, moderately evolute. Inner whorls subhexagonal in section, wider than high, strongly convex on flanks, flattened on venter. Outer whorls subovate in section, higher than wide, flattened on flanks, broadly rounded on venter. Umbilicus fairly wide. Umbilical wall fairly low, rounding abruptly into flanks on outer whorls. Shell ornamented with simple and bifurcating ribs and with lateral and ventral tubercles. The ribs curve backward on umbilical wall, incline forward gently on flanks, and cross venter nearly transversely. On the inner whorls all ribs bear acute lateral tubercles and slightly stronger ventral tubercles, are highest and widest on the upper part of the flanks, and are reduced in strength on the venter. During growth the tubercles become less prominent, the ribs become higher and narrower, and the ventral thinning of the ribs becomes less pronounced. The largest outer whorls are not tuberculated and are ornamented by high, narrowly rounded ribs that are strongest on the venter. Accompanying the loss of tuberculation, the furcation points become less distinct, and intercalary ribs appear. Constrictions are deep and narrow, and are particularly pronounced on the inner whorls. The suture line is unknown.

No Mexican or South American species referable to Dickersonia have been described. Some of the immature ammonites from the Salt Range of India, placed by Spath (1899, p. 43-48, Pls. 4-6 in part) in Blanfordiceras, considerably resemble the immature forms, or inner whorls, of Dickersonia in lateral aspect but have an entirely different ventral aspect. However, one species described by Spath (1899, p. 47, Pl. 6, fig. 9; Pl. 18, figs. 7a, b; Pl. 20, figs. 7a, b) as Blanfordiceras (gen. nov.) sp. nov. possibly belongs to Dickersonia but is more coarsely ribbed than the Cuban species. It is associated with an ammonite assemblage which Spath (1899, p. 124, 125) considers Tithonian.

*Dickersonia sabanillensis* Inlay, n. sp.

(Plate 6, figures 9-12, 14-20)

This species is represented by 15 silicified, fragmentary specimens showing nearly all the growth stages. Whorls in early growth stages subhexagonal in section and wider than high, in later growth stages subovate in section and higher than wide, thickest near the middle of the flanks, embracing to the lateral tubercles or about two fifths of the preceding whorls. Flanks strongly convex in earliest growth stage; later becoming flattened and subparallel below the lateral tubercles but converging markedly above to the venter; in mature forms nearly flat below but rounding evenly above into venter. Venter flattened and moderately broad on innermost and on the intermediate-sized whorls, but broadly rounded on the outer whorls. Umbilicus fairly wide; wall low, rounding evenly into flanks on inner whorls, rounding abruptly on outer whorls.

The ornamentation consists of fairly closely spaced ribs and of lateral and ventral tubercles. The ribs begin at the line of involution, curve backward on the umbilical wall, incline forward moderately on the flanks, and cross the venter transversely. The character of the ribbing changes considerably with age. On the inner whorls the ribs are threadlike on the lower part of the flanks, rather broad on the upper part of the flanks and on the venter, and are reduced in strength on the venter. During growth the ribs on both flanks and venter become high and narrow, and the ventral thinning becomes less pronounced. On the adult whorls the ribs are highest and strongest on the venter. On the innermost whorls about half of the
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sections by two species, of which D. type. Form discoidal, compressed in section, wider than high, strongly whorls subovate in section, higher on venter. Umbilicus fairly wide, flanks on outer whorls. Shell ornamented with lateral and ventral tubercles, line forward gently on flanks, and whorls all ribs bear acute lateral tubercles that are highest and widest on the upper venter. During growth the higher and narrower, and the venter. The largest outer whorls are narrowly rounded ribs that are tuberculated, the furcation points become deep and narrow whorls. The suture line is unknown.

able to Dickersonia have been described from the Salt Range of India, placed under the genera, considerably resemble B. falcata (gen. nov.) in lateral aspect but have an outline of the Cuban specimen which Spach (1939, p. 124), coarsely ribbed than the Cuban specimen.

D. ramonensis Imlay, n. sp.

This species is represented by 25 silicified specimens. Whorls in early stages subhexagonal in section and higher than wide, in later stages subovate in section and higher than wide, thickest near middle of flanks, embracing about two fifths. Flanks of a early stages rather strongly rounded below and converging markedly toward the venter, later flattened below and rounding evenly above. Venter flattened and fairly broad on innermost and intermediate-sized whorls, broadly rounded on outer whorls. Umbilicus fairly wide; wall fairly low, rounding evenly into flanks on inner whorls, rounding abruptly on outer whorls.

The ornamentation consists of moderately spaced ribs and of lateral and ventral tubercles. The ribs curve backward on the umbilical wall, incline gently forward on the flanks, and cross the venter transversely. On the inner whorls the ribs are fine on the lower part of the flanks; broad on the upper part of the flanks and on the venter; and are somewhat reduced in strength on the venter. During growth the ribs become high, narrow, more closely spaced, and the ventral thinning less pronounced. On the largest known whorl (Pl. 6, figs. 2, 3) the ribs on the venter are excavated on their posterior sides and are not reduced in strength along the middle. On the inner whorls about half the ribs bifurcate, and on the outer whorls nearly all the ribs bifurcate along a well-defined zone a little above the middle of the flanks. All ribs bear small, acute tubercles that are of slightly variable size along the zone of furcation. All ribs terminate ventrally in acute tubercles that are nearly uniform in strength and are slightly larger than the lateral tubercles. Both lateral and ventral tubercles become less distinct and are several intercalary ribs per whorl. There are five or six deep, narrow constrictions on each whorl. Generally, the rib anterior to the constriction is somewhat larger than average. Suture line unknown.

The holotype (Pl. 6, figs. 14, 15) at a diameter of 41 mm. has a whorl height of 14 mm., a whorl thickness of about 15 mm., and an umbilical width of 17 mm. The corresponding measurements of the paratype shown by Figures 11 and 12 of Plate 6 are 21.5 mm., 9 mm., 10 mm., and 8.5 mm.

This species differs from Dickersonia mononensis Imlay by its weaker and more closely spaced ribs and tubercles on the inner whorls, thicker ribs on the outer whorls, the disappearance of tubercles at an earlier stage, and a slightly wider venter.

Types: Holotype, U. S. National Museum 103403; 5 figured paratypes, 103404a-e; 1 unfigured paratype 103405a-b.


Dickersonia ramonensis Imlay, n. sp. (Plate 6, figures 1-3)

This species is represented by 25 silicified specimens. Whorls in early stages subhexagonal in section and higher than wide, in later stages subovate in section and higher than wide, thickest near middle of flanks, embracing about two fifths. Flanks of a early stages rather strongly rounded below and converging markedly toward the venter, later flattened below and rounding evenly above. Venter flattened and fairly broad on innermost and intermediate-sized whorls, broadly rounded on outer whorls. Umbilicus fairly wide; wall fairly low, rounding evenly into flanks on inner whorls, rounding abruptly on outer whorls.

The ornamentation consists of moderately spaced ribs and of lateral and ventral tubercles. The ribs curve backward on the umbilical wall, incline gently forward on the flanks, and cross the venter transversely. On the inner whorls the ribs are fine on the lower part of the flanks; broad on the upper part of the flanks and on the venter; and are somewhat reduced in strength on the venter. During growth the ribs become high, narrow, more closely spaced, and the ventral thinning less pronounced. On the largest known whorl (Pl. 6, figs. 2, 3) the ribs on the venter are excavated on their posterior sides and are not reduced in strength along the middle. On the inner whorls about half the ribs bifurcate, and on the outer whorls nearly all the ribs bifurcate slightly above the middle of the flanks. All ribs bear small, acute tubercles that are of slightly variable size along the zone of furcation. All ribs terminate ventrally in acute tubercles that are nearly uniform in strength and are slightly larger than the lateral tubercles. Both lateral and ventral tubercles become less distinct and are several intercalary ribs per whorl. There are five or six deep, narrow constrictions on each whorl. Generally, the rib anterior to the constriction is somewhat larger than average. Suture line unknown.

The holotype (Pl. 6, fig. 8) at a diameter of 43 mm. has a whorl height of about 18 mm. and an umbilical width of 15 mm. The paratype (Pl. 6, figs. 4, 5) at a diameter of 20 mm. has a whorl height of 7 mm., a whorl thickness of 9 mm., and an umbilical width of 9 mm.
The inner whorls of this species are intermediate in coarseness of ornamentation and width of section between those of Dickersonia sobanillosia Imlay and Curvoceras felicostatum Imlay. The outer whorls differ from those of C. felicostatum by complete lack of tuberculation and much more closely spaced ribbing. The specimen (U.S. National Museum 103410) shown in Figure 13 of Plate 6 is considerably corroded but appears to have finer and more widely spaced ribbing than is typical of D. vanomensis.


Genus Microcanthoceras Spath, 1925
Microcanthoceras sp. juv.
(Plate 4, figures 9, 10, 14-15)

The genus is represented by three small specimens which show several inner whorls. The specimen shown in Figures 14 and 16 of Plate 4 may be described as follows: whorls ovate in section, wider than high, embracing about one third; flanks evenly convex; venter broadly rounded. Umbilicus moderately wide; wall vertical at base, rounding evenly into flanks. Ribs high, narrow, strongly prosiradiate on the flanks, nearly transverse on the venter. On the posterior part of the outer whorl most of the ribs are simple. On the anterior part about two thirds of the ribs bifurcate a little below the middle of the flanks. The bifurcation points are swollen but not tuberculate.

The specimen shown in Figures 9 and 10 of Plate 4 differs from that just described by its more depressed whorl section and by its slightly coarser, less forwardly inclined ribbing. The largest fragment (Pl. 4, fig. 15) has nearly straight ribs which bifurcate at the middle of the flanks and are slightly swollen at the points of furcation. The general appearance of these specimens is much like that of Microcanthoceras alumene Imlay (1939, p. 45, Pl. 9, figs. 3-12), from the Tithonian of Mexico.

Figured Specimen: U.S. National Museum 103410a, b, 103412.


Genus Durangites Buchholz, 1910
Durangites cf. D. acanthicus Buchholz
(Plate 5, figures 5-7)

One small, silicified fragment of part of a whorl shows the essential features of the genus Durangites. Whorl ovate in section, slightly wider than high; flanks gently convex; venter nearly evenly rounded, slightly flattened along midventral line. Umbilicus wall steeply inclined at base, rounding evenly into flanks.

The ornamentation consists of many high, narrow, straight, tuberculate ribs which are nearly radial on the umbilical wall and on the flanks, cross the venter transversely at the posterior end of the fragment but at the anterior end incline forward as a gentle sinus. Nearly all ribs bifurcate at or slightly below the middle of the flanks. The points of furcation are elevated but not tuberculated. All ribs terminate ventrally in radially compressed tubercles of varying prominence. Generally every other pair of secondary ribs terminates ventrally in a single tuberle of considerable prominence. Thus, four ventral tubercles correspond to three primary ribs, and
every third ventral tubercle is particularly prominent. All ribs are much reduced in strength along the midventral line but not interrupted by a groove. One constriction present. The anterior end of the figured specimen has a whorl height of about 8.5 mm. and a whorl thickness of 9 mm.

This species closely resembles Durangites acaenicus Burekhardt (1912, p. 146, Pl. 36, figs. 7, 8, 10, 11, 15), particularly the posterior end of the outer whorl of Burekhardt's type but has fewer simple ribs and lacks lateral tubercles. As it is in the "Köllikeri stage" of development (Burekhardt, 1912, p. 144) it might be confused with species of Micracanthoceras, but that genus retains lateral tubercles to a much later growth stage, and at a comparable size is generally much more sparsely ribbed.

**FIGURED SPECIMEN:** U. S. National Museum 103413.

**OCCURRENCE:** Viñales limestone. Atlantic Refining Company of Cuba locality 268.

*Durangites vulgaris* Burekhardt

(Plate 3, figure 1)


One specimen showing only the lateral view of the outer whorl appears to be identical with the more convex variety of *Durangites vulgaris* Burekhardt from the upper Portlandian of México. Whorl strongly convex at its posterior end and gently convex at its anterior end. Umbilicus fairly wide; wall low and oblique, rounding evenly into flanks.

The ornamentation consists of high, narrow, tuberculate ribs that begin at the line of involution, curve forward to the middle of the flank, then recurve and incline slightly backward on the upper part of the flanks. On the posterior half of the outer whorl about one third of the ribs bifurcate, and on the anterior half the majority of the ribs bifurcate between the middle and the upper fourth of the flanks. The points of furcation are elevated but not tuberculated. On the posterior part of the whorl every second or third rib passes ventrally into prominent tubercles. On the anterior part of the whorl only about one rib in every six passes into a ventral tubercle. Generally the ventral tubercle marks the union of two secondary ribs issuing from a common primary rib. No constrictions present.

The figured specimen at a diameter of 32 mm. has a whorl height of 11 mm. and an umbilical width of 13 mm. The corresponding measurements of one of the Mexican specimens of *D. vulgaris* figured by Burekhardt are 31, 12, and 13 mm.

Besides *Durangites vulgaris*, the only other Mexican species similar to the Cuban form is *D. nodulatus* Burekhardt (1912, p. 155, Pl. 38, figs. 7-10), which has wider-spaced ribs and fewer single ribs.

**Plekotype:** U. S. National Museum 103414.

**OCCURRENCE:** Viñales limestone. U. S. Geological Survey Mesozoic locality 18581.

**Genus Lytopholites** Spath, 1925

*Lytopholites caribbeanus* Inlay, n. sp.

(Plate 7, figures 1-4)

This species is represented by 11 fragmentary, more or less distorted internal molds, of which some bear fragments of shell material. Whorls subovate in section, in early stages wider than high, in later stages apparently a little higher than wide, thickest near middle of flanks, embracing about one third; flanks convex on inner
whorls, flattened on outer whorls; venter broadly rounded on inner whorls, regularly rounded on outer whorls. Umbilicus fairly wide, shallow; wall low, inclined on inner whorls and rounding evenly into flanks, nearly vertical on outer whorls and rounding rather abruptly into flanks.

The ribs on the inner whorls are nearly straight, fairly low, narrowly rounded, separated by flat interspaces from two to three times as wide, incline forward gently on the umbilical wall and flanks, and do not bifurcate. During growth the ribs become flexuous, higher, broader at their base, narrower at their top, and more widely spaced. The ribs on the outer whorls are radial on the umbilical wall, are inflected forward on the lower part of the flanks, recurve slightly on the upper part of the flanks, and arch forward gently on the venter. They are triangular in cross-section, very broad at their bases, acute at their summit, highest on the ventrolateral margins, and faintly reduced in strength along the midventral line. Almost all ribs are simple, only two examples of furcation at the base of the flanks being noted. The interspaces are broadly rounded. Constrictions are not evident, although some interspaces are deeper than others.

Most of the specimens are too distorted for accurate measurements, but the holotype appears to be only slightly compressed. At a diameter of 48 mm. it has a whorl height of 17 mm., a whorl thickness of 16(?) mm., and an umbilical width of 20 mm.

The specimens show some variation in density of ribbing but not enough to suggest specific differences. Gerth (1925, p. 99) has noted considerable variation in density of ribbing on *Lytohoplitites burckhardti* (Mayer Fymar) in Burckhardt (1900, p. 17, Pl. 20, fgs. 1, 2; 1903, p. 61, Pl. 10, fgs. 17-20), but that species differs by the development of rather prominent ventral tubercles. Much more similar to the Cuban species is *L. vetustoides* (Burckhardt) (1903, p. 62, Pl. 10, fgs. 23-25) which, however, may be distinguished by its slightly weaker ribbing and the development of a more definite ventral sinus. The form from Algiers described by Roman (1936, p. 31, Pl. 1, fgs. 6, 6a) as *Himalayites ? absormis* has similarly strong, simple ribs but has ventral tubercles and a well-defined ventral sinus. It probably should be referred to *Lytohoplitites*.

**Types:** Holotype, U. S. National Museum 103415; 6 figured paratypes, U. S. National Museum 103416a-f.

**Occurrence:** Viñales limestone. Atlantic Refining Company of Cuba locality 5229.

**Genus Parodontoceras** Spath, 1923

*Parodontoceras butti* Imlay, n. sp.

(Plate 7, figures 10-12)

This species is represented by numerous specimens, but most of them are very poorly preserved. Whorl section subovate, higher than wide, embracing about one fourth; flanks flattened; venter narrowly rounded; umbilicus wide and shallow.

The ribs of the innermost whorls (Pl. 7, fgs. 10, 12) are high, narrow, closely spaced, inclined forward on the flanks, transverse on the venter, and most of them bifurcate below the middle of the flanks. During growth the points of furcation rise to, or a little above, the middle of the flanks, the anterior rib branches tend to separate as intercalary ribs, the frequency of simple, unbranched ribs increases, and the interspaces become wider. At a diameter greater than 50 mm. all the ribs are simple, strong, straight, widely separated, and only gently inclined forward. The ribs along the midventral line are not reduced in strength at any stage of develop-
rounded on inner whors, regularly, shallow; wall low, inclined on
early vertical on outer whors and
right, fairly low, narrowly rounded.
ness as wide, incline forward gently
rugose. During growth the ribs narrow at their top, and more
radial on the umbilical wall, are
recurved slightly on the upper parter.
They are triangular in cross,
spiral, highest on the ventrolateral
midventral line. Almost all rib
base of the flanks being noted,
are not evident, although some
accurate measurements, but the
At a diameter of 48 mm. it has a
0 mm., and an unoblivious width of
of ribbing but not enough to sug-
note considerable variation in
(Mayer Eymar) in Buechardt
p. 17-20), but that species differs
ulcereous. Much more similar to
(1903, p. 62, Pie 10, figs. 23-25)
weaker ribbing and the develop-
ment described by Roman
vein has similarly strong, simple
central sinus. It probably should
415; 6 figured paratypes, U. S.
ing Company of Cuba locality


Parodontoceras antilleanum Inlay, n. sp.

This species is one of the most common in the Viñales limestone, but most
specimens are much compressed and weathered. Whorl section subovate, higher
than wide, except in earliest growth stages, embracing about one third; flanks
flattened, venter narrowly rounded; umbilicus wide and shallow.

The ribs on the innermost whors (Pl. 8, figs. 7-9) are fine, densely spaced, inclined
forward on the flanks, transverse on the venter, and generally bifurcate below
the middle of the flanks. During growth the points of bifurcation rise to near the
middle of the flank, the anterior branches tend to separate as intercalary ribs,
simple ribs become more common, and the interspaces become wider. At a
diameter greater than about 50 mm. all the ribs are simple, moderately strong,
neatly, straight, fairly widely separated, and moderately inclined forward. The ribs
along the midventral line are not reduced in strength at any stage of development.
Constrictions not present. Suture line unknown. Most of the specimens are consi-
derably compressed, but that shown in Figures 8 and 9 of Plate 8 has a whorl
height of 17 mm. and a whorl thickness of 12 mm.

In fineness of ribbing this species resembles the small specimen figured by Buech-
hardt (1906, p. 130, Pie 39, fig. 6) as Hoplitites cf. H. calistoides Behrendsen from
the Tithonian of Mexico, but at a comparable size has less flexuous ribs, of which fewer bifurcate.


**Occurrence:** Viñales limestone. Atlantic Refining Company of Cuba localities 249, 5216, 5229, 5231(?)

**Genus Berriasella** Uhlig, 1905

*Berriasella* sp.

(Plate 8, figures 2, 3)

Two small fragments belong to a species with form and ribbing somewhat similar to *Berriasella lorioli* (Zittel) (1868, p. 103, Pl. 20, figs. 6, 8; Mazenot, 1933, p. 123, Pl. 19, figs. 3a-d, 4a, 5a, 6a, 7b). The whorls subquadrate in section, a little higher than wide, embracing about one third; flanks nearly flat; venter evenly rounded. Ribs high, narrow, radial, slightly flexuous, widely spaced, bifurcating regularly on the upper third of the flanks, and crossing the venter transversely without diminution in strength. Several intercalary ribs present on venter.

**Figured Specimen:** U. S. National Museum 103423.

**Occurrence:** Viñales limestone. Atlantic Refining Company of Cuba localities 268, 5216.

**Genus Spiticeras** Uhlig, 1905

*Spiticeras* sp.

(Plate 8, figure 1)

One crushed, much weathered specimen was provisionally assigned by Dickerson to "Astieria" cf. *A. astieriformis* Böse. The only distinct features are a series of prominent, rounded umbilical nodes from which radiate bundles of 4 or 5 narrowly rounded ribs that are closely spaced, incline slightly forward, and apparently do not branch on the flanks. The umbilicus appears to be fairly wide.

Generic determination of this specimen is not possible, but it probably belongs to the family Oloostephanidae, which would indicate an age not older than upper Portlandian.

**Figured Specimen:** U. S. National Museum 103424.

**Occurrence:** Viñales limestone. Atlantic Refining Company of Cuba locality 5271.

**Genus Leptoceras** Uhlig, 1883

*Leptoceras* hondense Imlay, n. sp.

(Plate 10, figures 1-3, 11, 12)

This species is represented by dozens of specimens, of which most are much weathered and compressed. Coiling erioceroid, whorls widely separated, ovate in section, higher than wide, increasing slowly in size. Flanks and venter evenly convex, flanks becoming flatter during growth.

First whorl beyond embryonic chambers apparently smooth. Succeeding whorls marked by simple, radial ribs that are strong on the flanks, considerably reduced in strength on the venter, and on the larger whorls bear small ventral tubercles. Interspaces from 1½ to 2 times wider than ribs, slightly wider relatively on the outer than on the inner whorls. No constrictions present.

*Leptoceras* hondense Imlay is the most common uncoiled ammonite in the Cuban collection. Well-preserved specimens are in general easily distinguished from the associated *L. catalinense* Imlay by their coarser ribbing and slower rate
of coiling. Many immature or weathered specimens cannot be placed definitely in either species, and some specimens appear to be intermediate between the two species. Among European species, *L. gracile* (Oppel) (Zittel, 1870, p. 233, Pl. 55, figs. 3a-d), from the late Jurassic of southern Europe, is similar but has coarser and wider-spaced ribbing. Dickerson, in his preliminary studies of the fauna of the Viñales limestone, considered *L.f. hondense* as probably identical with *L. beyrichii* (Karsten) (1858, p. 103, Pl. 1, figs. 4a-d; 1866, p. 61, Pl. 1, figs. 4a-d), from the Barremian of Colombia, but the Cuban species may be distinguished by its sparser ribbing.

*Leptoceras? hondense* may be identical with *Ancyloceras* cf. *A. annulatus* D'Orbigny of Kollum (1837, p. 88, Pl. 9, figs. 1-3), from the upper Portlandian of the San Carlos Mountains of Tamaulipas, Mexico.

**Types:** Holotype, U. S. National Museum 103426; figured paratypes, U. S. National Museum 103425, 103427a-c; 6 unfigured paratypes 103428a-f.

**Occurrence:** Viñales limestone. Atlantic Refining Company of Cuba localities 517, 5216, 5246, 5272.

*Leptoceras? catalinense* Imlay, n. sp.

(Plate 10, figures 1-4)

The species is represented by about 25 specimens. Coiling crioceroid. Whorls moderately to fairly widely separated, ovate in section, higher than wide, increasing rapidly in size. Flanks and venter evenly convex. First whorl beyond embryonic chambers apparently smooth. Succeeding whorls marked by simple, radial, or slightly prorsiradial ribs that thicken ventrally, and on the larger whorls bear small ventral tubercles. Interspaces equal to, or slightly wider than the ribs.

This species shows considerable variation in the rate of coiling, but the outer whorls are generally not as widely separated as in *L. hondense* Imlay, and the ribbing is much denser. *Crioceras* sp. ind. Burekhardi (1919, p. 58; 1921, Pl. 21, fig. 3), from the Subtenuoceras beds of Mexico, is probably a similar species, but its much larger size precludes close comparison. *Leptoceras* sp. ind. Mazenot (1899, p. 245, Pl. 40, fig. 2), from the Berrisan of France, has sparser ribbing that is slightly prorsiradial, but its general appearance is very similar. The resemblances of *L.f. catalinense* and *L.f. hondense* to some of the Barremian species (Uhlig, 1883, p. 146-150, Pls. 28 and 32 in part) of Europe is rather remarkable and undoubtedly influenced former assignments of the Viñales limestone to an early Cretaceous age.

**Types:** Holotype, U. S. National Museum 103429; figured paratypes, U. S. National Museum 103430a, b, 103431, 103432.

**Occurrence:** Viñales limestone. Atlantic Refining Company of Cuba localities 527, 5216, 5271(?) 5272.

**Genus Hamulina** D'Orbigny, 1850

*Hamulina? rosarioensis* Imlay, n. sp.

(Plate 9, figures 1-11; plate 12, figure 1)

This species is represented by numerous straight and hook-shaped fragments, but none shows the complete form, and nearly all are much weathered. It cannot be ascertained whether the species has 2 or 3 limbs, but the latter seems more probable. The small, coiled embryonic portion is shown in Figure 2 of Plate 9. The hook-shaped fragments have one long, nearly straight limb that passes by
means of a 180° turn into a much shorter, subparallel limb. The whorl section is ovate and perhaps slightly higher than wide.

The ribs are strong, rounded, nontuberculated, incline forward gently on the flanks but cross the venter and dorsum transversely, are a little stronger on the venter than on the dorsum, and increase regularly in strength during growth. The interspaces on the posterior part of the longer limb are about as wide as the ribs and anteriorly become somewhat wider. On the crook the interspaces are about twice as wide as the ribs, and on the shorter limb are about three times as wide as the ribs. There is no reduction of ribbing along the midline of the venter or dorsum.

This species cannot be placed satisfactorily in any of the genera, Bochiamites, Leptoeceras, or Protocycloceras, to which have been referred the few uncoiled ammonites found until now in late Jurassic deposits. Although agreeing in general form and ornamentation with Hamites of the Alban stage it may be distinguished by its ribbing, stronger on the dorsum and wider-spaced anteriorly. Besides, the great difference in age makes generic identity with Hamites seem very doubtful. Certain of the nontuberculate species of Hamulina (Gignoux, 1920, p. 123) of the Barremian stage are likewise similar, although not as coarsely ribbed. Assignment of the Cuban species to a new genus is considered inadvisable, because of the poor preservation of the fossils and lack of knowledge of the future line.


Genus Ptychoeceras D’Orbigny, 1842

Ptychoeceras? sp.
(Plate 19, figure 19)

One internal mold shows parts of two appressed limbs ornamented with straight, strong, narrowly rounded ribs that become strongest ventrally. The ribs incline gently forward on the smaller limb and gently backward on the larger limb. The interspaces on the smaller limb are a little narrower than the ribs, but on the larger limb become a little wider. The mold resembles Ptychoeceras in form and ornamentation but is possibly distinguished by its large size and by the strength of the ribbing on the smaller limb. As Ptychoeceras has been recorded only from the Barremian, Aptian, and Alban stages of the Lower Cretaceous, it undoubtedly did not range down into the Upper Jurassic. The Cuban specimen is too poorly preserved to serve as the type of a new genus but is worthy of notice as another example of the rich and varied assemblage of uncoiled ammonites that characterized the late Jurassic deposits of Cuba in marked contrast to the apparent paucity of uncoiled ammonites of the same age in other parts of the world.


“Genus” Lamellaptychus Trauth, 1927

Lamellaptychus rectocostatus (Peters) emend. Trauth?

Four immature valves from Cuba were questionably referred by Trauth (1930, p. 69) to Lamellaptychus rectocostatus (Oppel, 1863, Pl. 70, figs. 1, 4), which he said was characterized by the straightness of the imbricating ribs on the convex side of the valve, although in the earliest stages the ribs may be slightly flexuous. The
SYSTEMATIC DESCRIPTIONS

1459

Lamellaptychus angulocostatus (Peters) (Plate 11, figures 8-10)


Trauth considers that most of the specimens described by O'Connell (1921, p. 1942, Figs. 15, 16, 18, not Fig. 17) as Aptychus piniantensis belong to L. angulocostatus, which is common in the Neocomian of the Alpine-Mediterranean regions and is characterized by the acute angle formed by the ribs on the convex side of the valve. The collections in hand contain 23 specimens which agree in form and sculpture with those figured by O'Connell from Cuba and also with those figured by Pictet and Loriot (1858, p. 46-48, Pl. 10, figs. 3, 5a-e, 6a-e, 7, 8a-d, 9, 10-12) from the Neocomian of Switzerland.


Occurrence: Viñales limestone. Atlantic Refining Company of Cuba localities 149, 215, 257, 260, 257, 5271, 3069. O'Connell records this species from Mount Pimental, 3 miles north of San Cristóbal and from Río Hondo, 7 miles northeast of San Cristóbal in Pinar del Río Province. Trauth records the species from Bahia Hondo and Sorra in Pinar del Río Province, and from between Encrucijada and Santa Clara in Santa Clara Province.

Lamellaptychus angulocostatus (Peters) var. longa Trauth


Trauth distinguishes this variety from the typical form by its much more slender form and notes that in the Alpine-Mediterranean region it is always confined to the Neocomian. None of the specimens available to the writer are nearly so slender as the type (Pictet and Loriot, 1858, p. 46-48, Pl. 10, fig. 4) of the variety, but Trauth records three specimens from Cuba, including one figured by O'Connell (1921, p. 11, 12, Fig. 17).

Occurrence: Viñales limestone. O'Connell records the species from Río Hondo, 7 miles northeast of San Cristóbal in Pinar del Río Province. Trauth records it from between Encrucijada and Santa Clara in Santa Clara Province.

Lamellaptychus angulocostatus (Peters) var. atlanticus (Hennig)


Trauth referred four Cuban specimens to this variety, in which the convex side of the valve bears ribs that apically are acute-angled as in the typical form of Lamellaptychus angulocostatus, but that toward the external margin change to broad, backwardly directed curves. These curves are slightly offset apically at one
or more places. The type of the variety was obtained in the Cape Verde Islands from limestones which Hennig considered Upper Jurassic, but Trauth suggested that they are probably Neocomian in age. No specimens referable to this variety are present in the collections under examination.

**Occurrences**: Vinales limestone. Trauth records this species from between Encarnación and Santa Clara in Santa Clara Province, and from Soroa and the region south of Toro in Pinar del Rio Province.

*Lamellaptychus angulocostatus* (Peters) var. *cristobalensis* (O'Connell)

(Plate 11, figures 2, 3)


This variety, represented by seven specimens, is characterized by: (1) a rather pronounced keel extending from the apex diagonally to the junction of the lateral and external margins; (2) the acute-angled ribs near the apex; (3) the broad, backwardly curved ribs near the external margin; and (4) the more or less distinct offsets apically of the ribs in the vicinity of the keel. It is similar to the variety *atlantis* (Hennig) but may be distinguished by the extension of the acute-angled ribs farther toward the external margin and by the more convex lateral margins.

**Plesioptypes**: U. S. National Museum 103440a, b.

**Occurrences**: Vinales limestone. Atlantic Refining Company of Cuba localities 142 and 3083. O'Connell listed this species from the Rio Hondo, 7 miles northeast of San Cristobal and from the Rio San Cristobal on the Finca of Rafael Begos, about 9 miles north of San Cristobal in Pinar del Rio Province. The variety has also been found by the writer about 4 miles southeast of La Peña, in southern Coahuila, Mexico, where it is associated with ammonites of lower Hauterivian age.

*Lamellaptychus seramonis* (Coquand)

(Plate 11, figures 4, 5)


This is the most common aptychus in the available Cuban collections, being represented by 20 specimens. O'Connell (1921, p. 9, 10, Figs. 9-14) studied 8 specimens, which he placed in a new species, *Aptychus cubanensis* O'Connell, but Trauth, who examined 2 Cuban specimens of the same species, proclaimed its identity with *L. seramonis* (Coquand). Judging from the illustrations by Pictet and Loric (1883, p. 48-50, Pl. 11, figs. 1, 2, 4, 7, 8), the determination by Trauth seems to be correct.

*Lamellaptychus seramonis* is characterized by: (1) an inward bending of the lateral margin in conformity with the course of the ribs; (2) a prominent keel extending from the apex diagonally to the junction of the lateral and external margins; (3) the ribs being broadly curved rather than angulated toward the external margin; and (4) the ribs bending gently apically as they approach the harmonic margin and concomitantly becoming larger, broader, flatter, and wider-spaced. It is distinguished from *L. angulocostatus* (Peters) by the inflexion of the lateral margin and by the absence of angulated ribbing toward the external margin.

According to Trauth (1936, p. 74) *Lamellaptychus seramonis* (Coquand) is fairly common in the lower Neocomian and rare in the late Jurassic of the Alpine-Mediterranean region.
FOSSILS FROM CUBA

obtained in the Cape Verde Islands, Jurassic, but Trauth suggested this species is referable to this variety as this species from between Entrañado and Sorona and the region south

w. cristobalensis (O'Connell)

3)

Amst. Novit., no. 28, p. 7, 8, Figs. 7, 8

var. cristobalensis (O'Connell)

Sci. Pr., vol. 29, no. 1, p. 73.

is characterized by: (1) a reduction of the area of the apex; (2) the broad, back and the more or less distinct sutures is similar to the variety atlantidea of the acute-angled ribs further back lateral margins.

The Atlantic Refining Company of Cuba localities, the Rio Hondo, 7 miles northeast of the Finca of Rafael Begoza, 38 Rio Province. The variety this is from southeast of La Peña, in southern nonites of lower Hauterivian age.

(Coquand)

Amsterdam, Sec. Sci. Pr., vol. 29.

Table Cuban collections, being reponed, Figs. 9-14) studied 8 specimens, whose O’Connell, but Trauth, who proclaimed its identity with L. seranonis by Piet et and Lorol, 1889, but by Trauth seems to be correct, an inward bending of the lateral (2) a prominent keel extending internal and external margins; (3) the outward the external margin; and to reach the harmonic margin and wider-spaced. It is distinguished of the lateral margin and by the margin.

L. seranonis (Coquand) is fairly late Jurassic of the Alpine-Mediterranean Province.

SYSTEMATIC DESCRIPTIONS


OCCURRENCE: Viñales limestone. Atlantic Refining Company of Cuba localities 137, 142, 251, 252, 5211, and U. S. Geological Survey Mesozoic locality 18579. O’Connell records this species as Aptychus cubanensis from 9 miles north of San Cristóbal in Pinar del Río Province. Trauth records it from Sorona in the same province.

Lamellaptychus excavatus Trauth

(Plate 11, figures 1, 9)


This species, represented by 13 specimens, has not been reported previously from Cuba, but appears to be identical specifically with the type (Piet et and Lorol, 1889, p. 45-50, Pl. 11, figs. 3, 5, 6) from the early Cretaceous of Switzerland. It is similar to L. seranonis (Coquand) in form and sculpture, but its ribs are more closely spaced throughout and do not bend apically as they approach the harmonic margin.

PSEUDOTYPES: U. S. National Museum 103443a, b.


Genus Hadrocheilus Till, 1907

Hadrocheilus sp.

(Plate 11, Figure 7)

One cephalopod beak from the Viñales limestone apparently belongs to Hadrocheilus Till (1907, p. 560, 565, 659, 667, 675) and probably to the Depressi group. Only the dorsal surface is exposed, but this shows a short, much depressed form with a median and two lateral wings. The ceph is depressed, broadly rounded apically, and bears a low, rounded dorsal keel. The shaft has elevated, sharp, lateral margins that are bounded inwardly by depressed areas, is marked medially by a small furrow, and is distinctly impressed with respect to the ceph.

The Cuban specimen appears to have a more depressed form and more elevated lateral margins than any described species of Hadrocheilus but is not sufficiently well preserved to merit a specific name. The genus, according to Till (1907, p. 675-680), ranges through the Jurassic and Lower Cretaceous but attains its greatest development in species and individuals in the early Lower Cretaceous. He indicates that the Depressi group of Hadrocheilus is confined to the Upper Jurassic and Neocomian.


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FOSSILS FROM CUBA


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FOSSILS FROM CUBA

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1848, 1912.

US Survey,
PLATE 1.—LATE JURASSIC FOSSILS FROM CUBA

Figure  Phylloceras pinarensi Imlay, n. sp.

(1, 4) Lateral and ventral views of paratype U. S. Nat. Mus. 103379a (×2).

(2, 3) Lateral and apertural views of paratype U. S. Nat. Mus. 103379b (×2).

(5) Paratype U. S. Nat. Mus. 103379c.

(6-9) Suture, lateral view, cross section, and ventral view of holotype U. S. Nat. Mus. 103378.

All specimens from Atlantic Refining Company of Cuba locality 5218 (p. 1442).

Figures natural size unless otherwise indicated.
From Cuba

Nat. Mus. 103379a (×2).
S. Nat. Mus. 103379b (×2).

View of holotype U. S. Nat. Mus. 103379a (×2).

Late Jurassic fossils from Cuba.
PLATE 2.—LATE JURASSIC FOSSILS FROM CUBA

Hildoglochiceras cf. H. alamense Imlay.

Figures

(1, 2) Ventral and lateral views of specimen U. S. Nat. Mus. 103388a.
(6, 7) Ventral and lateral views of specimen U. S. Nat. Mus. 103388b.
Both specimens from Atlantic Refining Company of Cuba locality 5138 (p. 1445).
Hildoglochiceras cf. H. grossicostatum Imlay.

(3, 4) Lateral and ventral views of specimen U. S. Nat. Mus. 103387a.
Both specimens from Atlantic Refining Company of Cuba locality 5138 (p. 1444).

(8-10) Metahaploceras? sp.

(11-13) Metahaploceras cf. M. masapilense (Burckhardt).

(14) Virgatosphinctes aff. V. rotundidoma Ulbig.

All figures natural size.

CUBA
PLATE 3.—LATE JURASSIC FOSSILS FROM CUBA

Figure

(1) *Durangites vulgaris* Burchardt.

(2, 3) *Simoceras* sp. juv. cf. *S. volanense* (Oppel).

(4) *Aspidoceras* sp.

(5-7) *Durangites* cf. *D. acanthicus* Burchardt.

(8-10) *Virgatosimoceras?* sp.

(11) *Physodoceras* sp.

(12, 13) *Aspidoceras* sp.

Figures natural size unless otherwise indicated.
LATE JURASSIC FOSSILS FROM CUBA
PLATE 4.—LATE JURASSIC FOSSILS FROM CUBA.

Pseudoliosoceras cf. P. sitteli (Burckhardt).

(Figures)

(1-3) Views and suture of specimen U. S. Nat. Mus. 103383a.
(4) Lateral view of specimen U. S. Nat. Mus. 103383b.
(7, 8) Views of specimen U. S. Nat. Mus. 103384a.
(11, 12) Views of specimen U. S. Nat. Mus. 103384b.

Specimens represented by figures 1-4 are from the Atlantic Refining Company of Cuba locality 5231. Specimens represented by figures 7, 8, 11, and 12 are from Atlantic Refining Company of Cuba locality 268 (p. 1443).

(5, 6) Virgatosphinctes cf. V. cristobalensis Imlay.


(13) Virgatosphinctes cristobalensis Imlay, n. sp.

Holotype U. S. Nat. Mus. 103394 from Atlantic Refining Company of Cuba locality 5229 (p. 1447).

Micracanthoceras sp. juv.

(9, 10) Views of specimen U. S. Nat. Mus. 103411a (×2).

(14, 16) Views of specimen U. S. Nat. Mus. 103411b (×2).

(15) Lateral view of specimen U. S. Nat. Mus. 103412.

Specimens represented by figures 9, 10, 14, and 16 are from Atlantic Refining Company of Cuba locality 7553. Specimen represented by figure 15 is from the same company’s locality 268 (p. 1452).

Figures natural size unless otherwise indicated.
PLATE 5.—LATE JURASSIC FOSSILS FROM CUBA

Cenoceras flicostatum Imlay, n. sp.

Figure

(1, 2) Lateral and apertural views of paratype U. S. Nat. Mus. 103401a.

(3) Paratype U. S. Nat. Mus. 103401b.

(4) Paratype U. S. Nat. Mus. 103401c.

(5-7) Paratype U. S. Nat. Mus. 103398.

(8) Suture of paratype, U. S. Nat. Mus. 103401d (× 2).

(9) Paratype U. S. Nat. Mus. 103401e.

(10, 11) Ventral and lateral views of paratype U. S. Nat. Mus. 103399.

(12, 14, 15) Holotype U. S. Nat. Mus. 103397, ventral view shows posterior part of outer whorl.

(13, 16) Paratype U. S. Nat. Mus. 103401f.

Specimen represented by figures 10 and 11 is from locality 248. Specimens represented by figures 5-7, 12, 14, and 15 are from locality 293. Remainder of specimens are from locality 7530 of the Atlantic Refining Company of Cuba (p. 1448).

Figures natural size unless otherwise indicated.
LATE JURASSIC FOSSILS FROM CUBA

FROM CUBA

Nat. Mus. 103401a.

Nat. Mus. 103399.

Lateral view shows posterior part.

PLATE 6.—LATE JURASSIC FOSSILS FROM CUBA

Dickersonia ramonensis Inlay, n. sp.

Figure
(1) Paratype U. S. Nat. Mus. 103407a.
(2, 3) Ventral and lateral views of paratype U. S. Nat. Mus. 103407b, anterior part of ventral view directed downward.
(4, 5) Paratype U. S. Nat. Mus. 103407c.
(6, 7) Paratype U. S. Nat. Mus. 103407d.
(8) Holotype U. S. Nat. Mus. 103406.

All specimens from Atlantic Refining Company of Cuba locality 268 (p. 1451).

Dickersonia sabanillensis Inlay, n. sp.

(9) Lateral view of paratype U. S. Nat. Mus. 103404a.
(10) Ventral view of paratype U. S. Nat. Mus. 103404b.
(11, 12) Paratype U. S. Nat. Mus. 103404c.
(14, 15) Ventral and lateral views of holotype U. S. Nat. Mus. 103403.
(16, 19, 20) Cross section, lateral and ventral views of paratype U. S. Nat. Mus. 103404d.

(17, 18) Paratype U. S. Nat. Mus. 103404c.

All specimens from Atlantic Refining Company of Cuba locality 268 (p. 1450).

(13) Dickersonia cf. D. ramonensis Inlay

Specimen U. S. Nat. Mus. 103410 from Atlantic Refining Company of Cuba locality 7539 (p. 1452).

All figures natural size.
PLATE 7.—LATE JURASSIC FOSSILS FROM CUBA

*Lytokohoplites caribbeanus* Imlay, n. sp.

Figure

(1, 2) Ventral and lateral views of holotype U. S. Nat. Mus. 103415.

(3) Paratype U. S. Nat. Mus. 103416a.

(4) Deformed paratype U. S. Nat. Mus. 103416b showing lateral and part of ventral views.

(5, 6) Cross section and lateroventral view of paratype U. S. Nat. Mus. 103416c showing ventral furrow.

(7) Paratype U. S. Nat. Mus. 103416d.

(8) Paratype U. S. Nat. Mus. 103416e.

(9) Paratype U. S. Nat. Mus. 103416f.

All specimens from Atlantic Refining Company of Cuba locality 5229 (p. 1453).

*Parodontoceras butii* Imlay, n. sp.


(11) Holotype U. S. Nat. Mus. 103417.


All specimens from Atlantic Refining Company of Cuba locality 5210 (p. 1454).

All figures natural size.
FROM CUBA

MUS. 103415.

lateral and part of ventral

U. S. Nat. Mus. 103416.

of Cuba locality 5229

of Cuba locality 5216

LATE JURASSIC FOSSILS FROM CUBA
PLATE 8.—LATE JURASSIC FOSSILS FROM CUBA

Figure
(1) *Spiticeras* sp.
   Specimen U. S. Nat. Mus. 103424 from Atlantic Refining Company of Cuba locality 5271 (p. 1456).

(2, 3) *Berriasella* sp.
   Specimen U. S. Nat. Mus. 103423 from Atlantic Refining Company of Cuba locality 5216 (p. 1455).
   *Paradontoceras ootillanum*, Inlay, n. sp.

(4) Paratype U. S. Nat. Mus. 103421a.

(5) Paratype U. S. Nat. Mus. 103421b.

(6) Holotype U. S. Nat. Mus. 103420.

(7) Paratype U. S. Nat. Mus. 103421c.

(8, 9) Paratype U. S. Nat. Mus. 103421d.
   All specimens from Atlantic Refining Company of Cuba locality 5216 (p. 1455).

All figures natural size.
PLATE 9.—LATE JURASSIC FOSSILS FROM CUBA

Figure  Hamulina? rosariensis Imlay, n. sp.

(1) Four paratypes on slab U. S. Nat. Mus. 103435a.

(2) Three paratypes on slab U. S. Nat. Mus. 103434a, specimen on left has initial whorls.

(3, 5) Two paratypes on slab U. S. Nat. Mus. 103434b.

(4) Paratype U. S. Nat. Mus. 103434c.

(6-8) Three paratypes on slab U. S. Nat. Mus. 103435b.

(9) Holotype U. S. Nat. Mus. 103433.

(10) Eight paratypes on slab 103434d.

(11) Four paratypes on slab 103434e.

Slabs 103435a, b are from Atlantic Refining Company of Cuba locality 5216.
Slabs 103434a–e are from Atlantic Refining Company of Cuba locality 5229 (p. 1457).

All figures twice natural size.
PLATE 10.—LATE JURASSIC FOSSILS FROM CUBA

Figure. *Leptoceras? catalinense* Imlay, n. sp.

(1) Two paratypes on slab U. S. Nat. Mus. 103430, specimen on left showing initial whorls; Atlantic Refining Company of Cuba locality 5216.

(2) Paratype U. S. Nat. Mus. 103432 from Atlantic Refining Company of Cuba locality 257.

(3) Paratype U. S. Nat. Mus. 103431 from Atlantic Refining Company of Cuba locality 5272.

(4) Holotype U. S. Nat. Mus. 103429 from Atlantic Refining Company of Cuba 5216 (p. 1457).
   *Leptoceras? hondense* Imlay n. sp.

(5,6) Paratypes U. S. Nat. Mus. 103427a, b from Atlantic Refining Company of Cuba locality 5216.

(7) Paratype U. S. Nat. Mus. 103426 from Atlantic Refining Company of Cuba locality 257.

(8,9,11) Ventral and lateral views of holotype U. S. Nat. Mus. 103425 (× 2) from Atlantic Refining Company of Cuba locality 5246.

(12) Paratypes on slab U. S. Nat. Mus. 103427c from Atlantic Refining Company of Cuba locality 5216 (p. 1456).
   *Ptychoceras?* sp.

(10) Specimen U. S. Nat. Mus. 103436 from Atlantic Refining Company of Cuba locality 184 (p. 1458).

Figures natural size unless otherwise indicated.
LATE JURASSIC FOSSILS FROM CUBA
PLATE 11.—LATE JURASSIC FOSSILS FROM CUBA

Figure

*Lamellapychus excavatus* Trueth

(1, 5) Plesiotypes U. S. Nat. Mus. 103443a, b from Atlantic Refining Company of Cuba locality 252 (p. 1461).

*Lamellapychus angulocostatus* var. *crisidalensis* (O’Connell)

(2, 3) Plesiotypes U. S. Nat. Mus. 103440a, b from Atlantic Refining Company of Cuba locality 142 (p. 1460).

*Lamellapychus seruanensis* (Coquand)


*Hadrocheilus* sp.

(7) Specimen U. S. Nat. Mus. 103444 from Atlantic Refining Company of Cuba locality 226 (p. 1461).

*Lamellapychus angulocostatus* (Peters)


(9) Plesiotype U. S. Nat. Mus. 103439 from Atlantic Refining Company of Cuba locality 3033.

(10) Plesiotype U. S. Nat. Mus. 103437 from Atlantic Refining Company of Cuba locality 142 (p. 1459).

All figures twice natural size.
LATE JURASSIC FOSSILS FROM CUBA
PLATE 12.—LATE JURASSIC FOSSILS FROM CUBA.

Figure (1) *Hamulina? rosariensis* Imlay, n. sp.
Paratypes on slab U. S. Nat. Mus. 103431f (X 2) in association with *Pseudoliscoceras* and *Virgatosphinctes* (opposite side of slab) from Atlantic Refining Company of Cuba locality 5229 (p. 1457).

(2) *Corongoceras* cf. *C. flicostatum* Imlay.
Specimen U. S. Nat. Mus. 103400 from Atlantic Refining Company of Cuba locality 5229 (p. 1449).

Figures natural size unless otherwise indicated.
LATE JURASSIC FOSSILS FROM CUBA