

Stations on west slope of Tapion du Petit-Goave (Pliocene ?).

9793 (W 317 F). Arrondissement of Léogane, road from Léogane to Miragoâne, west slope of Tapion du Petit-Goave, altitude 150 meters above sea level. T. W. Vaughan and W. P. Woodring, collectors. March 6, 1921.

9470 (B 33 F). Arrondissement of Léogane, road from Léogane to Miragoâne, west slope of Tapion du Petit-Goave, altitude about 100 meters above sea level. J. S. Brown, collector. October 23, 1920.

Pliocene (?) fossils from west slope of Tapion du Petit-Goave.

Species.	9793	9470
Corals:		
Orbicella annularis (Ellis and Solander).....	x	....
Solenastrea bournoni Milne-Edwards and Haime.....	x	....
Solenastrea hyades (Dana).....	x	....
Maeandra labyrinthiformis (Linnaeus).....	x	....
Siderastrea sp. aff. S. sidera (Ellis and Solander).....	x	....
Agaricia agaricites var. purpurea (Le Sueur).....	x	....
Porites sp. cf. P. porites (Pallas).....	x	....
Porites sp. cf. P. astreoides Lamarck.....	x	....
Mollusca:		
Gastropoda:		
Bullaria ? sp.....	....	x
Pelecypoda:		
Arca umbonata Lamarck.....	....	x
Chlamys (Aequipecten) sp. cf. C. (A.) phrygium Dall.....	x	x
Chlamys (Plagiectenium) sp. cf. C. (P.) gibbus Lamarck.....	....	x
Ostrea sp.	x	....
Venus campechiensis Gmelin ?.....	x	....
Chione ? sp.....	x	x
Macrocallista ? sp.....	x	....

QUATERNARY SYSTEM.

GENERAL FEATURES.

The effects of the rise and decline of glaciation in the temperate regions are apparently not recognizable in the Republic, either directly or indirectly, and the limits of Pliocene, Pleistocene, and Recent time are poorly defined, depending on several criteria, none of which can be rigidly applied. Deposits that are poorly consolidated, that are undeformed or only slightly deformed, that are dissected by present streams, and that contain a fauna identical with or very similar to the living fauna are here considered Quaternary.

Quaternary sedimentary deposits are rather widely distributed in the Republic, although most of the areas in which they form the surface rocks are small. (See Pl. I.) They may be divided into marine and non-marine deposits.

MARINE DEPOSITS.

Marine Quaternary deposits are common only along the coast, where they form narrow fringes, at few places more than 1 or 2 kilometers wide.

However, they spread over virtually all the Bombardopolis Plateau, thus extending back many kilometers from the coast. Small patches are found along the north and south borders of the Cul-de-Sac Plain to and beyond the international boundary. This probably is the greatest distance inland at which marine Quaternary deposits have been found, but when they were deposited the sea occupied the trough now known as the Cul-de-Sac Plain, and these deposits, like the others, are therefore coastal fringes. These marine Quaternary deposits cover the emerged coastal terraces that stretch along nearly one-half the coast of the Republic.

STRATIGRAPHIC RELATIONS.

The Quaternary deposits everywhere rest on the underlying formations unconformably. The unconformity is angular as well as erosional, even with the Pliocene and Miocene, but at some places where there are no Pliocene deposits the discordance with the Miocene deposits may be slight.

LITHOLOGY AND LOCAL DETAILS.

The greater part of the marine Quaternary deposits are reef deposits very similar to those now forming at many localities around the shore of the Republic. They consist of reef rock, coralliferous limestone, and molluscan limestone, but reef rock and coralliferous limestone are the most common, a fact indicating that fringing reefs were flourishing during probably all of Quaternary time. If some of these rocks are indeed of Pleistocene age, as seems probable, there seems to be no basis, at least so far as the Republic of Haiti is concerned, for the contention that the vigorous growth of Pleistocene reefs was retarded by the supposed lowering of the temperature of tropical seas during Pleistocene time. Although detailed work should be done to warrant definite statements, it seems that the maxima of Pleistocene glaciation can not be recognized by their effect on the Pleistocene reefs. The reefs of supposed Pleistocene age are similar in many features to the Recent reefs. The list on page 250 shows that *Orbicella annularis* (Ellis and Solander) was the most common reef builder in the emerged Quaternary deposits, just as it is the most common coral on the living West Indian reefs.

At few places does the weathered surface of the limestone give a correct impression of its lithology, which can be observed only in very fresh stream-cut bluffs or in artificial excavations. In such favorable exposures the rock is seen to consist of thick-bedded, poorly assorted, and very poorly consolidated calcareous and detrital materials, in most places containing a large proportion of heads of corals and shells of mollusks. There are all gradations of rock from pure coral and pure coquina to gravel derived entirely from land debris. Ordinarily the purer calcareous rock is found near the sea or on the outer margins of terraces, and the detrital material is found at the landward margin of the deposits. The charac-

teristic gradation is well shown along the Rivière des Roseaux near Roseaux, a village about 7 kilometers east of Jérémie. The terrace near the shore is composed very largely of heads of corals and shells of mollusks. To the south the organic remains become rarer and rarer, and the detrital materials become more and more abundant, until in the bluffs about a kilometer south of Roseaux only dissected water-laid gravels can be found. The zone of gradation ordinarily, however, is not conspicuous. At some places where the initial slope was steep a narrow reef is plastered almost directly on the basement of the older rocks. This relation is shown at St.-Marc Bay, where relatively wide terraces veneered with reef rock or coralliferous limestone cover the promontories north and south of the bay. At the head of the bay, just south of the place where the road to Gonaïves leaves the coast and enters the ravine, a narrow fringe of coralliferous limestone rises to an altitude of 15 meters above sea level. The limestone grades laterally and vertically into marl and poorly consolidated gravels. The fossils listed on pages 250-254 (station 9551) were collected here. At some places the zone of gradation is obscured by later alluvial deposits or is indistinguishable from them. In places it seems that the deposits in the zone of gradation are softer than the more calcareous rock and have been eroded away, as at the rear of the coastal escarpments near Anse Rouge and north of Jean Rabel. The erosion in both these localities, however, has undoubtedly been due primarily to the presence of soft Miocene beds back of the Quaternary limestone.

A lateral gradation in constituent material somewhat like that just described was observed at some places directly on the shore, where the prevailing coralliferous limestone of the lowest coastal terraces is replaced for an interval by stratified gravel or sand that generally contains marine fossils in considerable numbers. This type of material doubtless represents the delta deposits of streams which at their mouths interrupted the continuity of the reefs by depositing a large amount of sediment. Such a gradation is particularly well shown just west of the mouth of Rivière de Jean Rabel, along the trail between Môle St.-Nicolas and Jean Rabel. The coralliferous limestone typically developed 2 or 3 kilometers west of that stream grades eastward into stratified sand and coarse gravel containing few fossils, such as that found in bluffs along the Rivière de Jean Rabel. Again, between Petit-Rivière de Nippes and Grande-Rivière de Nippes the prevailing coralliferous limestone is replaced by fine-grained soft brown sand containing shells of mollusks. (See list, pp. 250-254; station 9520.) At these two localities, as probably at most others, the main streams of Quaternary time seem to have occupied approximately the same valleys which they now occupy, and Quaternary delta deposits may normally be expected at the mouths of all the larger streams where the coast has emerged during Quaternary time.

Where they have been long exposed to weathering the Quaternary rocks assume an appearance very different from that which they show in fresh

excavations. The fossils are commonly dissolved by preferential leaching, leaving the surface of the rock pitted, and only casts or impressions of the fossils remain. A veneer of travertine deposited over the rock surface in many places accentuates its massive appearance. There is also a pronounced hardening of the outer crust, which commonly extends to a depth of several meters. This hardening is probably due mainly to firm cementation of the particles by redeposited calcium carbonate. The density of the rock also may be increased to some extent by this introduced material, some of which was probably brought to the surface by capillary water, which having penetrated the rock to a shallow depth returned to the surface and evaporated, leaving its dissolved material behind. As a result of these changes the purer calcareous Quaternary rock may closely resemble phases of the massive upper Eocene and other Tertiary limestones, as for instance, in the cliff shown in Plate XVII, A. Some of the Quaternary limestone also yields a red clay soil almost identical with that characteristic of areas of the massive Tertiary limestones.

The following section of Quaternary deposits is exposed in a sea cliff 7 meters high just west of the colonial fort on the west side of the entrance to the harbor of Port-de-Paix:

Section of Quaternary beds exposed near Port-de-Paix.

	Meters.
Reef rock, yellowish buff, soft, containing large heads of <i>Orbicella annularis</i> and other corals; station 9765.....	3.6
Waterworn pebbles, poorly consolidated, in matrix of sand; lenses of sand containing worn shells and small pieces of corals; station 9764.....	1.5
Sand, rusty brown, poorly consolidated, fragmentary shells in pockets	2
Sea level.	—
	7.1

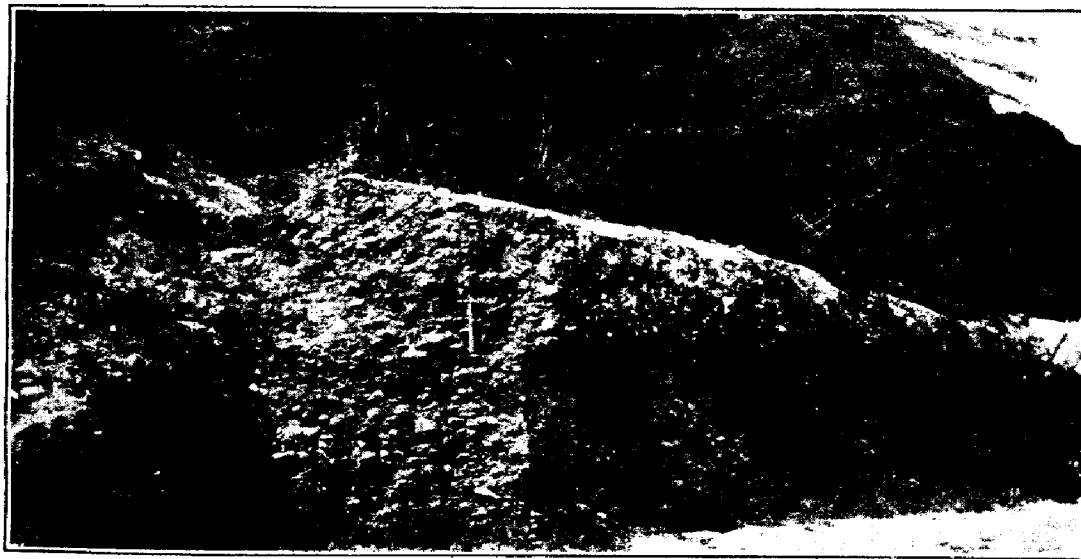
The lenses of sand in the middle bed furnished the largest collection of Quaternary mollusks obtained in the Republic. (See list, pp. 250-254, station 9764.) The overlying reef rock contained only a few mollusks.

The remarkable emerged coastal terraces of the Northwest Peninsula are described on pages 371-375, and the fossils obtained from the coralliferous limestone covering them are listed on pages 250-254 (stations 9841, 9840, 9844, 9838, 9837, 9836, 9835, 9834, 9833, 9832, and 9831).

In the Cul-de-Sac Plain the most extensive areas of Quaternary limestone lie along the south side. The best collection of corals was obtained at Balan, near the southwest corner of Étang Saumâtre. (See list, p. 250; station 9659.) Along the trail from Gantier to Fond-Parisien cavernous limestone crops out near Pont Quinet at an altitude of about 150 meters above sea level. This limestone is the surface rock for most of the distance from this locality eastward to Fond-Parisien and probably forms the ridge that extends northward to the lake. Partly dissolved corals were collected about 3 kilometers northwest of Fond-Parisien at an altitude of 90 meters above sea level. (See list, p. 250; station 9591.)



A. PITTED QUATERNARY LIMESTONE (ROCHE-À-RAVET) EXPOSED IN
FIFTH EMERGED SEA CLIFF ON THE TRAIL FROM PETIT
PARADIS TO BAYE DE HENNE.



B. PLEISTOCENE CONGLOMERATE ON THE ROAD LEADING UP TO FORT
NATIONAL, PORT-AU-PRINCE.
Note the hardened surface crust.

At numerous other localities where Quaternary deposits fringe the coast they consist of one of the types of deposits that have just been described. The terraces on which they rest are fully described in Part III.

THICKNESS.

Because of the great unevenness of the floor on which it was deposited and the unequal amount of erosion at the surface the thickness of the marine Quaternary is decidedly variable. It probably exceeds 50 meters at but few places, although on the Bombardopolis Plateau the maximum thickness may be 100 meters. At La Gorge, on Rivière du Môle, south-east of Môle St.-Nicolas, the contact of the Quaternary deposits with the underlying Miocene beds is at an altitude of less than 100 meters above sea level, and the Quaternary deposits rise to heights of about 400 meters above sea level on the plateau on either side of the river valley. It can not be assumed, however, that the intervening interval represents the thickness of the Quaternary, because on each of the terraces the Quaternary is represented only by a thin lens of deposits that gradually tapers landward and more rapidly seaward.

STRUCTURE.

The structure of the Quaternary formations is very simple. Although they have undergone arching, as indicated by the unequal amounts of emergence of the coastal terraces, especially in the Northwest Peninsula, they are not at all crumpled, as are the underlying formations. At most places they were deposited with a pronounced seaward dip, commonly from 5° to 15°, which is generally visible in large excavations or in deep stream channels. As the direction of the coast line changes the direction of dip determined by the initial slope usually changes correspondingly.

FOSSILS.

Some of the collections here classified as Quaternary may really be Pliocene. It is very difficult to distinguish Pleistocene from Pliocene faunas, a difficulty which probably accounts for the apparent scarcity of Pliocene deposits in the American tropics. No adequate attempt has yet been made in the American tropics to separate Pleistocene and Recent faunas, much less to recognize faunal zones in the Pleistocene.

Corals are the most abundant marine Quaternary fossils, as the most common rock is coral reef rock or coralliferous limestone. Virtually all the species are identical with living ones. *Orbicella annularis* (Ellis and Solander) was obtained at almost every locality where collections were made from rocks of this type. *Solenastrea bournoni* Milne-Edwards and Haime, *Siderastrea siderea* (Ellis and Solander), and *Acropora muricata* (Linnaeus) are other common Quaternary corals. The lists of Miocene corals (see pp. 178, 203, 217) show that the following Recent species were living in Miocene time: *Orbicella annularis*, *Dichocoenia stokesi*, *Stephanocoenia intersepta*, *Solenastrea bournoni*, *Solenastrea hyades*, and *Siderastrea siderea*. A small collection of Miocene corals may therefore

resemble a Quaternary fauna, unless it includes *Stylophora*, *Pocillopora*, *Antillia*, *Cyathomorpha*, or *Goniopora*.¹

The molluscan fauna of the Quaternary fringing reefs is rather meager, but the total molluscan fauna is extensive, because large collections were obtained at localities where the deposits consist of sand and gravel or of limestone that contains hardly any corals. *Strombus gigas* Linnaeus, *Arca umbonata* Lamarck, *Codakia orbicularis* (Linnaeus), and *Phacoides pennsylvanicus* (Linnaeus) are the common mollusks of the fringing reefs. Not enough time was given to the determination of the mollusks to show clearly whether any of them are different from living West Indian species. Most of those that are not determined specifically are poorly preserved.

Stations in marine Quaternary deposits.

9764 (W 301a F). Arrondissement of Port-de-Paix, on the coast, 100 meters west of old fort on west side of entrance to Port-de-Paix harbor; from middle bed of section on page 246. W. P. Woodring, collector. February 21, 1921.

9765 (W 301b F). Arrondissement of Port-de-Paix, same locality as 9764; from upper bed of section on page 246. W. P. Woodring, collector. February 21, 1921.

9841 (B 210 F). Arrondissement of Môle St.-Nicolas, trail from Môle St.-Nicolas to Jean Rabel, about 2 kilometers northeast of Môle St.-Nicolas. J. S. Brown, collector. January 30, 1921.

9840 (B 209 F). Arrondissement of Môle-St.-Nicolas, cliff at northeast end of bay. J. S. Brown, collector. January 30, 1921.

9844 (B 211a F). Arrondissement of Môle St.-Nicolas, trail from Môle St.-Nicolas to Bombardopolis, about 2 kilometers south of Môle St.-Nicolas. J. S. Brown, collector. January 31, 1921.

9838 (B 207 F). Arrondissement of Môle St.-Nicolas, trail from Môle-St.-Nicolas to Bombardopolis, about 8 kilometers northwest of Bombardopolis. J. S. Brown, collector. January 29, 1921.

9837 (B 206 F). Arrondissement of Môle St.-Nicolas, trail, from Môle St.-Nicolas to Bombardopolis, about halfway between the towns. J. S. Brown, collector. January 29, 1921.

9836 (B 205 F). Arrondissement of Môle St.-Nicolas, trail from Môle St.-Nicolas to Bombardopolis, about 7 kilometers northwest of Bombardopolis. J. S. Brown, collector. January 29, 1921.

9835 (B 204 F). Arrondissement of Môle St.-Nicolas, trail from Môle St.-Nicolas to Bombardopolis, about 5 kilometers northwest of Bombardopolis. J. S. Brown, collector. January 29, 1921.

9834 (B 203 F). Arrondissement of Môle St.-Nicolas, trail from Môle St.-Nicolas to Bombardopolis, about a kilometer northwest of Bombardopolis. J. S. Brown, collector. January 29, 1921.

9833 (B 200 F). Arrondissement of Môle St.-Nicolas, trail from Bombardopolis to Baie de Henne, about 3 kilometers west of Baie de Henne and halfway up slope of Morne Chien. J. S. Brown, collector. January 27, 1921.

9832 (B 199 F). Arrondissement of Môle St.-Nicolas, trail from Bombardopolis to Baie de Henne, 2 kilometers west of Baie de Henne, foot of Morne Chien. J. S. Brown, collector. January 27, 1921.

9831 (B 197 F). Arrondissement of Gonaïves, trail from Terre-Neuve to Anse Rouge, gap in low range of coastal hills about 5 kilometers southeast of Anse Rouge. J. S. Brown, collector. January 25, 1921.

¹ There are other West Indian Miocene genera now confined to the Indo-Pacific region, or extinct. (See Vaughan, T. W., U. S. Nat. Mus. Bull. 103, p. 222, 1919.) The genera listed are known in the Miocene fauna from the Republic of Haiti.

9551 (W 2 F). Arrondissement of St.-Marc, road from St.-Marc to Gonaïves, steep slope on east side of road at outskirts of St.-Marc. W. P. Woodring, collector. September 29, 1920.

9479 (B 120 F). Arrondissement of St.-Marc, road from St.-Marc to Port-au-Prince, 4 kilometers northwest of Mont Rouis. J. S. Brown, collector. December 7, 1920.

9659 (W 110 F). Arrondissement of Port-au-Prince, Balan, southwest corner of Étang Saumâtre. W. P. Woodring, collector. November 24, 1920.

9504 (W 30 F). Arrondissement of Port-au-Prince, trail from Gantier to Fond-Parisien, 4 kilometers east of Gantier, at an altitude of 150 meters above sea level. W. P. Woodring, collector. October 20, 1920.

9591 (W 31 F). Arrondissement of Port-au-Prince, trail from Gantier to Fond-Parisien, 3 kilometers northwest of Fond-Parisien, at an altitude of 90 meters above sea level. W. P. Woodring, collector. October 20, 1920.

9539 (B 28 F). Arrondissement of Léogane, road from Léogane to Miragoâne, about 2 kilometers west of l'Acul. J. S. Brown, collector. October 22, 1920.

9576 (B 29 F). Arrondissement of Léogane, road from Léogane to Miragoâne, Source Mahot. J. S. Brown, collector. October 22, 1920.

9469 (B 30 F). Arrondissement of Léogane, road from Léogane to Miragoâne, short distance west of Source Mahot. J. S. Brown, collector. October 22, 1920.

9613 (B 35 F). Arrondissement of Nippes, trail from Miragoâne to Anse-à-Veau, about a kilometer east of village of Charlier. J. S. Brown, collector. October 28, 1920.

9520 (W 103 F). Arrondissement of Nippes, trail from Miragoâne to Anse-à-Veau, about halfway between Petit-Rivière de Nippes and Anse-à-Veau. W. P. Woodring, collector. November 18, 1920.

9614 (B 36 F). Arrondissement of Nippes, roadside cut descending steep slope in town of Anse-à-Veau. J. S. Brown, collector. October 29, 1920.

9484 (B 115 F). Arrondissement of Nippes, about 300 meters east of Petit-Trou de Nippes. J. S. Brown, collector. November 22, 1920.

9637 (B 100 F). Arrondissement of Grand'Anse, trail from Les Roseaux to Corail, about 2 kilometers east of Les Roseaux. J. S. Brown, collector. November 19, 1920.

9638 (B 101 F). Arrondissement of Grand'Anse, shore line at Les Roseaux. J. S. Brown, collector. November 19, 1920.

9627 (B 74 F). Arrondissement of Coteaux, cliffs along coast 5 kilometers northwest of Port-à-Piment. J. S. Brown, collector. November 13, 1920.

9473 (B 67 F). Arrondissement of Cayes, sea cliff a kilometer northwest of Port-Salut. J. S. Brown, collector. November 11, 1920.

9474 (B 68 F). Arrondissement of Cayes, sea cliff 1.5 kilometers northwest of Port-Salut. J. S. Brown, collector. November 11, 1920.

9652 (K 22 F). Arrondissement of Aquin, trail from Aquin to Côtes-de-Fer, about 9 kilometers west of Côtes-de-Fer. W. S. Burbank, collector. November 12, 1920.

9650 (K 29 F). Arrondissement of Jacmel, trail from Bainet to Jacmel, from surface of lowest terrace. W. S. Burbank, collector. November 14, 1921.

9603 (W 63 F). Arrondissement of Jacmel, east side of Jacmel Bay about 2 kilometers southeast of Jacmel, at an altitude of 1 meter above sea level. W. P. Woodring, collector. November 1, 1920.

9514 (W 62 F). Arrondissement of Jacmel, east side of Jacmel bay, about a kilometer southeast of Jacmel, at an altitude of 50 meters above sea level. W. P. Woodring, collector. November 1, 1920.

9602 (W 61 F). Arrondissement of Jacmel, same locality as 9514, at an altitude of 60 meters above sea level. W. P. Woodring, collector. November 1, 1920.

NONMARINE DEPOSITS.

The nonmarine Quaternary deposits consist of stratified but generally poorly sorted silt, clay, sand, or gravel deposited by streams. The material of which they are composed is usually identified as derived from adjacent highlands. They are unconsolidated, and although the beds in many places have a slight initial dip, equivalent to that of the slope on which they were deposited, they are not deformed. No attempt was made to separate Pleistocene and Recent deposits. In general the older (probably Pleistocene) deposits are more dissected than the younger deposits. It is equally difficult to distinguish the Quaternary deposits from similar deposits of Pliocene age. The degree of dissection and the general geologic history have been utilized in attempting this separation.

The presence of nonmarine Quaternary gravels at the landward margin of the marine Quaternary deposits and the reasons for their apparent or actual absence at many places have been mentioned on page 245.

Extensive areas of sands and gravels of Quaternary age are found on some of the plains adjoining the sea, particularly in the eastern part of the North Plain, east of the longitude of Fort Liberté. Here they floor a dissected plain, and a thin veneer of gravels covers parts of the rock platform that extend along the mountain front to the south. (For description of surface features see pp. 356-358.) The deposits consist of unconsolidated gravels, sands, and clays, derived chiefly from eroded and weathered products of the quartz diorite, which crops out in the mountains and on the platform on which the deposits lie. The beds have a gentle seaward slope, parallel to the surface of the plain. The beds of sand and gravel are lenticular and cross-bedded. The clay is fine and dark, and at places it contains indeterminate fragments of plants. On the plain northeast of Acul Samedi, where the deposits are well exposed, the sands and gravels cap small mesas. Near the surface the sandy beds are at places cemented into relatively hard sandstones by iron and manganese oxides. Residual concretionary masses of these oxides are scattered on the surface. (See pp. 477-478.)

The deposits probably were laid down by streams during the retreat of the sea after the cutting of the rock platform. More careful study might show that some of the beds are marine. Coral reefs and coralliferous limestones, probably of Quaternary age, were found on the eastward prolongation of the plain near Copey, in the Dominican Republic.¹

Other unconsolidated gravels and sands of Quaternary age occupy considerable areas in the interior, generally at the foot of high mountain ranges or in interior valleys and plains.

Quaternary deposits cover stream terraces along the large streams. The most extensive terrace deposits are in the drainage basin of Rivière Arti-

¹ A geological reconnaissance of the Dominican Republic: Dominican Rep. Geol. Survey Mem., vol. 1, pp. 165, 174-175, 1921.

bonite. The terraces are described on pages 380-385. The separation of the Pliocene Hinche formation from the Quaternary terrace deposits in the Central Plain may be artificial. In general the Quaternary deposits here contain a greater proportion of large cobbles and boulders of limestone and brown or black chert derived from the surrounding mountains.

Similar terrace deposits are widespread in the Artibonite Valley. Along the trail from Mirebalais to Saut d'Eau the deposits on the west side of Rivière Tombe consist of gravel, coarse sand, and lenses of white marl. At places boulders of chert and basalt larger than a man's head are strewn on the surface. These deposits are as much as 30 meters higher than the stream and are well dissected. The land gastropods listed on page 257 (station 9457) were collected from coarse sand 25 meters above the stream at a locality about 5 kilometers southwest of Mirebalais. Fresh-water and land gastropods were collected from silt a kilometer southeast of Mirebalais, on the road to Las Cahobas. (See list, p. 257, station 9902.) Some of these stream deposits may be of the same age as the Hinche formation of the Central Plain, but more detailed work would be required to separate Pliocene and Quaternary deposits.

In the lower part of the Artibonite Valley Quaternary terrace gravels extend along the north side of the river. At places the surface is strewn with boulders and cobbles. (See Pl. XXX, A, p. 386.) On the south side of the river a narrow band of gravels extends downstream from Les Verrettes. Northwest of the road from St.-Marc to Gonaïves the gravels grade into conglomeratic coralliferous limestone.

The relations of the Quaternary gravels near Port-au-Prince to the water supply of the city are discussed on pages 571-573.

The nonmarine Quaternary deposits are similar to the marine in showing a peculiar hardening near the surface, which causes them to resemble much older and more consolidated rocks. The process is essentially the same as with the marine deposits. Near the surface the bedding usually is destroyed by this process, which is assisted by slump and creep. A typically hardened surface is shown in Plate XVII, B. This effect is not noticeable more than 2 or 3 meters below the surface of the ground.

The thickness of the nonmarine Quaternary deposits is perhaps even more variable than that of the marine. Only at a few places, probably, does it exceed 50 meters.

FOSSILS.

Land and fresh-water mollusks are the only invertebrate fossils obtained from nonmarine deposits of Quaternary age. Most of the land mollusks, which were examined by the late Mr. John B. Henderson, of the United States National Museum, are similar to species now living in Haiti.

Stations near Mirebalais (nonmarine Quaternary).

9457 (W 135 F). Arrondissement of Mirebalais, trail from Mirebalais to Saut d'Eau (Ville Bonheur), about 5 kilometers southwest of Mirebalais. W. P. Woodring, collector. December 7, 1920.

9902 (W 181 F). Arrondissement of Mirebalais, road from Mirebalais to Las Cahobas, about a kilometer east-southeast of Mirebalais. W. P. Woodring, collector. January 8, 1921.

Nonmarine Quaternary fossils collected near Mirebalais.

Species.	9457	9902
Gastropoda :		
Limnaea sp.	×
Cepolis (Plagiptychus) indistincta Ferussac.....	×
Pupoides marginatus nitidulus Pfeiffer.....	×
Obeliscus sp.	×
Obeliscus (Dolicholestes) sp., apparently different from any described West Indian species	×
Pleurodonte (Parthena) sp. cf. P. (P.) angusta Ferussac.....	×
Pleurodonte (Parthena) undulata Ferussac.....	×
Pleurodonte (Luquilla) sp. cf. P. (L.) audebardi Pfeiffer.....	×

EXTINCT QUATERNARY MAMMALS AND BIRDS.

Extinct Quaternary mammals, principally rodents, ground sloths and bats, have been found in caves and kitchen middens in Cuba, Porto Rico, and other West Indian islands. Miller¹ has described three rodents, belonging to the genera *Isolobodon*, *Plagiodontia*, and *Brotomys*, from kitchen middens at San Pedro de Macoris and San Lorenzo in the Dominican Republic. During the reconnaissance of the Republic of Haiti a preliminary examination was made of two caves in the arrondissement of Marmelade in order to determine whether a similar fauna could be discovered in the Republic. The results fully justified the preliminary exploration and indicate that more extensive exploration of these and other caves in the Republic is warranted.

The caves examined are on the south slope of the mountains northeast of St.-Michel de l'Atalaye and northwest of the plantation of the United West Indian Corporation. The mountains here consist of limestone of middle Eocene age. In this region there are a large number of caves, formed during a period when the drainage systems were different from the present. Many of the caves stand high on the mountain slope and have no apparent relation to the present drainage, either surface or subterranean. There is little evidence of active solution. The caves are dry and are apparently being filled with residual clay, rain-washed debris, and other material. Many of them contain a thick floor cover of guano left by the thousands of bats that now inhabit or recently inhabited them.

¹ Miller, G. S., Jr., Bones of mammals from Indian sites in Cuba and Santo Domingo: Smithsonian Misc. Coll., vol. 66, no. 12, 10 pp., 1 pl., 1916.

The larger of the two caves explored is about 3 or 4 kilometers northeast of St.-Michel de l'Atalaye and the same distance northwest of the plantation. It stands about 600 meters above sea level, nearly 200 meters above the Central Plain, which adjoins the mountains to the south. Its length is about 40 meters and its width and height 10 to 20 meters. Several large columns, formed by the union of stalactites and stalagmites, extend from the floor to the roof. The cave has two large openings, separated by a pillar, and a third small opening on the sloping hillside, which affords entrance nearly on the plane of the floor. Near the rear of the cave there is an opening or skylight, about 5 meters in diameter, through which long roots of figuier trees extend. Fragments of rock and surface wash falling down the skylight have built up a small cone of coarse débris beneath it. An excavation nearly 2 meters deep and a little more than a meter in diameter was made in the middle of one of the largest open spaces. Only firm, dry, reddish dirt was encountered. The rock floor appears to be very deep here and was not approached in this pit. Another hole was made near the rear end of the cave, about a meter from the wall and 5 meters from the cone of débris near the skylight. The excavation was less than a meter deep and about a meter in diameter. Rocks and boulders were embedded in the cave earth. From very near the surface downward this hole yielded bones.

The smaller cave examined is about 2 kilometers north-northwest of the plantation and perhaps 2 kilometers east of the first cave, on the south side of a deep dry ravine. The diameter of the opening is about 30 meters. The roof is arched, all in one chamber, and the floor is convex, the rear half being nearly bare rock, partly covered by a thin deposit of bat guano. The mouth, which was formerly much larger, is choked by a pile of débris from the cliff that rises above it. This débris has rolled inward as well as outward, covering the floor of the front part of the cave. An excavation was made at the lowest part of the cave adjacent to one of the vertical rock walls, following down the wall to a depth of nearly 2 meters. At the bottom the rock wall sloped inward steeply, and the entire floor of the excavation was on rock. The material excavated consisted of loose stones, between which lay dirt and guano. Bones were found from a depth of 0.6 meter to the bottom, increasing in number downward.

The bones obtained are the remains of mammals and birds. The mammals have been examined by Mr. G. S. Miller, jr., of the United States National Museum, and the birds by Mr. Alexander Wetmore, of the Biological Survey, United States Department of Agriculture. Papers containing descriptions of the remains have recently been published.¹ The remains identified by Miller and Wetmore are tabulated below.

¹ Miller, G. S., jr., *Remains of mammals from caves in the Republic of Haiti*: Smithsonian Misc. Coll., vol. 74, no. 3, 8 pp., 1922. Wetmore, Alexander, *Remains of birds from caves in the Republic of Haiti*: Smithsonian Misc. Coll., vol. 74, no. 4, 4 pp., 2 text figs., 1922.

Mammals:

Rodents:

Isolobodon portoricensis Allen.*Aphaetreus montanus* Miller
n. gen. and n. sp.*Ithydontia levir* Miller n. gen.
and n. sp.*Brotomys voratus* Miller?

Ground sloth:

Megalocnus?

Mammals:—Continued.

Man:

Homo sapiens (head of left femur).

Unidentified fragments.

Birds:

Chaemepelia passerina (Linnaeus).*Crotophaga ani* Linnaeus.*Tyto ostologa* Wetmore n. sp.*Tolmarchus gabbii* (Lawrence).

Rodents of the genus *Isolobodon* furnished the most abundant remains in both caves. The new genus *Aphaetreus* is represented by a mandible with a full set of cheek teeth, and the new genus *Ithydontia* by isolated teeth, all of which were collected in the larger cave. A small ground sloth, probably resembling the extinct *Megalocnus* of Cuba, is represented by a nearly perfect caudal vertebra, an imperfect probably dorsal vertebra, a fragment apparently of the proximal end of the radius of a young animal, all obtained in the larger cave; and by two imperfect caudal vertebrae and the proximal end of a fragment of the shaft of a rib, collected in the smaller cave. The human remains consist of the head of a left femur found at the same level with the remains of the ground sloth in the smaller cave. The bone substance is lighter and less infiltrated with mineral matter than the bones of the sloth. A chipped chert, identified by Mr. Walter Hough, of the United States National Museum, as a human artifact, was found at an undetermined level in the same cave. The human remains are probably younger than the others. The unidentified fragments include parts of a foot of perhaps a large rodent and a piece of a large bone, probably of a ground sloth.

Three of the birds—a dove (*Chaemepelia*), an ani (*Crotophaga*), and a petchary (*Tolmarchus*)—are now found in the Republic. The fourth, *Tyto ostologa*, is a very remarkable extinct gigantic barn owl, represented by the head of a metatarsus and other fragments. Evidently this bird was the marauder that brought into the caves the rodents whose bones are found there in such large numbers. Some of these rodents are so large that no living owl of the Republic could handle them.

Aside from the interesting discovery of the unknown gigantic owl, the remains obtained from the excavations increase our knowledge of the extinct early Quaternary mammalian fauna of the West Indies. Although no carnivores or ungulates have yet been found, the known fauna is becoming more and more diversified with each exploration. The extinct Haitian mammals support Miller's suggestion¹ that the West Indian early Quaternary mammals descended directly from a South American fauna probably not older than Miocene. This suggestion harmonizes with the view that during late Miocene time the West Indian lands were more extensive than now and probably were directly connected with Central America, and that they were separated into islands during Pliocene time.

¹ Miller, G. S., Jr., op. cit., p. 4, 1916.