THE MIOCENE AND RECENT MOLLUSCA OF PANAMA BAY*

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INTRODUCTION

The material studied has been in the Paleontological collection of Columbia University for several years. The label on the material reads as follows: "Brought up by marine dredge from depths varying from 10 ft. to 40 ft. in the mud at the mouth of the Rio Grande near La Boca about one mile from the mainland in Panama Bay." It was apparently collected by Mr. Donald F. MacDonald in 1907, formerly Geologist of the Canal Commission, and sent by him to Columbia University. The material has been partially identified by Dr. J. J. Galleway and Mr. S. W. Lowman in 1923. I discovered that this collection is a mixture of Lower Miocene and Recent shells, for the collector was unable to keep them separate under the circumstances. The faunas of the two horizons which are separated and the relative abundance of each species are as follows:—

LOWER MIOCENE SPECIES

1. *Arca dariensis* Brown and Pilsbry
2. *Arca cf. pennelli* Gabb
3. *Arca cf. pitteeri* Dall
4. *Arca (Scapharca) golfoyaguensis* Maury
5. *Cancellaria harrisi* Maury
6. *Cancellaria laevescens* Guppy
7. *Cardium* sp.
8. *Cardium parvulum* n. sp.
9. *Clementia dariaea* Conrad
10. *Conakia orbicularis* Linne
11. *Conus imitator* Brown and Pilsbry
12. *Corbula silirostris* n. sp.
13. *Corbula cf. collazica* Maury
14. *Corbula glypta* n. sp.
15. *Corbula cf. sivistiara* Adams

*A thesis submitted for the degree of M. A. in Columbia University.
16. *Crassitelliites rudis* n. sp.
17. *Crepidula plana* Say
18. *Crepidula cf. plana* Say
19. *Distoritix gatunensis* Toula
20. *Drillia zooki* Brown and Pilbry
21. *Drillia limonetta* Olsson
22. *Lucina cf. callozoensis* Hubbard
23. *Marginella cf. cinceraea quadriplicata* Böse
24. *Marginella evax* n. sp.
25. *Melongena mengeana* Dall
26. *Metula cancellata* Gabb
27. *Myrtacea limoniana* Dall
28. *Natica guppyana* Toula
29. *Natica youngi* Maury
30. *Ostrea sp.*
31. *Patella caliculus* n. sp.
32. *Patella calix* n. sp.
33. *Pecten cf. circularis* Sowerby
34. *Pecten filiformis* n. sp.
35. *Pecten (Amusium) luna* Brown and Pilbry
36. *Pecten reliquus* Brown and Pilbry
37. *Phacoids hispaniola* Maury
38. *Phos costatus* Gabb
39. *Pitaria acuticosirata* Gabb
40. *Pitaria laboreana* Maury
41. *Polinices stanislas-meunieri* Maury
42. *Solariam gatunense* Toula
43. *Strombina elegans* n. sp.
44. *Strombina laevistriata* n. sp.
45. *Strombina tenuilineata* n. sp.
46. *Tellina cibaoica* Maury
47. *Tellia costracana* Olsson
48. *Tellina panamaensis* n. sp.
49. *Tellina tenuilineata* n. sp.
50. *Terebra cracilenta* n. sp.
51. *Terebra gausapata laevisca* Maury
The undescribed species are not easy to place in the proper horizon, because the Miocene fossils are well and beautifully preserved, and most shells of the two horizons are equally fresh. I tentatively separate them upon these criteria: (1) species most closely resembling described forms, (2) the degree of their freshness in comparison with other collections, and (3) by the range of other species which were attached to the shells.

On application of the above criteria there seems to be little doubt the shells belong to two horizons, Gatun formations and Recent. The number of species of each group shows that the Recent sea mud does not extend very deep, and that it lies unconformably on Lower Miocene.

RECENT SPECIES

1. *Cardium parvulum* n. sp.  
2. *Cardium procerum* Sowerby  
3. *Cardium* sp.  
4. *Crepidula plana* Say  
5. *Crepidula cf. plana* Say  
6. *Drillia inequistriata* n. sp.  
7. *Oliva callosa* n. sp.  
8. *Oliva cf. litterata* Lamark  
9. *Ostrea* sp.  
10. *Patella caliculus* n. sp.  
11. *Pecten circularis* Conrad n. var.  
12. *Pecten cf. latiauritus fucicobes* Dall  
13. *Potamides mete* n. sp.  
15. *Raeda maxima* n. sp.  
16. *Triton cf. barthelemeyi* Bernardi  
17. *Tapes staminea* Conrad

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SYSTEMATIC DESCRIPTION

PHYLUM MOLLUSCA

Class PELECYPODA Goldfuss

Family ARCIDÆ Dall

Genus ARCA Lamarck

ARCA cf. PENNELLI Gabb

Plate 1, Fig. 1.

Arca pennelli Maury, Bull. Amer. Paleo., Vol. 5, No. 29, 1917, p. 177, pl. 29, fig. 8.

Shell inequilateral, very oblique; amphidetic area wide; beaks distant, conspicuous; hinge line transversely dentate, with many small similar teeth; surface sculptured by 35 squarish plicæ with concentric impressed lines making beads of the plicæ on the marginal part of the shell.

Height, 42; length, 52 mm.

OCCURRENCE: Formation Santo Domingo.

HORIZON: Gatun formation.

ARCA cf. PITTECERI Dali

Plate 1, Fig. 2.


Shell small, upper and basal margin subparallel, beaks small, at the anterior about one-fourth of the length of the valve; surface sculptured by 30 squarish plicæ beautifully beaded by the impressed concentric lines; interspaces narrower than plicæ, marked by fine concentric striations. Ligament area narrow, lanceolate, marked by two curved grooves.

Height, 12; length, 17 mm.

OCCURRENCE: Gatun Stage, Costa Rica

HORIZON: Gatun formation.

ARCA DARIENSIS Brown and Pilsbry

Plate 1, Figs. 3, 3a.


Shell long, upper and basal margin subparallel; beaks small, at the anterior two sevenths of the length; valve slightly unequal, the left surpassing the other along the basal margin; surface sculptured by 31 radial, squarish plicæ; interspaces considerably wider than the plicæ, marked by numerous fine,
concentric lamellæ; toward the ends of both valves the plications widen and are divided by a median groove, on both sides of which the plicæ become nodulose. Left valve closely nodulose at the lower part, short, scaly near the beaks. Sulcus shallow; ligament area narrow, lanceolate, marked by two or three curved grooves. Interior radially striate, the margins crenulate.

Height, 16; length, 32 mm.

**Occurrence**: Gatun formation, Isthmus of Panama.

**Horizon**: Gatun formation.

**Arca (Scapharca) Golfoyauquensis** Maury

Plate 1, Fig. 4.


Shell inequilateral, oblique; lunule depressed; cardinal area sculptured by diverging curved grooves; surface sculptured by 38 squarish plicæ, beaded by concentric impressed lines; posterior broad and anterior narrow, hinge line long, with numerous vertical teeth, oblique at both ends.

Height, 34; length, 49 mm.

**Occurrence**: Zone H (Lower Miocene) Ric Cana at Caimito, Santo Domingo.

**Horizon**: Gatun formation.

Family **Ostreidae** Lamarck

Genus **Ostrea** Linné

**Ostrea**, sp.

Plate 1, Fig. 5.

This is a young shell. It is small, thin and elongate, with variable outline, broadly attached to some foreign body; the shell margin bends abruptly up at a right angle. The beak is obscurely denticulate.

**Horizon**: Gatun formation.

**Ostrea**, sp.

Plate 1, Fig. 6.

This shell is young, small, obscurely denticulated, wider than long, outline variable, outer margin strongly upturned and sharply folded. The two specimens are broadly attached to the recent Triton shells, and the margin abruptly bends up at a right angle.

**Horizon**: Recent.
Bulletin of the Geological Society of China

Family PECTINIDAE Lamarck
Genus PECTEN Müller

PECTEN RELIOUUS Brown and Pilsbry

Plate 1, Fig. 7.


The valves are gently convex towards the beaks; the right valve is somewhat more convex than the left. There are about 24 plicæ on the right valve which have very deep sloping sides, and are parted by interspaces wider than the ribs. Over all these, there is a fine concentric sculpture of delicate lamellae which remains much more prominent in the interplical spaces. The anterior ear is nonplicate.

Height, 58; width, 60 mm.

Occurrence: Gatun formation, Panama Canal Zone.

Horizon: Gatun formation.

PECTEN CIRCULARIS Sowerby

Plate 2, Figs. 9, 9a.


Valves subequal about as long as high, very convex, inequilateral, the posterior part of the disk being somewhat obliquely produced; margins sharply serrate. The right valve has 19 to 21 flat-topped plicæ, with sides steeply sloping; the interspaces are much narrower than the plicæ, sculptured by obsolete, wavy lines of growth; hinge line about two-thirds the length of the shell; ears equal in length; anterior ear with four faint plicæ and numerous imbricating incremental lines; byssal notch deep, with more faint radials on the lower half. Left valve darker in color than the right, with sharp, concentric laminae on its disk. Cardial crura well developed. Color pattern from light to dark brownish red.

Height, 44; width possibly 49; diam., 22 mm.

Horizon: Recent.
Pecten cf. Circularis Sowerby

Plate 1, Fig. 8


This shell is somewhat longer than high, subequivalved, biconvex, being somewhat obliquely produced posteriorly; margins more or less sharply serrate; sides being straight and sloping at a steep angle. There are 19 to 21 prominent squarish, flat-topped plicae, ornamented with looped incremental lines near the periphery of the disk; interspaces very much narrower than the plicae flat, ornamented by a dense fringe of fine, sharp, concentric lamellae; hinge line more than one half as long as the disk; anterior ear is somewhat longer than the posterior, and ornamented by low ridges and numerous imbricating concentric lines; posterior ear nearly rectangularly truncated; byssal notch of medium size.

Length, 40; diameter, 22 mm.

HORIZON: Probably Gatun formation.

Pecten Fililextus n. sp:

Plate 2, Fig. 10

Shell of medium size, biconvex, inequilateral. Right valve with 19 low, flat-topped plicae, have sides gently sloping; interspaces narrower than the plicae, with fine, sharp, imbricating lamellae. Posterior ear slightly notched, anterior nearly rectangularly truncated. Hinge line longer than one half of the length. This species differs from the Recent *P. circularis* by its more prominent concentric striations.

Height, 38; length 36; diam., 18 mm.

HORIZON: Probably Gatun formation.

Pecten cf. Latiauritus Fucicolus Dall

Plate 2, Fig. 11


Shell slightly longer than high, subequivalved, inequilateral, slightly convex; disk oblique, sides nearly straight; margins rough; 15 low, rounded, wide plicae, sculptured, with obsolete concentric laminae on the disk; ears unequal, posterior one much longer than the anterior, nearly rectangularly truncated, byssal notch deep, with five prominent radials on both ears, with
concentric lamellæ, hinge line about two-thirds of the length; no sinus between the posterior ear and the disk; surface crossed by zigzag streaks of white.

Height, 43; width, 45 mm.
HORIZON: Recent.

**Pecten latiauritus** Conrad *Splendens* n. var.
Plate 2, Fig. 12.

*Pecten latiauritus* Rogers, *The Shell Book*, p. 417

Shell slightly longer than high, subequivalved, slightly convex, inequilateral; disk oblique to the hinge line; sides nearly straight; margins rough. Left valve with 14 plicæ prominent, rounded; interspaces almost equal to the plicæ, sculptured by numerous fine concentric lamellæ; hinge line longer than two-thirds the length of the disk; posterior ear longer than the anterior, the former nearly rectangularly truncated, the latter deeply notched, each sculptured by fine radials with numerous concentric lines. Shell brownish red.

This species differs from *P. latiauritus* Conrad var. *fucicolus* Dall in its fine thread-like concentric striations.

Height, 22; length, 23 mm.
HORIZON: Recent.

**Pecten latiauritus** Conrad *Indentus* n. var.
Plate 2, Fig. 13.

Shell slightly longer and high, subequivalved, slightly convex, inequilateral, the disk being somewhat oblique to the hinge line; sides nearly straight; margins serrate. Right valve with 14 squarish plicæ and flat interspaces equal to the plicæ sculptured by fine, prominent concentric lamellæ; hinge line longer than two-thirds the length of the disk; posterior ear longer than the anterior, the former nearly rectangularly truncated, the latter deeply notched, each sculptured by about five radials with concentric imbricating lamellæ.

This species differs from the above two varieties in its squarish plications.

Height, 21; length, 22 mm.
HORIZON: Recent.

**Pecten (Amusium) Luna** Brown and Pilsbry
Plate 2, Fig. 14.

Shell subcircular, slightly convex, ears comparatively small, depressed below the plane of the valve and separated by a ledge; surface, smooth, with faint growth line and very fine radial striae. Internal surface sculptured with paired plicæ and equal interspaces.

**OCCURRENCE:** Gatun formation, Isthmus of Panama

**PECTEN (AMUSIUM) sp.**

Plate 3, Fig. 15.

Shell rather small, rather flat, smooth with faint growth line; internally sculptured by paired ridges.

**HORIZON:** Gatun formation.

**Family CRASSATELLIDÆ Dall**

**Genus CRASSATELLITES Kruger**

**CRASSATELLITES RUDIS n. sp.**

Plate 3, Fig. 16.

Shell solid, attenuated anteriorly; umbos small, depressed; resilifer present; hingeplate heavy, flat, with two cardinal teeth in each valve; lateral teeth present, one posterior present; adductor impressions deep, pallial line simple. Surface sculptured by numerous, concentric, nodulose lamellæ which become prominent ridges near the umbo. This feature is very characteristic.

Height, 31; length, 47 mm.

**HORIZON:** Gatun formation.

**Family LUCINIDÆ Fleming**

**Genus LUCINA Brugier**

**LUCINA cf. CALLOZOENSIS Hubbard**

Plate 3, Fig. 17.


Shell lenticular, transversely elongated, surface with prominent growth lines. This specimen has been crushed.

Height, 38?; length 49; diam., 27 mm.

**HORIZON:** Gatun formation.

**Genus CODAKIA Scopoli**

**CODAKIA ORBICULARIS (Linné)**

Plate 3, Fig. 18.


*Codakia orbicularis* Maury, Bull. Amer. Paleon., No. 29, 1917, p. 202, pl. 35. Fig. 1.
Shell of medium size, rounded posteriorly and anteriorly; beaks small; surface rather scaly, sculptured by many radial plicae, alternating with finer threads especially on the posterior end, anterior with numerous, fine, concentric lamellae.

Height, 33; length, 39 mm.

**OCCURRENCE:** Lower Miocene, Camito, Santo Domingo.

**HORIZON:** Gatun formation.

**Genus MYRTAEA Turton**

**MYRTAEA LIMONIANA Dall**

[Plate 3, Fig. 19.]

Myrtaea limoniana Dall, Trans. Wagner Free Inst. Sci. Vol. 3, pt. 6, 1903, p. 1358, pl. 52, Fig. 10.—Olsson, Bull. Amer. Paleo., No. 39, 1922, p. 221, pl. 32, Fig. 11, 23.

Shell small, thin, and slightly convex, surface sculptured by fine, thin and sharp, elevated, concentric lamellae, slightly nodulose; beaks small and pointed; lunule more smooth than the rest of the surface.

**OCCURRENCE:** Gatun Stage, Port Limon, Costa Rica.

**HORIZON:** Gatun formation.

**Genus PHACOIDES Blainville**

**PHACOIDES (LUCINISCA) HISPANIOLA Maury**

[Plate 3, Fig. 20.]

Phacoides hispaniola Maury, Bull. Amer. Paleo. No. 29, 1917, p. 204, pl. 35, fig. 4.

Shell thin, subcircular, slightly convex, beaks small, acute, directed forward. On the umbo, only concentric lines are shown; the center of the valve is sculptured by radial plicae and concentric lines, marked by minute spinose beads on the intersecting places of the two sets of sculpture, the primary radial plicae alternate with two or three fine secondary striae which disappear towards the beaks. Hinge line normal with two strong lateral teeth and one cardinal tooth.

Height, ?; length, 9 mm.

**OCCURRENCE:** Gatun Stage, Port Limon, Costa Rica.

**HORIZON:** Gatun formation.

**Family CARDIIDAE Fischer**

**Genus CARDIUM Linneé**

**CARDIUM cf. PROCERUM Sowerby**

[Plate 3, Fig. 21.]

Li: Miocene & Recent Mollusca of Panama Bay

Shell very convex, nearly equilaterial, rounded oval. Slightly higher than long. Umbos prominent, incurved, turned slightly forward. Surface marked by 24 radiating squarish plicæ with fine concentric lamellae. Two cardinal teeth, one anterior and one posterior in each valve. No lunule or escutcheon present. Ligament external. Adductor impressions very shallow.

Height, 47; length, 43 mm. 
HORIZON: Recent. 

**CARDUM PARVULUM** n. sp. 
Plate 3. Fig. 22. 

Shell less convex than that preceding, nearly equilateral, slightly longer than high. Umbos incurved, turned slightly forward. Surface marked by 24 radiating plicæ, somewhat sharp, interspaces narrower than the plicæ, with fine concentric lamellæ. 

This specimen is characterized by its small size, and differs from *C. procerum* Sow. in its oblong form, but it might be a young shell.

Height, 12; length, 14 mm. 
HORIZON: Probably Recent. 

**CARDIUM** sp. 
Plate 3. Fig. 23. 

An internal mold, showing the internal sculpture of the genus. 
HORIZON: Gatun formation. 

Family **VENERIDÆ** Leach 
Genus **CLEMENTIA** Gray 

**CLEMENTIA DARIENA** (Conrad) 
Plate 4, Fig. 24, 

*Moretrix dariena* Conrad, Pacific R. R. Report, V, p. 328, pl. 6, Fig. 55. 

Shell thin, large, oblique, inequilateral; beaks prominent; surface sculptured by concentric ridges which become low, imbricating lamellae on the umbo, some of the ridges sometimes discontinuous. 
Height, 56; length, 58; and diam., 33 mm. 
OCCURRENCE: Gatun formation, Costa Rica and Santo Domingo. 
HORIZON: Gatun formation, 

Genus **VENUS** Linne 

**VENUS EBERGENYII** Böse 
Plate 4, Fig. 25,
Shell subtrigonal, inequilateral, anteriorly rounded, posteriorly angular, ornamented with high concentric ridges which die out gradually into low lamellae towards the umbo; on the ridges obscurely striated vertically, between the ridges covered by many lamellae; umbo rather small; lunule depressed, minutely striated; posterior area prominent, striated.

Height, 17; length, 29 mm.

OCCURRENCE: Paso Real near Tuxtepec, Cax., Mex.

HORIZON: Gatun formation.

**Venus walli** Guppy

*Plate 4, Figs. 26, 26a.*


Shell subtrigonal, inequilateral, anteriorly rounded, posteriorly angular, sculptured by numerous small, close radiating pliculae, interrupted by high concentric crenulate ridges which are higher and closer towards the ventral margin; umbo rather small; lunule impressed, minutely striated, circumscribed by a sharp groove; posterior cardinal area prominent, striated.

On the disk the pliculae are distinctly paired; but on the umbo, the concentric ridges die out gradually into lamellae, and the pliculae are evenly interspaced.

Height, 42; length, 55 mm.

OCCURRENCE: Lower Miocene, Manzanillo, Trinidad

HORIZON: Gatun formation.

**Genus Tapes** Megerle

**Tapes staminea** Conrad

*Plate 4, Fig. 27.*


Shell rounded posteriorly and anteriorly; beaks small but prominent; surface sculptured by 50 uneven radial plicae, beautifully beaded at some portions; with numerous concentric impressed lines on the ribs, interspaces narrow, with the concentric, imbricating lamellae. Lunule slightly nodulose.

Height, 12; length, 19 mm.

HORIZON: Recent.
Genus PITARIA Roemer

PITARIA (LAMELLICONCHA) ACUTICOSTATA Gabb

Plate 4, Fig. 28.


Shell of medium size, oval triangular; anterior rounded, sculptured by many concentric ridges and with faint radial striae.

Height, 31; width, 41 mm.

OCCURRENCE: Zone G, Lower Miocene, Santo Domingo.

HORIZON: Gatun formation.

PITARIA (LAMELLICONCHA) LABREANA Maury

Plate 4, Fig. 29.


Shell small, elongate, oval, anterior rounded, rather compressed, sculptured by many concentric round-edged lamellae which die out gradually towards the beaks; beaks small.

Height, 2r; length, 27 mm,

OCCURRENCE: Brighton, Trinidad.

HORIZON: Gatun formation.

Family TELLINIDÆ Deshayes

Genus TELLINA Linm.

TELLINA CIBAIOICA Maury

Plate 4, Fig. 30.


Shell medium in size, very highly polished; shallowly sulcate posteriorly; right valve has two lateral teeth. Surface sculptured by very fine, impressed lines obsolete posteriorly, and marked by exceedingly fine close radial striae.

Height, 27; length, 45 mm.

OCCURRENCE: Lower Miocene, Rio Cana at Caimito, Santo Domingo.

HORIZON: Gatun formation.
Tellina costaricana Olsson

Plate 4, Fig. 31.


Shell rather small, depressed; beaks small and inconspicuous about the middle of the shell so that the anterior and posterior ends are of nearly the same length; posterior wide and rounded; the anterior narrower and less rounded at its extremity; sides nearly straight, surface sculptured by even concentric lines which are slightly lamellate on the posterior-dorsal margin.

Height, 22; length, 38 mm.

OCCURRENCE: Gatun Stage, Banana River, Costa Rica.

HORIZON: Gatun formation.

Tellina panamanensis n. sp.

Plate 5, Fig. 32.

Shell medium in size, inequilateral, beaks small, posterior end rounded and wide, the anterior less wide and round, surface sculptured by concentric, imbricating lamellae which are very prominent, and marked by numerous close radial lines which only can be seen under a lens.

This species is related to T. costaricana Olsson, but differs from it by its prominent concentric, imbricating lamellae.

Height, 27; length, 43 mm.

HORIZON: Gatun formation.

Tellina tenuilineatus n. sp.

Plate 5, Fig. 33.

Shell medium in size, possibly nearly equilateral, beaks depressed, small, posterior wide and rounded; surface sculptured by slightly wavy concentric impressed lines, with very fine close radial lines.

This species is characterized by its nearly equilateral form and especially its slightly wavy concentric impressed lines.

Height, 30 mm.; length?

HORIZON: Probably Gatun formation.

Family Psammobiidae Dall
Genus Psammobia Lamarck
Psammobia sp.
Plate 5, Fig. 34.

Shell inequilateral, posterior wide and rounded, anterior less wide but
still rounded; beaks small but prominent, hinge line rather long; surface sculptured by numerous fine lamellae with fine, close, radial striae.

This specimen is related to Recent *P. mexima*, but it is medium in size and not as fresh as recent shells.

**Height, 37; length, 46 mm.**

**HORIZON**: Probably Gatun formation.

**Family MACTRIDÆ Gray**

**Genus RAETA Gray**

**RAETA MAXIMA, n. sp.**

Plate 5, Fig. 35.

Shell rather large, anterior rounded, beaks small; surface sculptured by concentric ridges, more than 40 in number, some of the ridges discontinued and marked by broader, concentric ridges internally, resilifer present.

This shell is closely related to *R. canaliculata* Say but differs in its ridge-bounded escutcheon, and larger shell.

**Height, 86; length, 74 mm.**

**HORIZON**: Recent.

**Family CORBULIDÆ Fleming**

**Genus CORBULA Lamarck**

**CORBULA cf. COLLAZICA Maury**

Plate 5, Figs. 36, 36a.


Shell oval triangular, rather small, anterior end rounded and the posterior produced, truncated obliquely, surface sculptured with many fine close set, even, concentric ridges, alternating with linear interspaces.

**Height, 16; length, 23 mm.**

**HORIZON**: Gatun formation.

**CORBULA ALTROSTRIS n. sp.**

Plate 5, Fig. 37.

Shell inequilateral, very convex; beaks small but prominent; very short scaly at the middle part; surface sculptured by numerous concentric lamellae.

This species is related to *C. chilthyana* Adams but differs in its prominent umbo.
CORBULA GLYPTA n. sp.
Plate 5, Fig. 38, 38a,

Shell rather small, thin, oval triangular, inequilateral, posterior rounded, and anterior angular, truncated obliquely; beaks small; depressed transversely cross the valve. Surface sculptured by numerous fine lamellæ; lunule impressed.

This species is related to *C. kjoeriana* Adams, but differs in its depressed shell.

Height, 13; length, 24 mm.

HORIZON: Probably Gatun formation.

CORBULA cf. SWIFTIANA Adams
Plate 5, Fig. 39.

*Corbula swiftiana* Adams, Bull. of U.S. Nat. Mus. No. 37, 1889, pl. 2, fig. 5.

Shell inequilateral, convex, posterior somewhat angular, anterior rounded; beaks small; surface sculptured by numerous fine concentric lamellæ, slight lamellæ posteriorly.

Height, 25; length, 31 r.m.

HORIZON: Gatun formation.

Class GASTROPODA Snails
Subclass STREPTONEURA Spengel
Order ASPIDOBANCHIA Schweigger
Family PATELLIDÆ Carpenter
Genus PATELLA Linné
PATELLA CALIX n. sp.
Plate 5, Fig. 40.

Shell cup-shaped, oval, depressed conical, with subcentral apex. Surface sculptured by the primary alternating with several secondary radial plicæ, and with concentric ridges. The concentric sculpture on intersecting the radial, raises into beads.
Li: Miocene & Recent Mollusca of Panama Bay

HORIZON: Probably Gatun formation.

PATELLA CALICULUS n. sp.

Plate 6, Fig. 41.

Shell small, cup-shaped, oval, depressed conical, with sub-central apex. Surface sculptured by the primary plicae alternating with several secondary radial plicae, and with concentric ridges. The concentric sculpture on intersecting the radial, raises a row of beads surrounding the apex. Apex depressed.

This species is characterized by its sculpture and a few plicae.

HORIZON: Probably Recent.

Family SOLARIIDÆ Chenu

Genus SOLARIUM Lamarck

SOLARIUM GATUNENSE Toula

Plate 6, Fig. 42.

Solarium gatunense Toula, Jahr. der Geol. Reich. 1909, p. 692, pl. 25, (1), fig. 3.

Shell depressed conical, narrowly and deeply umbilicate; whorls angular, aperture somewhat equilateral. Surface sculptured by spirals with beaded and granulated character, and becoming obsolete on the later whorls so the spirals become smooth except for growth-lines.

Height, 26; width, 36 mm.

OCCURRENCE: Gatun formation Panama Canal; Costa Rica.

HORIZON: Gatun formation.

Family CAPULIDÆ Cuvier

Genus CREPIDULA Lamarck

CREPIDULA PLANA Say

Plate 6, Fig. 43, 44.


Shell flat, elongate, apex marginal; platform covering about half the length of the shell. The Gatun specimens are small.

HORIZON: Two shells belong to Gatun formation (fig. 43) and one Recent (fig. 44).
CREPIDULA cf. PLANA Say

Plate 6, Fig. 45.

Shell elongate, apex marginal, not enrolled; platform covering about half the length of the shell. The shell is very much distorted instead of flat; otherwise it fits this species perfectly.

HORIZON: Probably Recent.

Family NATICIDÆ Forbes

Genus NATICA Scopali

NATICA GUPPYANA Toulou

Plate 6, Fig. 46.


Shell with short spire and large body whorl; aperture large, semicircular, expanded, broad round anteriorly. Surface sculptured by even, wide and deep sulcations, which cross the face of the whorl from its upper suture to the umbilicus.

Height, 21; width, 16 mm.

OCCURRENCE: Gatun, Banana River, Costa Rica.

HORIZON: Gatun formation.

NATICA YOUNGI Maury

Plate 6, Fig. 47, 47a

Natica youngi Maury, Bull. Amer. Paleo., No. 29, 1917, p. 135, pl. 23, figs. 11, 12.

Shell subglobular, with short spire and large body whorl; aperture subcircular; whorls 5, rounded; surface smooth except for growth lines; posterior callus of inner lip thickest at the angle of the aperture; umbilical callus coiled on the umbilicus wall near the base, leaving the upper part of the umbilicus open.

Height and width, 24 x 18, 40 x 30 mm.

OCCURRENCE: Lower Miocene, Caimito, Santo Domingo, Costa Rica and Chiapas.

HORIZON: Gatun formation.
Li: Miocene & Recent Mollusca of Panama Bay

Genus POLINICES Montfort

POLINICES STANISLAS-MEUNIERI Maury

Plate 6, Fig. 48.


Shell oval, with short and conical spire and large body whorl which make together five and a half rounded whorls; body whorl very slightly concave in front of the suture, others evenly rounded; aperture semicircular; inner lip with a thick posterior callus extending half of the distance from the angle of the aperture to the base, and concealing the upper part of the perforation; the callus is then reduced to half its width by a rectangular truncation.

Height, 36; width, 28 mm.

OCCURRENCE: Lower Miocene, Santo Domingo; Gatun formation, Banana River, Costa Rica.

HORIZON: Gatun formation.

Family TURRITELLIDÆ Gray

Genus TURRITELLA Lamarck

TURRITELLA GATUNENSIS Conrad

Plate 6, Fig. 49.


Shell turreted, surface sculptured by spiral threads, crossed by bending transverse lines, the upper, surface of each whorl very much excavated. Aperture subcircular. The base smooth.

Height, ?; width, to mm.

OCCURRENCE: Ballast Point, Isthmus of Panama.

HORIZON: Gatun formation.

Family CERITHIIDÆ Menke

Genus POLAMIDES Brogt.

POTAMIDES META n. sp.

Plate 6, Fig. 50,

Shell turreted, with epidermis, aperture with faint canal; surface sculptured by spiral lines and crossed by longitudinal threads, at the intersect-
ing places of the two sets of sculpture, marked by beads; and marked by wide separated, strong, ridges.

This species is related to *P. sacrata* Gld., but differs from it in its less acute spire and its thickened outer lip.

Height, 32; length, 9 mm.

**HORIZON:** Probably Recent.

**Family COLUMBELLIDÆ Troschel**

**Genus STROMBINA Mörch**

**STROMBINA LAEVISTRIATA n. sp**

*Plate 6, Fig. 51.*

Shell fusiform, solid, with slender, conical spire, a little attenuated above, elsewhere smooth in outlines; whorls eight, nearly flat; surface sculptured by fine, close, spiral, and longitudinal ribs, with an impressed spiral groove just below the suture. On the body whorl there are longitudinal wrinkles, denticulated within. Aperture narrow and rather short; varix prominent. Anteriorly there are spiral grooves.

This species is related to *S. cyphonotus* Pilsbry and Johnson, but differs in size and ornamentation.

Height, 25; width, 10 mm.

**HORIZON:** Probably Gatun formation.

**STROMBINA ELEGANS n. sp.**

*Plate 6, Fig. 52.*

Shell fusiform, with slender, conical spire; surface smooth, with longitudinal wrinkle on the surface of the outer lip, a small, strong varix present. At the base there are spiral grooves. Surface ornamented by beautiful, purple, wavy streaks.

This species is characterized by its slender form and its purple, wavy streaks.

**HORIZON:** Recent.

**Family NYCTILOCHIDÆ Dall**

**Genus TRITON Montf.**

**TRITON cf. BARTHELEMYI BERNARDI**

*Plate 7, Figs. 53, 53a.*

Shell fusiform, spire moderate, high shoulder angle rather sharp; inner lip thickened internally and notched, outer lip expanded; whorl 7; protoconch smooth. Surface sculptured by 5-7 uneven, spiral bands with many lower, longitudinal riblets.

Height, 74; width, 44 mm.

HORIZON: Recent.

Genus DISTORTRIX Link.

DISTORTRIX GATUNENSIS Toula

Plate 7, Fig. 34.

DISTORTRIX gatunensis Toula, Jahrbuch der Geol. Reich., 1909, p. 700, pl. 25 (1) fig. 10. Shell fusiform, spire moderately high, aperture with thickened outer lip and open, slightly bent canal. Operculum horny with marginal nucleus, varix present. Surface sculptured by spirals and longitudinal ribs, with beads at the intersecting places of the two sets of sculpture. At the base there are spiral grooves.

Height, 52; width, 24 mm.

OCCURRENCE: Gatun formation, Panama Canal.

HORIZON: Gatun formation.

Family BUCCINIDÆ Troschel

Genus PHOS Montf.

PHOS COSTATUS gabb.

Plate 7, Figs. 55, 55a.


Shell bucciniform, turriculate; spire sharp, elevated; aperture wide, short, with open, bending canal. Whorls ornamented with prominent, longitudinal folds, and spiral threads and sulci; denticulated within.

Height, 25; greatest diam., 15 mm.

OCCURRENCE: Lower Miocene, Santo Domingo.

HORIZON: Gatun formation.

Genus METULA Adams

METULA CANCELLATA Gabb

Plate 7, Fig. 56.


Shell elongate-oval, with epidermis; spire moderately high, aperture
rather narrow, with short notch. Surface sculptured by many wider, spirals and longitudinal riblets, but less in number than \textit{Metula gabbi} Brown and Pilsbry. The second and the third whorls separated by a deep groove; the protoconch is lost. The spirals pass the longitudinal folds. Under a microscope the secondary longitudinal riblets can be seen.

Height, 38; width, 12 mm.

\textbf{OCCURRENCE:} Lower Miocene, Santo Domingo, Panama Canal Zone, and Costa Rica.

\textbf{HORIZON:} Gatun formation.

\textbf{Genus \textit{MELONGENA} Schum}

\textbf{\textit{MELONGENA} (\textit{PUGILINA}) MENGEEANA} Dall

\begin{itemize}
  \item \textit{Solenostria menggeana} Dall, Wagner Free Inst. Sci., Vol. 3, p. 122, pl. 9, Fig. 1.
  \item \textit{Melongena menggeana} Böse, Bol. Ins. Geol. Mex., 1906, p. 40, pl. IV, Fig. 1.
\end{itemize}

Shell fusiform, small, bulbous nucleus lost, only six sculptured whorls remained, the last whorl enlarged very much, with transverse folds on the surface, 12 on the last whorl, beginning near the suture and continuing over the periphery, becoming obsolete on the base of the whorl; the incremental lines are also somewhat alternated in strength and quite distinct; the spiral ridges, sharp, even, crossed the folds and descend into the interspaces, again with two spiral threads on each side of the ridges, the ridges being weaker on the canal. Aperture elongated; the throat strongly lirate.

Height, 29; diam., 18 mm.

\textbf{Geological range:} This species was only described from the Pliocene beds of Florida and other localities.

\textbf{HORIZON:} Gatun formation.

\textbf{Family \textit{VOLULIDÆ} Gray}

\textbf{Genus \textit{MARGINELLA} Lamarck}

\textbf{\textit{MARGINELLA EVAX} n, sp.}

\begin{itemize}
  \item Plate 7, Fig. 58.
\end{itemize}

Shell small, oblong, widest at the upper third of the length. Spire conical, short, and so enveloped that the suture is blended. The outer lip is broad, straight, thickest outside, incurved and not denticulated, and dilated near the lower end. Columella bears four folds.
This species is related to *M. gatunensis* Brown and Pilsbry, and *M. leander* Brown and Pilsbry, and differs from both in its proportion of dimensions and from the former by its lack of dentation on the inner side of the outer lip.

Height, 27; diam., 13 mm.

**HORIZON:** Probably Gatun formation.

*MARGINELLA* cf *CINERACEA QUADRIPLICATA* Böse

*Marginella cineracea quadriplicata* Böse, Bol. Inst. Geol. Mex., No 22, 1906, p 42, pl. 5, fig. 1

Shell small, oblong, spire conical, short, and so enveloped that the sutures blend. The outer lip thin, without any thickened part; the inner lip bears four folds. Aperture open, somewhat straight, abruptly but slightly dilated at the lower end.

Height, 20; width, 8 mm.

**HORIZON:** Probably Gatun formation.

**Family OLIVIDÆ** d’Orbigny

**Genus OLIVA** Martyn

*OLIVA* cf. *LITTERATA* Lamarck

*Oliva litterata* Lamarck, Ann. du Mus. XVI, p. 315.—Martini and Chemnitz, Sys. Concho Cabinet, V, 1888, p. 64, pl. 15, Fig. 1-8.

Shell rather small, elongate, beautifully ornamented by zigzag brown streaks, widest at the upper half of the length. Spire conical, short; with a narrow canaliculate suture. The outer lip broad. The inner has sixteen implications. Aperture narrow and long, with an outwardly reflected callus anteriorly. Canal short.

Height, 26; width, 7 mm.

**HORIZON:** Recent.

*OLIVA CALLOSA* n. sp.

*Oliva callosa* n. sp.

*Plate 7, Fig. 61.*

Shell solid; spire very low, with a narrow canaliculate suture; surface ornamented by zigzag reddish-brown streaks and with growth lines. The
outer lip broad, the inner has about 16 implications. Aperture open and long, with an outwardly reflected callus anteriorly. Canal short.

This species differs from O. mariae Durros in its low spire.

Height, 28; width, 19 mm.

HORIZON: Recent.

Family CANCELLARIIDÆ Adams

Genus CANCELLARIA Lamarck

CANCELLARIA HARRISI Maury

Plate 7, Fig. 62.

Canc4laria htrvisi Maury. Bull. Amer. Paleo., No. 29, 1917, p. 64, pl. 10, figs. 9, 10.

Shell fusiform, 8 whorls, the first two smooth, on the third ribs and spirals appear; the latter increase from striæ to flat narrow bands, on the last one alternating with finer secondary and tertiary spirals; on crossing the ribs, at the shoulder are nodulose, on the body whorl ribs 14, on the earlier whorls the ribs are more numerous. Columella triplicate, the lower fold bordering the anterior canal. Aperture open; sharp keel on the base.

Height, 34; diam., 29 mm.

OCCURRENCE: Lower Miocene, Caimito, Santo Domingo.

HORIZON: Gatun formation.

CANCELLARIA LAEVESCENS Guppy

Plate 8, Fig. 63.


Shell thick, ovate, spire concellated by numerous equidistant ribs and close spiral ridges, the ribs broader and highly elevated; whorls 6 in the present specimen, the body whorl slightly more than two-thirds of the height of the shell, nearly smooth except with growth-lines, decussated by low distinct ridges, the latter becoming quite obsolete near the aperture except the upper part. Columella strongly folded with two very prominent plaits; callus thick spreading; outer lip denticulated within; canal short and twisted.

Height, 30; width, 17 mm.

OCCURRENCE: Lower Miocene, Santo Domingo.

HORIZON: Gatun formation.
Li: *Miocene & Recent Mollusca of Panama Bay*

Family **TEREBRIDAE** Adams

Genus **TEREBRA** Lamarck

**TEREBRA GAUSAPATA LAEVIFASCIOLA** Maury

Plate 8, Fig. 64.


Shell small, very slender, elongate. Each whorl sculptured by a subsutural band about a quarter the length of the whorl, a deep sulcus beneath the subsutural fasciole, beneath which there are 6 to 7 spiral, low bands crossed by higher, longitudinal wider-separated riblets.

Height, 44; greatest diam., 10 mm.

**OCCURRENCE:** Lower Miocene, Cercado de Mao, Santo Domingo

**HORIZON:** Gatun formation.

**TEREBRA GATUNENSIS** Maury

Plate 8, Fig. 65.

*Terebra gatunensis* Maury, Bull. Amer. Paleo., No. 29, 1917, p. 31, pl 4, fig. 5

Shell turreted, slender, with an acute spire. Each whorl sculptured by a subsutural band about a quarter the width of the whorl, marked off by a furrow, and beneath which five or six spiral cords; and with many fine, longitudinal growth-lines which bend a little at the furrow. Columella twisted, with sharp keel at the back.

Height, 44; width, 9 mm.

**OCCURRENCE:** Lower Miocene, Cercado de Mao, Santo Domingo.

**HORIZON:** Gatun formation.

**TEREBRA MACROSPIRA** n. sp.

Plate 8, Fig. 66.

Shell long, slender; whorl 17 (this specimen is a decollated one); surface sculptured by arcuate, longitudinal riblets, very low at the last six whorls, and passing into sharp defined arcuate riblets upward. Columella not plicated, but a sharp keel at the base.

This species differs from *T. sulcifera* Sowerby in its ornamentation.

Height, 91; diam., 18 mm.

**HORIZON:** Gatun formation.
TEREBRA CRACILENTA n. sp.
Plate 8, Fig. 67.

Shell slender, with acute spire, ornamented by subsutural band about a quarter of the width of the whorl marked off by a furrow, beneath which four stronger spirals and two weaker spirals which intersecting with radial longitudinal riblets, rises into very prominent beads on the subsutural band and the four upper spirals, and especially prominent on the fourth spiral.

This species is related to T. gatunensis Maury, but differs in ornamentation.

Height, 45; diam., 10 mm.
HORIZON: Gatun formation.

TEREBRA TENUIS n. sp.
Plate 8, Fig. 68.

Shell slender, with acute spire, ornamented by a subsutural band about a quarter of the width of the whorl, marked off by a furrow, beneath which are four spiral bands, which intersecting with radial longitudinal riblets, rises into prominent beads; below the four bands are one to two faint bands.

This species differs from T. gausapata laefasciola Maury in its ornamentation and more radial riblets.

Height, 46; width, 10 mm.
HORIZON: Gatun formation.

Family TURRITIDÆ Adams

Genus DRILLIA Gray

DRILLIA LIMONETTA Olsson
Plate 8, Fig. 69

Drillia limonetta Olsson, Bull. Amer. Paleo., No. 39, 1922, p. 70, pl. 5, Fig. 10.

Shell small, solid, whorls from eight to nine; surface sculptured by moderate strong ribs which on the spiral whorls pass from suture to suture but are only slightly flexed near the upper suture; on the body whorl, ribs 11, which are much enlarged and outer lip thickened; the ribs do not reach the canal; and marked by a few spiral threads, and covered by fine, irregular threads which are nearly obsolete on the upper portions of the whorls but
Li: Miocene & Recent Mollusca of Panama Bay

are strong on the base and the canal; aperture subelliptical with a short, bended canal, denticulated within the outer lip.

Height, 31; width, 10 mm.

OCCURRENCE: Gatun Stage, Port Limon, Costa Rica.

HORIZON: Gatun formation.

DRILLIA ZOOKI Brown and Pilsbry

Plate 8, Fig. 70.


Shell small, with long and arcuate spire, aperture narrow and short. Surface sculptured by prominent longitudinal folds, \( II \) on the last whorl, below the fasciole below the suture; on the folds crossed by spiral lines. On the body whorl, the folds gradually die out, only spiral lines ornamented with canal at the base.

Height, 27; greatest diam., 7 mm.

OCCURRENCE: Gatun formation, Isthmus of Panama.

HORIZON: Gatun formation.

DRILLIA INAEQUISTRIATA n. sp.

Plate 8, Fig. 71.

Shell slender and long, the last whorl occupying over half the height of the shell, aperture narrow and rather long, with canal at the base. Beneath the fasciole below the suture, surface ornamented by prominent folds, rather irregular, and crossed by spirals.

This species is characterized by its slender form and close folds.

Height, 55; width, 9 mm.

HORIZON: Probably Recent.

Family CONIDÆ Adams

Genus CONUS Linné

CONUS IMITATOR Brown and Pilsbry

Plate 8, Figs. 72, 72a.

Conus imitator Brown and Pilsbry, Bull. Amer. Paleol., No. 39, 1922, p. 45, pl. 3, Fig. 39.

Shell conical, moderate high spire, rather flat; aperture narrow and long; shoulder angle rather sharp, whorls slightly concave between the sutures; surface sculptured by 3 or more faint raised spirals and strongly arcuate.
growth-lines; the last whorl with faint spirals above and with about 14 spiral grooves at the base.

Height, 17; width, 11 mm.

OCCURRENCE: Gatun Stage, Costa Rica.

HORIZON: Gatun formation.
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Map of the Panama Bay

From map issued by the Isthmian Canal Commission

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