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Reports on Fossil Mollusca of Molokai and Maui

By JENS MATHIAS OSTERGAARD
UNIVERSITY OF HAWAII

LOCATION OF DEPOSITS

During a period of eight days, December 1935 and January 1936, I investigated fossiliferous marine deposits on the islands of Maui and Molokai. One day was spent on Maui, where such deposits are scarce and seven days on Molokai in a study of fairly large areas of richly fossiliferous beds. The study was made at the suggestion of Harold T. Stearns, geologist, U. S. Geological Survey, and the field work was financed by the Survey.

The marine rock studied on Molokai is within about one and a half miles of the town of Kaunakakai, which is on the leeward shore. This marine rock is best exposed in stream beds, where running water from rain storms has removed the basaltic detritus from its surface and worn away much of the limestone. Between the stream beds, the limestone is exposed in many places beneath talus of basaltic boulders and gravel at altitudes of more than 200 feet above sea level. Fossil mollusks were collected at an elevation of about 195 feet above the sea.[1]

On Maui, the marine rock is exposed in small patches in stream beds at Target Range Gulch, Olowalu, about six miles southeast of Lahaina, on the leeward side of the island. These deposits are mostly fine beach breccia of corals and shells of mollusks, firmly cemented with lava fragments of the talus slope in which lie the stream beds.[2]

[1] Stearns, H. T., Pleistocene shore lines on the islands of Oahu, Maui, Hawaii: Geol. Soc. Am., Bull. 46, p. 1953, 1935.

[2] Loc. cit., p. 1932.

Limestone Horizons

On Molokai, an alluvial coastal plain approximately one half mile wide, skirts the shore at Kaunakakai. From this plain the boulder strewn basaltic flows of the main range of the island rise gently. About one and a half miles west of Kaunakakai close to Coconut Grove, Kalamaula Stream and its tributaries cut well-defined stream beds in calcareous marine rock.

A brief description of each site with a list of fossils is given in order of horizons.

Ten-foot horizon

In the highly fossiliferous, firmly cemented calcareous beach breccia near the mouth of Kalamaula Stream the following mollusks were found:

Gastropoda

- Conus omaria Hwass
- Cymatium pileare (Linnaeus)
- Cypraea helvola Linnaeus
- Mitra ticaonica Reeve
- Modulus tectum (Gmelin)
- Natica marochiensis (Gmelin)
- Trochus intextus Kiener
- Turbo intercostalis Menke
- Turbo sp.
- Turris amicta E. A. Smith

Pelecypoda

- Antigona reticulata (Linnaeus)
- Arca helblingii Chemnitz

A Turbo found at this horizon is not known to live in Hawaii. Because of their fragmentary state, the four specimens collected have not yet been identified. Also at this horizon is a marine deposit of considerable extent. The rocks are so firmly cemented and the fossils so difficult to remove that only two gastropods, *Conus ceylonensis nanus* Broderip and *Turbo intercostalis* Menke were obtained.

Fifty-foot horizon

From scattered outcrops of beach rock in the bed of a stream which joins Kalamaula Stream on the west, were taken two gastropods, *Cypraea caputserpentis* Linnaeus and *Turbo intercostalis* Menke and one pelecypod, *Cardium orbita* Broderip and Sowerby.

Seventy-five-foot horizon

In the bed of a stream that enters Kalamaula Stream from the east, marine rock is widely exposed and is continuous for perhaps

500 feet west of the tributary stream. The following fossils were found in the stream bed:

Gastropoda
- Cerithium obeliscus Bruguiere
- Cypraea caputserpentis Linnaeus
- Cypraea helvola Linnaeus
- Cypraea sulcidentata Gray

ONE HUNDRED-FOOT HORIZON

In the bed of the stream that joins Kalamaula Stream on the west at about the 100-foot horizon are small, scattered patches of beach breccia resting on clay and overlain by basalt. From limestone fragments among the boulders one gastropod, *Cypraea helvola* Linnaeus and one pelecypod, *Antigona reticulata* Linnaeus were found.

Two and a half miles east of Kalamaula Stream the marine formation at the 100-foot horizon is well developed and rich in fossils. Three unnamed stream beds which run parallel over the basaltic slope, 500 to 700 feet apart, will be referred to as streams 1, 2, 3 from west to east.

In the stream bed 1, the lower limit of an extensive limestone formation, about 400 to 200 feet in area, is exposed as a firmly cemented beach rock rather poor in fossils. Two gastropods *Natica marochiensis* (Gmelin) and *Turbo intercostalis* Menke were obtained.

The 100-foot horizon passes the lower margin of another extensive marine formation, which as exposed by stream bed 2, consists of a highly fossiliferous beach rock four to five feet thick, resting on basaltic boulders and clay. In it are large basaltic boulders. The following fossils were obtained:

Gastropoda
- Conus abbreviatus Nuttall
- Cypraea helvola Linnaeus
- Cypraea moneta Linnaeus
- Modulus tectum (Gmelin)
- Trochus intextus Kiener
- Turbo intercostalis Menke
- Vexillum aureolata (Swainson)
- Vexillum dermestina (Lamarck)

Pelecypoda
- Antigona recticulata (Linnaeus)
- Jagonia bella (Conrad)
- Trapezium oblongum (Linnaeus)

In the stream bed 3, about 10 feet below the 100-foot level, a highly fossiliferous conglomerate six feet thick rests on clay and is

capped by basaltic boulders. The following fossil shells were found here:

Gastropoda
- Cypraea caputserpentis Linnaeus
- Cypraea helvola Linnaeus
- Strombus maculatus Nuttall
- Trochus intextus Kiener
- Turbo intercostalis Menke

Pelecypoda
- Antigona reticulata (Linnaeus)

ONE HUNDRED AND FIFTEEN-FOOT HORIZON

At an altitude of about 115 feet in stream bed 1, a highly fossiliferous marine conglomerate, about two feet in thickness, overlies the basaltic flows and transported boulders. The conglomerate is firmly cemented and consists of corals and marine gastropods and numerous water-worn fragments of basalt ranging in size from small grains to cobbles a foot in diameter. This is part of an extensive, unbroken formation of which the lower level is on the 100-foot horizon. The following fossils were found:

Gastropoda
- Conus ceylonensis Hwass
- Conus sumatrensis Hwass
- Cypraea helvola Linnaeus
- Cypraea madagascariensis Gmelin
- Modulus tectum (Gmelin)
- Trochus intextus Kiener
- Turbo intercostalis Menke

At stream bed 2 lies the thickest marine rock, about 12 feet, with its upper surface slightly below the 115-foot level. It is highly fossiliferous, but so firmly cemented that fossils are removed with difficulty. It rests on large water-worn basaltic boulders of the stream bed. Three gastropods, *Cypraea helvola* Linnaeus, *Modulus tectum* (Gmelin), and *Turbo intercostalis Menke* and one pelecypod, *Antigona reticulata* (Linnaeus) were collected in the bank of the stream bed at about four feet below the surface. Two gastropods, *Nerita neglecta* Pease and *Turbo intercostalis* Menke, were collected in the bank of the stream bed 10 feet below the surface.

A fourth stream bed lies about 700 feet east of stream bed 3. Marine rock is found in three rather small isolated patches, the lowest of which is about on the 150-foot horizon and extends for about 300 feet along the stream bed. The marine rock is a beach breccia with numerous basaltic pebbles and boulders and rests on basaltic boulders of the stream bed. The following fossils were found:

Gastropoda

Cypraea caputserpentis Linnaeus
Cypraea helvola Linnaeus
Morula dumosa (Conrad)
Trochus intextus Kiener
Turbo intercostalis Menke
Strombus hellii Rousseau

Pelecypoda

Antigona reticulata (Linnaeus)
Pecten sp.

A fragment of a Pecten found here belongs to a species not known to live in Hawaii, but it might be found living elsewhere.

ONE HUNDRED AND THIRTY-FOOT HORIZON

In the stream bed 1, about 250 feet upstream from the 115-foot horizon and at the 130-foot horizon, is a highly fossiliferous marine breccia in the western bank of the stream. It is almost covered with basaltic boulders. The following fossils were found:

Gastropoda

Cerithium columna Sowerby
Cypraea caputserpentis Linnaeus
Morula dumosa (Conrad)
Trochus intextus Kiener
Turbo intercostalis Menke

About 100 feet east of this locality in the bank of a rivulet are a few partly dislodged blocks of fossiliferous marine rock which rest on an alluvial talus. Two gastropods were found, *Trochus intextus* Kiener and *Turbo intercostalis* Menke.

In stream bed 2, about 40 feet from the upper limit of the marine rock in this bed and at an elevation of approximately 120 feet, marine limestone forms a bed four to five feet in thickness and contains basaltic rocks ranging in size from boulders to small pebbles. Here was found *Cypraca tessellata* Swainson.

In stream bed 3, marine rock is exposed in three areas of considerable extent. In the middle area at an elevation of about 140 feet a highly fossiliferous limestone, four to five feet thick, rests on boulders of the stream bed. The following fossils were found:

Gastropoda

Conus flavidus Lamarck
Cypraca carneola Linnaeus
Cypraea helvola Linnaeus
Mitra ticaonica Reeve
Turbo intercostalis Menke

Pelecypoda

Trapezium oblongum (Linnaeus)

ONE HUNDRED AND FIFTY-FOOT HORIZON

This horizon is represented in the stream bed directly west of Kalamaula Stream by a richly fossiliferous beach rock five to six feet thick overlying alluvial soil deposit of the stream bed. The following fossils were found:

Gastropoda

Bursa cruentata Sowerby
Cerithium boeticum Pease
Cerithium columna Sowerby
Cerithium sp.
Conus abbreviatus Nuttall
Conus ceylonensis nanus Broderip
Conus flavidus Lamarck
Conus omaria Hwass
Conus vitulinus Hwass
Coralliophila bulbiformis Conrad
Coralliophila neritoidea Lamarck
Cylindra fenestrata (Lamarck)
Cymatium pileare (Linnaeus)
Cymatium rubiculum (Linnaeus)
Cypraea caputserpentis Linnaeus
Cypraea cicercula Linnaeus
Cypraea helvola Linnaeus
Cypraea isabella Linnaeus
Cypraea madagascariensis Gmelin
Cypraea punctulata Gmelin
Cypraea sulcidentata Gray
Mitra astricta Reeve
Mitra episcopalis (Linnaeus)
Mitra tabanula Lamarck
Modulus tectum (Gmelin)
Morula dumosa (Conrad)
Morula fiscellum (Chemnitz)
Pyramidella sulcata A. Adams
Strombus maculatus Nuttall
Terebra gouldi Deshayes
Trochus intextus Kiener
Turbo intercostalis Menke
Turbo Sp.
Turris amicta E. A. Smith.
Vexillum dermistina (Lamarck)

Pelecypoda

Antigona reticulata (Linnaeus)
Arca ventricosa Lamarck
Cardium orbita Broderip and Sowerby

The unidentified Turbo belongs to the same species as the four broken shells found at the mouth of the stream on the 10-foot level. *Cylindra fenestrata* (Lamarck) is not known to live in Hawaii but it is reported from the South Pacific and the Philippines.

ONE HUNDRED AND EIGHTY-FOOT HORIZON

In a stream bed joining stream bed 1 to the west, is an extensive outcrop of a fossiliferous conglomerate overlain by basaltic boulders and soil and resting upon the basalt of the stream bed. The following were found:

Gastropoda

Cypraea helvola Linnaeus
Strombus maculatus Nuttall
Trochus intextus Kiener
Turbo intercostalis Menke

About 75 feet farther up stream bed 1 and at an elevation of perhaps 185 feet conglomerate outcrops from beneath the talus. It consists of a small amount of marine material cementing large basaltic boulders and resting, at least in part, on the basal basalt. The following gastropods were found: *Coralliophila neritoidea* Lamarck and *Turbo intercostalis* Menke.

In a side stream bed which joins the second stream bed to the west and about 525 feet from their junction is found a small amount of beach rock from which was obtained a pelecypod, *Arca ventricosa* Lamarck.

Along the third stream bed, at an altitude between 145 and 190 feet above sea level, an uninterrupted marine deposit extends to the west of the stream bed. Exposed in the bank of the stream bed at the 180-foot level is a highly fossiliferous rock four or five feet thick. The following mollusks were found:

Gastropoda

Conus omaria Hwass
Cypraea helvola Linnaeus
Cypraea madagascariensis Gmelin
Cypraea sulcidentata Gray
Turbo intercostalis Menke

Pelecypoda

Arca helblingii Chemnitz
Cardium orbita Broderip and Sowerby
Spondylus zonalis Chemnitz

ONE HUNDRED AND NINETY-FIVE-FOOT HORIZON

The uppermost marine rock, with numerous basaltic pebbles and boulders in stream bed 4, is the highest on the island of Molokai from which marine fossils have been collected. Mollusks found were:

Gastropoda

Cypraea helvola Linnaeus
Morula dumosa (Conrad)
Trochus intextus Kiener
Turbo intercostalis Menke

Pelecypoda

Antigona reticulata (Linnaeus)

The marine rock—a fine beach rock with no recognizable fossils—in the Kalamaula Stream bed near Kaunakakai reaches more than 200 feet above sea level. At somewhat higher elevations scanty amounts of fine beach rock were found in stream beds.

Maui

Marine deposits on Maui were found only at Target Range Gulch at Olowalu, about six miles southeast of Lahaina on the leeward side of the island. Here the marine rock occurs on a lava talus slope and is exposed by stream erosion. A narrow alluvial coastal plain skirts the shore line.

TWO HUNDRED AND THIRTY-EIGHT-FOOT HORIZON

At the uppermost exposure, close to a level station and at an elevation of 238 feet above the sea, is a small amount of beach conglomerate of finely fragmented corals and shells firmly cemented with angular and rounded fragments of lava and resting on the lava talus of the stream bed. In the small fragmentary shells of this beach conglomerate only *Turbo intercostalis* Menke could be identified.

ONE HUNDRED AND EIGHTY-FOOT HORIZON

Where the mouth of a tributary stream meets the main stream (unnamed), a calcareous marine deposit which includes gastropods and madreporarian corals were found. This, like the above formation, rests on a talus of lava. The following gastropods were found: *Columbella turturina* Lamarck, *Modulus tectum* (Gmelin), and *Morula dumosa* (Conrad).

In the main stream bed, opposite the above-described location, a marine conglomerate rests on lava boulders. Here was found *Terebra cancellata columellaris* Hinds.

ONE HUNDRED AND SEVENTY-FOOT HORIZON

In a small marine deposit in the bank of a creek in Target Range Gulch, the shell and coral fragments constituting the rock were so firm that the only recognizable fossils were scarce. The following gastropods were found: *Conus abbreviatus* Nuttall, *Trochus intextus* Kiener, and *Turbo intercostalis* Menke.

In the stream bed from this point down to an elevation of about 30 feet above the sea are scattered patches of marine rock.

FORTY-FIVE-FOOT HORIZON

An extensive marine conglomerate is found in the banks of the stream bed opposite Target Range. It is especially abundant in fragmented lava. The following shells were found:

Gastropoda

Cerithium obeliscus Bruguiere
Conus rattus Hwass
Cypraea helvola Linnaeus
Modulus tectum (Gmelin)
Morula ochrostoma (Blainville)
Strombus hellii Rousseau
Turbo intercostalis Menke

FOSSILS NOT IN PLACE

In Target Range Gulch about 50 feet above sea level was found *Terebra pertusa* Born. At about 30 feet elevation was found *Codakia thaanumi* Pilsbry in a dislodged block of beach conglomerate. *Strombus hawaiiensis* Pilsbry was found on the alluvial plain at the mouth of Target Range Gulch.

CONCLUSIONS

The table of distribution of fossil mollusks of Molokai shows that a great uniformity of species persists from the lowest to the highest horizons—a fact which indicates that the marine deposits of the various horizons are nearly of the same age. This implies a comparatively rapid change in the relation of sea to land.

It seems obvious that the upper formations were first laid down and that as the others followed the retreating ocean, they were subjected to the dissolving and recementing agencies of rain water and to the subsequent action of stream erosion. It also appears that the upward shift of the ocean was much more rapid than the downward shift, since no trace of coral reef is found anywhere and cemented beach detritus rests directly upon the boulders or water worn surface of the stream beds. The three species of mollusks unknown to Hawaii —*Cylindra fenestrata, Turbo* sp., and *Pecten* sp.—suggest a geologic age which might be interpreted as late Pleistocene. The conditions governing the marine formations of Maui appear to be identical to those of Molokai.

FOSSIL MOLLUSCA OF MOLOKAI

GASTROPODA	HORIZONS BY ELEVATION IN FEET ABOVE SEA LEVEL									
	10	50	75	100	115	130	140	150	180	195
Bursa cruentata (Sowerby)	—	—	—	—	—	—	—	×	—	—
Cerithium boeticum Pease	—	—	—	—	—	—	—	×	—	—
Cerithium columna Sowerby	—	—	—	—	—	×	—	×	—	—
Cerithium obeliscus Bruguiére	—	—	×	—	—	—	—	—	—	—
Cerithium sp.	—	—	—	—	—	—	—	×	—	—
Conus abbreviatus Nuttall	—	—	—	×	—	—	—	×	—	—
Conus ceylonensis Hwass	—	—	—	—	×	—	—	—	—	—
Conus ceylonensis nanus Broderip	×	—	—	—	—	—	—	×	—	—
Conus flavidus Lamarck	—	—	—	—	—	—	×	×	—	—
Conus omaria Hwass	×	—	—	—	—	—	—	×	×	—
Conus sumatrensis Hwass	—	—	—	—	×	—	—	—	—	—
Conus vitulinus Hwass	—	—	—	—	—	—	—	×	—	—
Coralliophila bulbiformis Conrad	—	—	—	—	—	—	—	×	—	—
Coralliophila neritoidea (Lamarck)	—	—	—	—	—	—	—	×	×	—
Cylindra fenestrata (Lamarck)	—	—	—	—	—	—	—	×	—	—
Cymatium pileare (Linnaeus)	×	—	—	—	—	—	—	×	—	—
Cymatium rubiculum (Linnaeus)	—	—	—	—	—	—	—	×	—	—
Cypraea caputserpentis Linnaeus	×	—	×	×	—	×	—	×	—	—
Cypraea carneola Linnaeus	—	—	—	—	—	—	×	—	—	—
Cypraea cicercula Linnaeus	—	—	—	—	—	—	—	×	—	—
Cypraea helvola Linnaeus	×	—	×	×	×	—	×	×	×	×
Cypraea isabella Linnaeus	—	—	—	—	—	—	—	×	—	—
Cypraea madagascariensis Gmelin	—	—	—	—	×	—	—	×	×	—
Cypraea moneta Linnaeus	—	—	—	×	—	—	—	—	—	—
Cypraea punctulata Gmelin	—	—	—	—	—	—	—	×	—	—
Cypraea sulcidentata Gray	—	—	×	—	—	—	—	×	×	—
Cypraea tessellata Swainson	—	—	—	—	×	—	—	—	—	—
Mitra astricta Reeve	—	—	—	—	—	—	—	×	—	—
Mitra episcopalis (Linnaeus)	—	—	—	—	—	—	—	×	—	—
Mitra tabanula Lamarck	—	—	—	—	—	—	—	×	—	—
Mitra ticaonica Reeve	—	—	—	—	—	—	×	—	—	—
Modulus tectum (Gmelin)	×	—	—	×	×	—	—	×	—	—
Morula dumosa (Conrad)	—	—	—	—	×	×	—	×	—	×

FOSSIL MOLLUSCA OF MOLOKAI—Continued

	HORIZONS BY ELEVATION IN FEET ABOVE SEA LEVEL									
GASTROPODA	10	50	75	100	115	130	140	150	180	195
Morula fiscellum (Chemnitz)								×		
Natica marochiensis (Gmelin)	×			×						
Nerita neglecta Pease					×					
Pyramidella sulcata A. Adams								×		
Strombus hellii Rousseau					×					
Strombus maculatus Nuttall				×				×	×	
Terebra gouldi Deshayes								×		
Trochus intextus Kiener	×			×	×	×		×	×	×
Turbo intercostalis Menke	×	×		×	×	×	×	×	×	×
Turbo sp.	×							×		
Turris amicta E. A. Smith	×							×		
Vexillum aureolata (Swainson)				×						
Vexillum dermestina (Lamarck)				×				×		
PELECYPODA										
Antigona reticulata (Linnaeus)	×			×	×			×		×
Arca helblingii Chemnitz	×								×	
Arca ventricosa Lamarck								×		
Cardium orbita Broderip & Sowerby		×						×	×	
Jagonia bella (Conrad)				×						
Pecten sp.					×					
Spongylus zonalis Chemnitz									×	
Trapezium oblongum (Linnaeus)				×			×			