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Notes on reef habitats and gastropod molluscs of a
lagoon island at North Male Atoll, Maldives

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North Male Atoll evinces most of the peculiarities characteristic of several Maldivian atolls but not found elsewhere. Its rim, with maximum dimensions of 51 x 37 km, is formed mainly by about 25 faros, small atolls within the larger complex. Also included in the rim are a few single islands partially surrounded by fringing reefs; the largest of these is Male Island, the seat of government. In addition, more than 80 faros and small islands occur within the lagoon. The faros and islands of the rim are separated by about 30 large channels around its entire circumference. The channels are 30 - 150 m deep, i.e. much deeper than typical Pacific atoll channels.

The large size of the channels results from meteorological and hydrographic conditions associated with the regular alternation of northeast and southwest monsoons. The resulting increased oceanic circulation in and through the lagoon is the proximate cause of the faros and inner or lagoon islands. The term composite atoll applies to North Male and some other Maldivian atolls because of these features.

Origin of Maldivian Atolls

Although I have held elsewhere (Kohn, 1961) that Darwin's subsidence theory is the best general explanation of the origin of atolls, other processes have probably been more important in determining the present features of the Maldivian atolls. Certain aspects of Maldivian atolls support the antecedent platform theory (Hoffmeister and Ladd, 1944).

Formation of Lagoon Islands

The islands within some Maldivian atoll lagoons probably begin as coral growth on a platform at suitable depth (50-60 m). Growth is enhanced by the unusually large flow of oceanic water through the broad, deep channels, and conditions favor peripheral development of the reef into a faro (see Hoffmeister and Ladd, 1944). As the rim of the faro grows toward the surface, its integrity increases and its lagoon, known as the velu, becomes increasingly protected and a region of sediment deposition. Gradually, the faro is transformed into an island with a fringing reef. As Agassiz (1903) noted, all stages of such transformations may be observed on North Male Atoll.

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Funidu Island

The island studied is not named on charts, and we have transcribed the name given us orally by the inhabitants as Funidu. It is an elliptical island (about 138 x 89 m) just inside the main southeast channel into North Male lagoon and just northwest of a line between the northeast tip of Male Island and the south tip of Hulule Island. It is the unnamed island visited in 1901 or 1902 and described by Alexander Agassiz (1903: p. 43, pl. 9, fig. 2). Agassiz's description of the island is as follows:

"As a type of an inner island, we examined a small well-wooded island which rises in the middle of the southeast passage into North Male with nearly thirty fathoms on either side on it. The island is elliptical, and is placed on the northwestern horn of an elliptical flat which stretches out in a southeasterly direction. The flat slopes very gently to the sea, is edged on the outer rim by a sink forming a shallow ditch of varying width, flanked by coral boulders or masses of beach rock extending as an irregular wall along the greater part of the outer edge of the reef flat. The greatest width of the reef is from two hundred and fifty to three hundred feet. It diminishes gradually in width to the northwestern corner, where the island is steep to. Corals grow in great abundance at a depth of from five to three fathoms upon the steep slopes of the reef flat; they grow with less profusion to six or seven fathoms, where they are separated by wide lanes and patches of sand which eventually cover the whole bottom at a depth of from eight to nine fathoms. From the three-fathom line, they also diminish in number towards the surface and spread over the edge of the flat, which is partly bare at low water; they extend but a short way over it, the greater part of the flat being covered by dead corals overgrown with Nullipores. The sand beaches surrounding the island are steep, from six to seven feet in height. The central part of the island is lower than the beaches which surround it, forming a shallow sink from twelve to eighteen inches or more in depth. Considerable moisture accumulates in this shallow sink, and in the rainy season a pool is probably formed of more or less brackish water. This structure is most characteristic of the islands of the Maldives, whether they occur in the interior of the great sheets of enclosed waters or on the outer rims of the plateaus. The sink has been formed by the washing up of the beaches round a central area, as we have seen it in the Paumotu and elsewhere in other Pacific atolls. Before the vegetation became too dense, beach sand was blown towards the interior and partly filled the central area, until this was prevented by the growth of bushes and shrubs, when the beaches merely increased in height and the sand of the upper ridge of the beach was driven sparingly

towards the centre of the island, or its further passage stopped by the belt of denser vegetation which had come up on the higher parts of the coral sand beach. The island of Male has gradually developed and been formed much in the same manner as this island."

The account describes the island much as we observed it in 1957, except we do not recall that the central portion appeared lower than the uppermost beaches. Perhaps during the intervening 55 years sufficient sand has blown onto the island to eliminate the vestiges of the velu, as apparently happened earlier on Male.

Agassiz's observations of the fringing reef around Funidu are confined to the following note on the corals:

"The corals growing on the slopes of this island are marked for their luxuriance; they grow as abundantly as they do on the sea face of any atoll. This is in striking contrast to their scanty development in the interior of typical lagoons. It can readily be explained from the great depths of the passes and the great mass and purity of the water passing into the interior of the enclosed basin of North Male. . . . The branching corals consist mainly of species of Madreporas, of Pocilloporas, and Milleporas. While the massive corals are usually Astreans, Porites, and the like, Maeandrinae are not common."

With Dr. Willard D. Hartman, I made four trips to Funidu Island, 19-23 September 1957, during the course of the Yale Seychelles Expedition. Notes on habitats and inhabitants were referred approximately to the coordinates indicated in fig. 1, as accurately as could be done in the field (see Kohn, 1956, for method of recording data). The density of symbols in fig. 1 indicates the relative thoroughness of the observations. The gastropod molluscs have been identified from collections of the Peabody Museum of Natural History, Yale University. No attempt has been made to verify further the names used.

On the north side of the island (quadrats B4-B8) the sand beach is narrow and followed seaward by about 12 m of sloping beachrock covered with a thin algal mat, in the intertidal zone. The surface of the beachrock is smooth, but it is marked by depressions, potholes, and crevices. Seaward of this zone at about the tidal datum (0: approximately mean low water springs), the beachrock becomes a very smooth level bench covered with a thin layer of sand. The width of this zone is mainly 7 m or less. Seaward is a wide zone of living corals in very shallow water, the tops of the heads appearing to extend above datum. Mitra litterata Lamarck and other species of Mitra were collected in shallow crevices in the limestone and Trochus flammulatus Lamarck on live coral in the outer zone as well as on inshore beach rock at about 0 - +1' tide level. In B8, some rocks (nature not recorded) extended upward to about +2' and perhaps suggest rather recent elevation.

On the east side of the island, a large tide pool is in C9. The following were collected in C9 and D9 on beach rock exposed at low tide: Thais tuberosa Röding, Nerita histrio L., Engina mendicaria L., Vasum turbinellum L., and Bursa sp.

Quadrats F5-F8 are characterized by a flat, smooth limestone pavement covered by a very thin layer of sand immediately seaward of the rather steep, coarse sand beach. Latirus smaragdula (L.) was ubiquitous on this thin layer of sand. Drupa spp., Morula spp., Peristernia sp., Nassarius sp., and Columbella sp., were also present. Mitra spp. were collected from crevices in the limestone rock. Seaward, the sand-covered bench supports isolated coral heads. The sandy area is gradually reduced and the coral becomes increasingly dense and solid toward the outer edge (G5, G6, H4, H5, H6).

In F7, smooth beachrock slopes offshore at about a 30° angle just offshore from the narrow sand beach. In some areas there are two tiers of beachrock. Latirus smaragdula and Mitra litterata were collected on this beachrock. Offshore portions of the reef on the east side could not be investigated because of the rather heavy surf. There appeared to be much coral rubble and dead coral in this region. Increased abundance of Drupa morum Röding was noted in F7 and is probably correlated with the heavier surf in this region. Morula tuberculata Blainville, not found in calmer areas to the west, was also present. It occurred both intertidally and subtidally; other species collected in this quadrat appeared to be only subtidal. The substratum of F8 is mainly beachrock and closely resembles F7.

A broader sand beach is present on the west side (C3, D3), followed seaward by a broad area of thin sand on smooth, level limestone bench which forms a channel suitable for landing a small boat in C3. Specimens of Turbo argyrostoma L., with epizoic Hipponix sp., Vasum turbinellum, Nassarius graniferus (Kiener), Cerithium sp., Strombus mutabilis Swainson, Polinices sp., Mitra mitra L., Drupa grossularia lobata Blainville, and Peristernia nassatula Lamarck were collected in this area. Seaward (C2, D2, E2) is a zone of dense growing coral. The heads appear to extend several inches above datum, and many species of coral are present. The heads are interspersed with sandy areas containing some rubble, the substrate being at about -2.5'. In some places there is a very gentle slope to the reef edge, which drops off precipitously into blue water (about 90 m acc. Admiralty Chart 66b). Turbo argyrostoma were collected from living coral, their shells often bearing epizoic Hipponix sp. Lambis lambis (L.) occurred on sand under overhanging coral heads, and Atrina sp. occurred buried in sand. Cerithium nodulosum, Cerithium sp., Peristernia nassatula occurred on sand amid living and dead coral; Drupa ricinus (L.), D. grossularia lobata, and Latirus smaragdula on dead coral; and Morula elata Blainville, Thais hystrix L., and Cypraea sp. cf. C. poraria L. on living coral heads. Mitra litterata, Mitra sp., Vasum turbinellum, and a haliotid also occurred in C2, D2, and E2.

Unidentified species of Nassarius and Mitra were collected completely buried in sand under coral rocks in unidentified quadrats.

Conus at Funidu. I am presently preparing a more detailed report on Conus in the Maldives, to be published elsewhere, and will therefore only briefly summarize the occurrence of this genus at Funidu. In all, 199 specimens of 16 species of Conus were collected. Conus was most abundant on beachrock, where average density was about one individual per square meter.

Acknowledgment

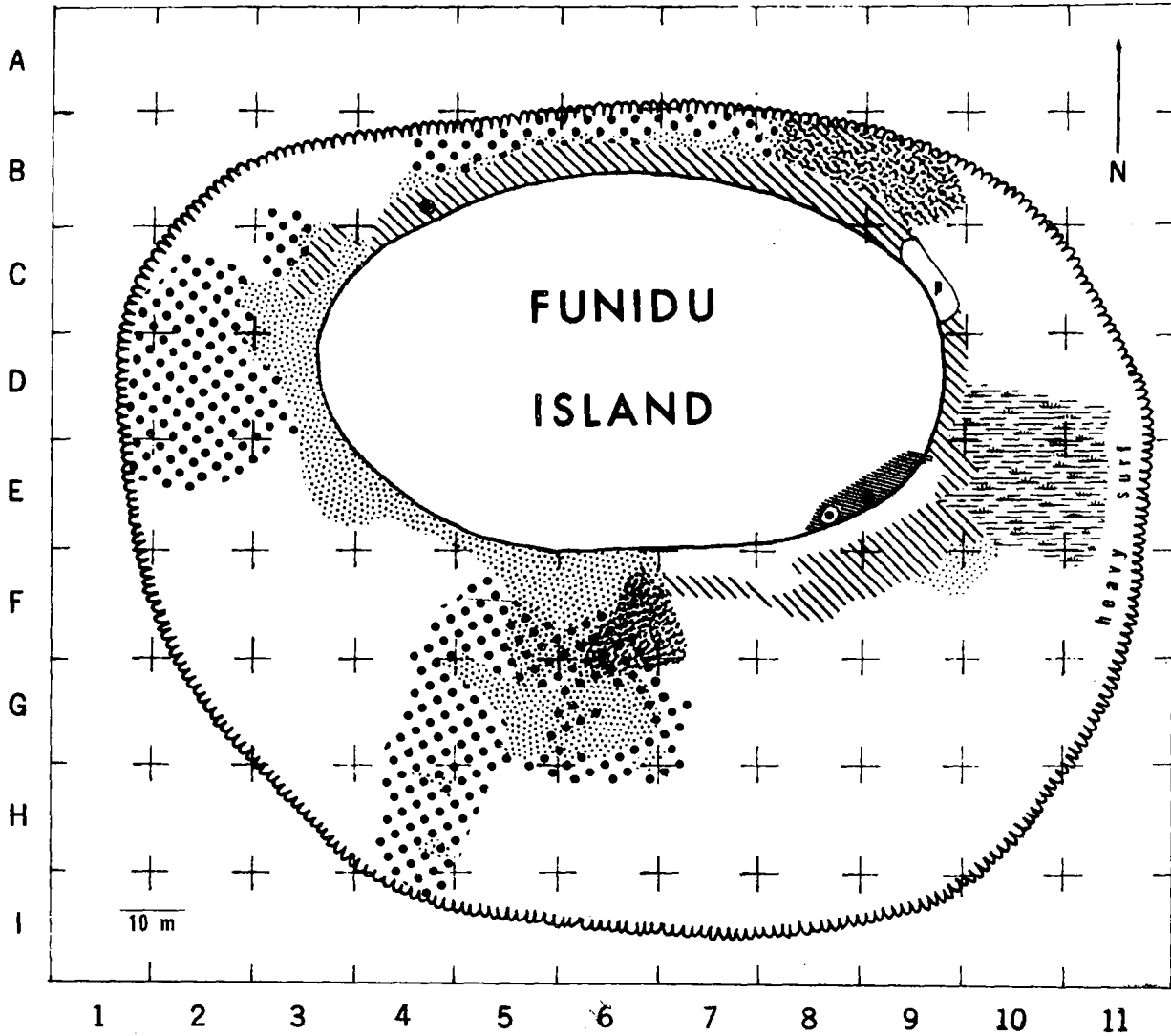
The Yale Seychelles Expedition, during which these observations were made, was made possible by the generosity of Mr. Alfred C. Glassell, Jr.









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Caption for map on following page:

Funidu Island and fringing reef, North Male Atoll, Maldiv Islands (4°10' N, 73°25' E). The substratum of portions of the reef flat examined, and other features, are indicated by symbols. Based on H.O. Chart 5664 and observations by the author, 19-23 September 1957.



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|--|--|---|---|
|  smooth, sloping beachrock with thin layer of algae |  flat, smooth limestone pavement with very thin layer of sand |  living coral heads |  dead coral heads and rubble |
|  coral rubble |  apparently eroding portion of island |  tide pool |  tree stump |