

Tales from Oceanic Islands: The Biogeography of Insular Marine Gastropods from off Brazil

by José H. Leal



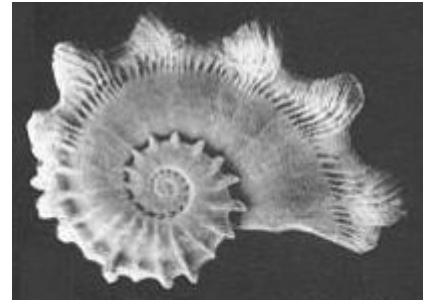
A newly created volcanic island is devoid of life, until it is colonized by organisms from other, geologically older areas. The classical theory of island biogeography discusses how physical factors, such as the surface area of an island, its age, and its distance from the mainland interact to determine how quickly such an island will be colonized and how many species are likely to live there. Other factors besides physical ones are important too. Each particular species has a certain mixture of capabilities and limitations that define its ability to disperse and colonize an island. The study of the processes that make it possible for these shallow water benthic (bottom-living) creatures to cross stretches of deep water and colonize a geologically young oceanic island is a paramount aspect of marine biogeography.

Most true oceanic islands have originated from volcanic activity in the deep ocean floor. As a result of plate tectonics and sea-floor spreading through geological time, weaker regions of the oceanic crust have been punctured sporadically by hot magma from below. Big piles of solidified lava and debris produced in these areas during periods of intensified volcanic activity create true oceanic islands and submerged seamounts. Such islands occur off the coast of Brazil: in the western extremity of the Romanche Trench off northeastern Brazil are the Fernando de Noronha Archipelago and Atol das Rocas; more to the south, in the eastern end of the Vitoria-Trindade Seamount Chain (also known as Martin Vaz Fracture Zone), are the islands of Trindade and Martin Vaz Archipelago. Created since the birth of the Atlantic some 100 million years ago, these islands have formed chains perpendicular to the South American coast. In the case of this particular ocean, the islands and seamounts situated closer to the continent are usually older than those found in the open ocean, a consequence of the local direction of sea-floor spreading.

My dissertation project at the Rosenstiel School of Marine and Atmospheric Science/University of Miami consists of a biogeographical study of the prosobranchs (hard shelled, benthic, or bottom-dwelling, gastropods) from these islands in the southwestern Atlantic Ocean. The main goals of my research are to survey the prosobranchs found in these islands and to attempt to determine why they are there, i.e., how the faunal composition of each island can be determined by the interaction between the physical factors of the island and the capabilities and limitations of the each species present there.

More than 320 species of mollusks live in these islands, over a third the number of species Professor Rios examined in 1985 for the entire Brazilian coast. The mollusks included in my study come from samples I collected, by SCUBA in the shallows and dredging in the depths, as well as from E.C. Rios' collection in the Museu Oceanografico do Rio Grande, Brazil, and from other museum collections worldwide.

The most fundamental (and time-consuming) part of my project is the accurate taxonomic identification of these species, a task I am performing with much help from specialists in the U.S. and abroad. For close examination and illustration of very small shells and protoconchs, I have used extensively the scanning electron microscope (SEM) at the Electron Microscopy Laboratory at the Rosenstiel School of Marine and Atmospheric Science. Figures 1-15 exemplify my SEM micrographs of some of these adult micromollusks, juvenile shells and protoconchs.



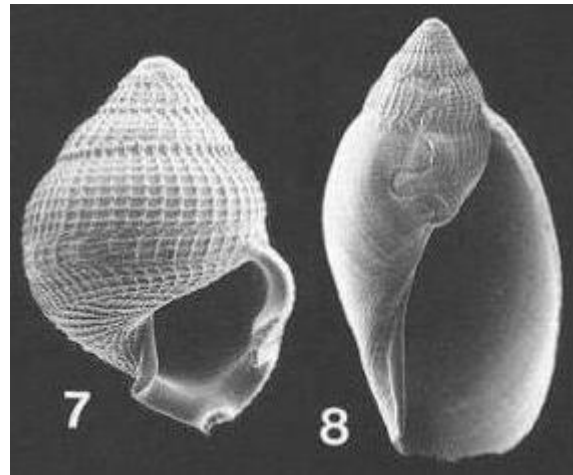
One of the reasons I chose this study of the Brazilian oceanic islands as my dissertation project is that it contributes to a Brazilian federal survey of these islands aimed at establishing marine national parks and natural reserves in these pristine localities. One of them, Atol das Rocas, has already been designated an ecological reserve. Proposals have been forwarded to the Brazilian government suggesting similar procedures for Fernando de Noronha and Trindade Island. Trindade Island has, in fact, recently been spared the threat of construction of a military base.

A basic objective in my project is to investigate the source of the prosobranchs that have colonized the islands, and at the same time to test some propositions in insular biogeography. Another aspect to my study is a computer-assisted comparison of prosobranch faunas among the islands, and between each island and the adjacent Brazilian coastal areas. Special attention is paid to the presence of endemic species on any island or group of islands. Endemism is a delicate subject to approach, considering that a quarter to a fifth of the species involved in the project are unnamed, and that, despite Rios' pioneer efforts, a large part of the Brazilian coastal molluscan fauna is still unknown.

The type of reproductive strategy used by different species may affect faunal composition from island to island. In the development from embryo to adult, some prosobranch species go through a pelagic, or planktonic swimming larval stage. Others undergo direct development, hatching as miniature adults from a brood pouch or egg capsules, and settling down immediately to the life of an adult. The presence of a planktonic larval stage allows a species greater opportunities for dispersal by ocean currents, so that it may colonize distant areas, provided adequate environmental conditions are present, and the arrival of larvae is frequent enough to enable the new population to survive. Larval transport by large oceanic currents occurs in the same way as when seeds and spores of plants are carried by the wind, facilitating the dispersal of these plants from one area to another.

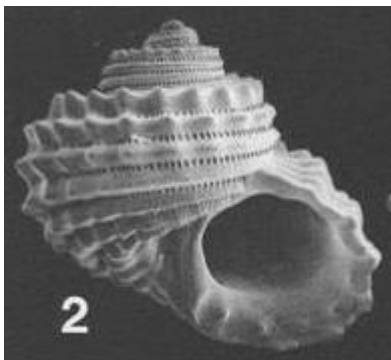
During this free-living, swimming period, a larva can be an active feeder, or planktotrophic, eating microscopic algae and organic particles; or it can be lecithotrophic, nourished only by its own yolk supply. The ability to feed while in the larval stage enables planktotrophic types to last longer than lecithotrophs, thus giving them a larger potential for dispersal, just as lecithotrophs are, in turn, better "dispersers" than direct developers. Isolated, geologically young oceanic islands have a larger percentage of planktotrophic species, or species that evolved from them, than coastal areas or oceanic islands near the coast.

Determining reproductive strategies is an important step in the investigation of a species' relative predominance in the different islands. This is accomplished (1) by direct data from the literature, when life histories are known, (2) through comparisons of the larval shell or protoconch morphology when life history is known only for another, closely related species, and (3) when necessary, by complete inference, using protoconch morphology. Planktotrophic larvae usually build protoconchs with elaborate sculptures and more than two or three whorls. Also, planktotrophic protoconchs are frequently divided into a small, well-defined embryonic shell (protoconch 1) and a larger larval shell (protoconch U). A sinuous double curve in the external lip of the planktotrophic larval shell, called the sinusigerous lip, allows space for the winglike velar lobes of the larva. This sinusigerous lip is visible in the illustration of the larval shell of the widely distributed planktotroph, *Cypraea cinerea* Gmelin, 1791, in Figures 7-8. Lecithotrophic types have a poorly defined embryonic shell; the larval shell has 1.5 to 2 whorls, and no sinusigerous lip. In direct developers the entire protoconch is the embryonic shell.



Dr. P. Bouchet of the Museum National d'Histoire Naturelle, Paris, and I have studied the general distribution of prosobranchs and their types of reproductive strategies in ten seamounts and islands along the Vitoria-Trindade Seamount Chain, and have a paper in preparation. We have found the ratio of planktotrophs to lecithotrophs in both Trindade and Martin Vaz to be just about the same as in the closest continental area, 1,100 km to the west, even though the total numbers of species decreases from the continent towards the open ocean. This fact apparently contradicts observations made in other areas of the world where planktotrophs are relatively more frequent than lecithotrophs in oceanic islands. But the apparent contradiction can be explained by the presence of the chain itself: the submerged but relatively shallow seamounts are usually only 100 km apart, so shorter-lived lecithotrophic larvae probably colonize the seamounts in a stepping-stones fashion, moving in stages from continent to seamount to seamount.

However, in the case of direct developers, there has been a marked reduction in numbers in the easternmost seamounts in the chain (towards the ocean). Groups in which the eggs and juveniles are unusually large, as in the family Volutidae, are completely absent from the chain.



In examining material from Atol das Rocas and Fernando de Noronha, off northeastern Brazil, I am finding that their prosobranch faunas are apparently much richer and more diverse than those of Trindade and Martin Vaz. The warmer equatorial waters and the larger number of habitat types available in these localities, including small coral reefs, probably explain this difference. Endemic species are infrequent, perhaps owing to the relatively smaller distance from the coast, but are present nonetheless; several endemic microprosobranchs have already been examined (e.g., *Parviturbo* sp., Figure 2; "undetermined barleeid,"

Figure 14).

Another curious aspect of oceanic islands is that they can provide relatively stable environments for species or genera that otherwise went extinct in other areas because of some shift in their environment. Possible examples of such differential extinction in my research are *Rissoina indiscreta* Leal & Moore, 1989, from Atol das Rocas and northeastern Brazil, a species apparently closely related to the Indo-West Pacific *R. turricula* Pease, 1861 and to a large complex of fossil (Miocene and Pliocene) species in tropical seas. The tun shell genus *Malea* is known at present only from the Indo-West and Eastern Pacific, and in the Atlantic Ocean only from Atol das Rocas and Fernando de Noronha, but has been reported by Olsson & Petit from the late Miocene and Upper Pliocene of Florida, Venezuela and Colombia. Another significant example is *Neritopsis atlantica* Sarasua, 1973, family Neritopsidae. The family has extensive Paleogene fossil representation, but only two living species are known, one in the Indo-West Pacific and one in the Atlantic Ocean. *Neritopsis atlantica* was described from Cuba, and we have found several recently dead shells of the species in Trindade Island, representing a very odd type of distribution for this relatively large (1.5 cm width) species.



In the end result, my project has also had more general consequences. In allowing me to work with a large number of species and the processes affecting their distribution, I have been led to a better understanding of the origins and relationships of the molluscan fauna in the southwestern Atlantic Ocean.

- [Plate of Figures](#)

Further Reading:

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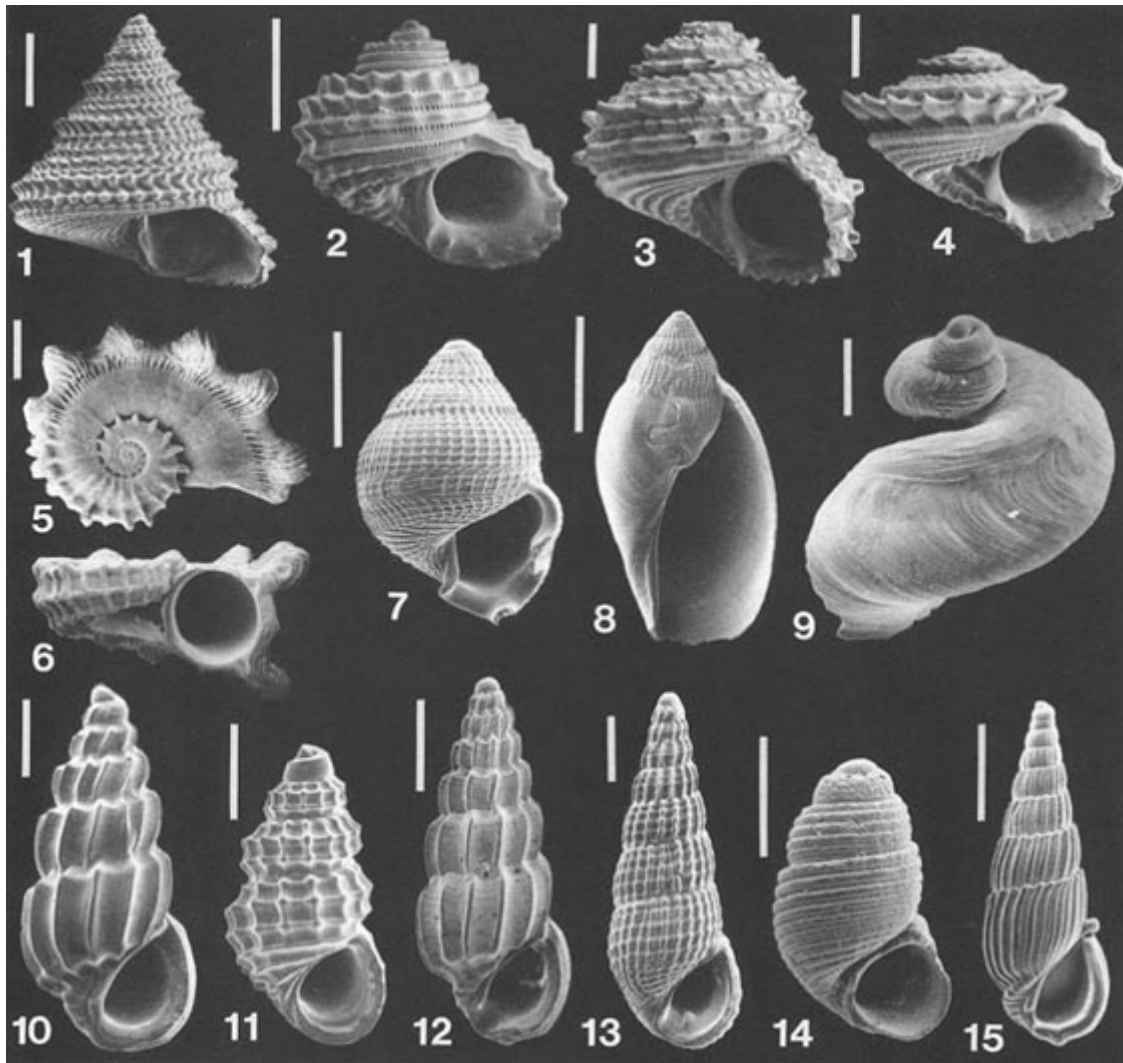
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Caption for original plate:

List of Figures Figure 1. *Calliostoma echinatum* Dall, 1881, juvenile shell, Trindade Island. Figure 2. *Parviturbo* sp., Fernando de Noronha Island. Figure 3. *Arene flexispina* Leal & Coelho, 1985, Martin Vaz Island. Figure 4. *Arene* sp., Trindade Island. Figures 5, 6. *Cyclostrema tortuganum* (Dall, 1927), Jaseur Seamount. Figures 7, 8. *Cypraea cinerea* Gmelin, 1791, Fernando de Noronha Island; 7. larval shell; 8. juvenile shell. Figure 9. *Siliquaria squamata* Blainville, 1827, juvenile shell, continental shelf adjacent to Vitoria Seamount, eastern Brazil. Figure 10. *Rissoina* sp., Vitoria Seamount. Figure 11. *Manzonina caribaea* d'Orbigny, 1842, Fernando de Noronha Island. Figure 12. *Rissoina indiscreta* Leal & Moore, 1989, paratype 23, Atol das Rocas. Figure 13. *Rissoina fenestrata* Schwartz, 1860. Figure 14. Undetermined barleeid, Fernando de Noronha Island. Figure 15. *Folinia bermudezi* Aguayo & Rehder, 1936, Fernando de Noronha Island.

Scale bars for Figures 1-6, 8, 12-13, 15 = 1mm; Figures 7, 10-11, 14 = 0.5mm; Figure 9 = 2mm.

- [back to article](#)

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