

Introduction

New Caledonia: Land of Nickel, World of Corals

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Ouen Island. © P.-A. Pantz

Reef ecosystems are an important part of the coastline of many countries in the intertropical zone. Some of these countries are even made exclusively of coral islands or atolls, such as the Maldives and Chagos archipelago in the Indian Ocean, and the Marshall Islands, Kiribati, Tuvalu and Tokelau in the Pacific Ocean. Coral reefs, and the lagoons they delimit, are like fortifications that shelter and feed a profusion of species. They are highly productive and represent the main source of protein for millions of people, while simultaneously protecting coastlines. In the Western imagination, coral reefs embody the peaceful, turquoise blue waters of the southern seas, their beautiful white sandy beaches and the wonder of brightly colored fish – all of which attract numerous tourists.

Coral reefs are among the few ecosystems to grow and develop on their own substratum. They are built up by the accumulation of calcareous coral skeletons and consolidated by other organisms such as red calcareous algae. They shelter a multitude of different life forms and create a complex network of biological functions and interactions.

Their continuity in time and space critically relies on the ability of these organisms to live, persist and thrive so that the whole structure continues to grow. This is also what contributes to their vulnerability. The increase and extension of reefs is perpetually counterbalanced, not only by physical and mechanical erosion due to tropical storms and cyclones, but also by bioerosion due to organisms that perforate

and erode the calcareous skeletons, breaking them down into debris and sand.

« Reefs are as old as the world ». However, in the past they were built by other organisms, most of which disappeared during major biological extinction periods and different types of reef formations have succeeded one another over geological time. Precambrian stromatolites, built by blue-green algae or cyanobacteria, were replaced during nearly 250 million years by bryozoans, stromatoporoids (a sort of primitive sponge), and primitive corals, most of which disappeared during the great Permian extinction. During the Cretaceous period, reefs were mostly built by rudists, a kind of giant bivalve mollusk, which in turn became extinct, giving way to today's hard corals. After each of these extinctions, it took hundreds of thousands or even millions of years for new reefs to be rebuilt. Traces of an exuberant past life and its high biodiversity can be seen in these ancient fossilized reefs, found on all continents.

Modern reefs, as we know them today, are present in about a hundred countries. Estimates of their surface area vary from one study to another, depending on the methods and criteria used to determine their limits. They occupy only 0.2% of the ocean surface but support the highest levels of marine biodiversity. We know of 35,000 to 60,000 coral reef associated species, but the actual figure is more likely to be between one and nine million. This discrepancy can be explained by our poor knowledge of infinitely small species (bacteria, fungi, microalgae, etc.) and of habitats that are not easily accessible (deep environments, microhabitats, etc.). This exceptional biodiversity is not evenly distributed among the world's reefs however. For example, the Indo-Pacific region is ten times more species rich than the Western Atlantic region, and it is possible to identify a gradual decline in the number of species moving away from the coral triangle, a species hotspot region between the Philippines, Indonesia and Papua New Guinea. For instance, there are about 60 coral species in the reefs of the Western Atlantic, while 500 to 600 species populate those in the Indo-Pacific. In contrast, along the western coasts of South America and Africa, coral reefs are rare or absent due to large freshwater discharge from the Amazon and Congo River basins.

The largest coral reefs are in South East Asia and Oceania. French overseas reefs and lagoons occupy 57,557 km² and rank fourth after Indonesia, Australia and the Philippines. The eight French overseas collectivities host nearly 10% and 20% of the world's reefs and atolls, respectively.

The lagoons and reefs of New Caledonia cover an area of about 40,000 km² and its 1,500 km long barrier reef is the world's longest continuous barrier reef, the second largest after the Great Barrier Reef.

These coral reefs have been used by mankind since its arrival 3,000 years ago. Evidence of this can be seen in the abundant remains of fish bones and shells found in the archaeological sites of New Caledonia. The first scientific collections date back to Captain Cook's expedition in 1774. From then on, the settlement of Europeans in New Caledonia paved the way for early naturalistic explorations and the publication of literature on the archipelago's marine life and coral reefs. Charles Darwin produced one of the first cartographic representations of New Caledonia's reefs, which was executed with remarkable precision for its time. Surprisingly, New Caledonia was not visited by the famous expeditions of the 19th and early 20th centuries that crisscrossed the oceans aboard *L'Astrolabe*, *L'Uranie* or *La Zélée*.

Between 1850 and 1913, Marist missionaries and amateur naturalists such as Montrouzier, Balansa or Vieillard contributed to the early naturalistic collections of New Caledonia, but it is only after the Second World War that the scientific investigation of lagoons and reefs really began. The first biological oceanography studies were signed by Mr. and Mrs. Catala, who undertook the first marine ecology survey with a comprehensive study of the Canards islet coral reef communities, published in 1950.

For 70 years, research dedicated to the reefs and lagoons of New Caledonia continuously expanded and involved many actors including researchers in various disciplines (natural sciences, human and social sciences) and NGOs and stakeholders in charge of the protection and conservation of nature and heritage. An abundant literature, including scientific papers, atlases and collective works,

testifies to the attraction of researchers from all backgrounds and disciplines to the reefs and lagoons of New Caledonia. Their wide variety of habitats and exceptional biodiversity have been acknowledged by UNESCO, which in 2008 registered part of the reefs, lagoons and associated ecosystems on the World Heritage List. Since April 23rd 2014, this natural heritage of exceptional value belongs to the Natural Park of the Coral Sea, the largest French marine protected area.

In this book, you will find the contributions of more than 100 researchers and stakeholders in charge of environmental management, who have devoted part of their time to understanding the role of this extraordinary ecosystem and its interactions with human societies. Through their eyes, we wish to share our astonishment at such a diversity of forms and complex interactions, but also our doubts about the resilience of these ecosystems to global change (human activity, rising temperatures, ocean acidification, etc.). We wish to demonstrate the links that mankind has developed with this ecosystem since its arrival 3,000 years ago and we offer a number of avenues to explore past and present knowledge and practices. We also discuss the current regulations that have been developed to assist in the preservation of this outstanding natural heritage.

Readers will first learn more about the diversity of the reef and lagoon communities and their habitats, which are linked to the archipelago's geological history and maritime environment (part 1). They will then discover that the biodiversity of this ecosystem is characterized by high species richness, as well as rarity and singularity, that each species has its own niche and that each biological function counts (part 2). The book then discusses the range of threats to which reefs and lagoons are exposed, including the impact of global climate changes, and the ways in which they can be resisted (part 3). Authors of human and social sciences then lead us to take a different look at the lagoon, which, in the Kanak culture, is also an invisible world where the memory of ancestors is omnipresent and which, for 3,000 years, has offered New Caledonian men and women more than resources: a place of life and expression (part 4). Finally, with the help of some charismatic species, we outline some conservation challenges and provide an overview of the management, protection and

conservation methods put in place by the provincial and government authorities of New Caledonia, who are in charge of environmental protection and management of the maritime environment (part 5).

We hope that readers will endorse the authors' conviction that managing reefs and lagoons cannot be achieved without taking into account species and spaces, as well as the different forms of knowledge, practices and uses of these environments. We believe that interplay between research and conservation issues is the only way to maintain this universal heritage, the reefs and lagoons of New Caledonia, in good condition for a long time to come.

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