

It worked in the laboratory, and the hope is that it will also work in the open sea. A group of researchers from Rio de Janeiro, Pernambuco and Bahia should start in April the reproduction in tanks of three of the 15 species of corals found in the shallow and warm waters of the Brazilian Northeast. By the end of the year, according to the time schedule of the Living Coral project, the first colonies of corals created in the laboratory should be implanted in the region of Porto Seguro, in the south of Bahia. This repopulation is the newest prospect for recovering coral reefs, the richest and most fragile environment of the planet, which are spread along 3,000 kilometers of the Brazilian coast, from the north of Maranhão to the south of Bahia. Veritable submerged gardens, which

rals – made up basically by a mouth with tentacles and a single cavity, responsible for gas exchanges, digestion and excretion.

On the Coral Coast, the surface of the reefs still inhabited by marine invertebrates varies from 5% to 25% - otherwise, three quarters of the surface of the limestone hills are bare or covered by algae, traditional rivals of the corals. The exuberance of the scenery may, however, be deceptive, because in the shallower water of this region there still live colonies of massive starlet corals (*Siderastrea stellata*), a globe of up to 1 meter in diameter, and of branching fire coral (*Millepora alcicornis*), which are reminiscent of mustard-colored bushes, so called because they cause burns in those who dare to touch their branches. In the deeper waters, colonies are to be found of the large star coral (*Montastrea cavernosa*), the species shown on the following page, whose brown and velvety surface recalls some strange planet full of volcanoes.

Unique species - Even in the better preserved places like the Abrolhos Bank, a region where the archipelago of the same name is to be found, in the south of Bahia, coral cover does not exceed 35% at some few spots – levels similar to those in regions with larger areas of reefs, like the Caribbean and Australia. Although only 15 of the 650 known species of corals grow off the Brazilian shore, the proportion of species that are exclusive to the country is high: seven of them are only found over here, concentrated in a restricted area that corresponds to 0.4% of the world's reefs, according to recently concluded research by Rodrigo Leão de Moura, a biologist from Conservation International Brazil's unit in Caravelas, Bahia.

Studies published in the *Science* magazine of August 15, 2003, details the seriousness of the international situation of coral reefs, protected since 1975 by the Convention on International Trade in Endangered Species of Wild Fauna and Flora, of which Brazil is a signatory. In one of the articles, marine biologist Terence Hughes, from James Cook University, in Australia, estimates that 30% of the reefs are already seriously damaged, and another 60% should be lost by 2030, because of a process of alteration to the delicate balance of these marine environments, intensified last century by excessive fishing, pollution, agriculture, devastation of coastal forests and the climatic changes of the planet.

One of the signs that caught the attention of international groups of researchers to the state of conservation of the corals was a phenomenon called bleaching, easily identified for making the corals lose color. Observed in reefs from regions thousands of kilometers distant from each

OCEANOGRAPHY

Oasis in danger

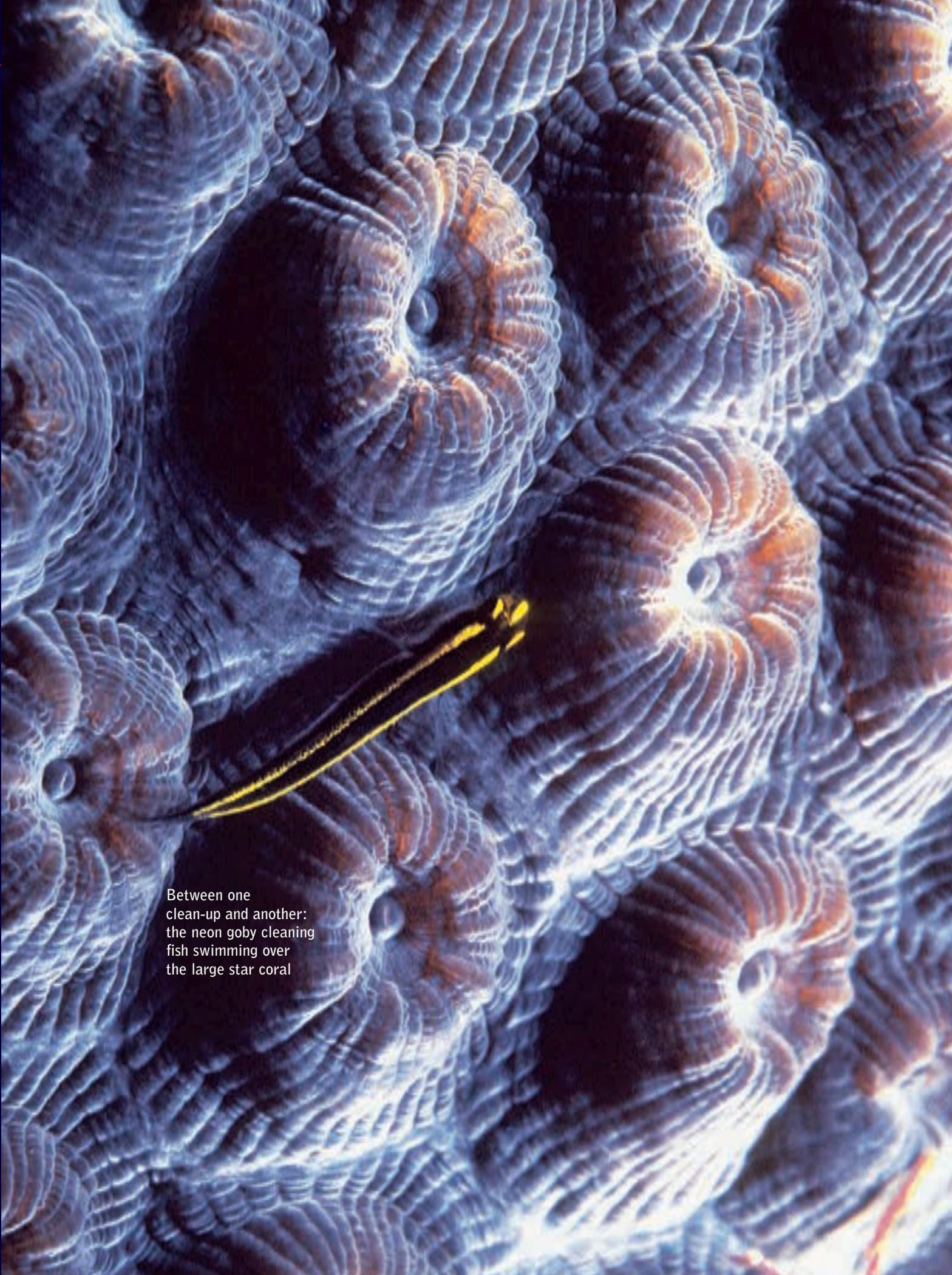
Biologists plan the repopulation of the coral reefs, one of the richest environments in the world, threatened by excessive fishing

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Published in January 2004

blend tones of green, red, blue, white and brown, in the format of a brain, a fan, a globe or a bush, the reefs are the ecosystem with the second greatest diversity of species in the world, behind only the tropical forests. Environments of extraordinary importance to life on land and at sea, they are under threat all over the world.

The first national survey showed that the state of conservation of the coastal reefs in Brazil – the only ones in the South Atlantic – is worrying, even in protected areas like the Coral Coast, a long sequence of beaches with white sands bordered by coconut trees and a swimming pool blue sea. In front of these beaches there is the most extensive formation of reefs in Brazil, which extends for 130 kilometers, from the municipality of Tamandaré, in the south of the state of Pernambuco, to Paripueira, in the north of Alagoas. The reefs are limestone hills covered by millions or billions of extremely simple invertebrate animals – the co-



Between one
clean-up and another:
the neon goby cleaning
fish swimming over
the large star coral

other, such as off the coast of Australia and in the Indian Ocean, bleaching is an indication of the influence of the changes in the climate and of the increase in the temperature of the oceans on the corals. There is evidence that, in some cases, a rise of just 1 degree in the temperature of the water already causes the death or expulsion of microscopic algae (zooxanthellae) that live in the inside of the corals in a system of interaction with reciprocal benefits: the corals shelter the zooxanthellae, and, in exchange, these algae provide them with nutrients and oxygen and assist in the formation of the limestone skeleton. But when the environment is altered beyond a limit, the substances produced by the zooxanthellae become toxic for the corals, which then eliminate the

Reefs suffer with small variations in temperature

algae responsible for their typical colors. As a consequence, they lose color and may die, depending on the quantity of algae they lose. The specialists warn of the risk of the corals di-

appearing in the next few decades, should nothing be done to contain the increase in the temperature of the planet, deriving, in good measure, to the emission of carbon dioxide and other pollutants in the atmosphere.

On the Brazilian coast, bleaching has now been identified at spots on the coast distant up to 2,000 kilometers from each other. The most serious situation occurred in Maracajaú, Rio Grande do Norte, where 12% of the colonies showed white patches, according to this first national survey, coordinated by Beatrice Padovani Ferreira, an oceanographer from the Federal University of Pernambuco (UFPE), with funding from the Ministry of the Environment's Conservation and Sustainable Use of Brazilian Biological Diversity Project (Probio). Coral bleaching has also arisen, to a lesser degree, in Abrolhos, on Atol das Rocas, in Fernando de Noronha and on the Coral Coast – a strong indication that it really is part of a phenomenon on a world-wide scale, according to Beatrice. In spite of this suspicion, the cause of the problem in

Brazil is still not known for sure. “The coral bleaching observed in Abrolhos in 2003 may be linked to the excess of sunlight”, ponders Clovis Barreira e Castro, a specialist in corals from the National Museum of the Federal University of Rio de Janeiro (UFRJ) and one of those taking part in this study, presented in September to the Ministry of the Environment. Castro raises this suspicion, because it rained little and the waters were very clear the major part of the time during the year in which this episode of coral bleaching was observed.

Fish disappeared - The effects of the damages to the reefs do not appear just in the eyes of the specialists. They also arise in daily life, particularly of those who live on the coast or enjoy their seaside holidays there. Even in the most refined restaurants on Boa Viagem beach, the most feted in Recife, it is almost impossible to find the tasty steaks of grouper (*Epinephelus spp* or *Mycteroperca spp*). Traditional inhabitants of the Brazilian reefs, these fish, and the itajara (jewfish or *Epinephelus itajara*) as well – a big brown fish with black patches, up to 3 meters long and 400 kilos in weight, which it is forbidden to fish in Brazil – may indicate how the health of the corals is faring. When these carnivorous fish like the groupers began to get scarce, the fishermen started to catch smaller varieties and, more recently, herbivorous fish like the parrotfish (*Scarus trispinosus*), which weigh no more than 20 kilos. Voracious eaters of algae, parrotfishes are beginning to replace both groupers and itajaras on the menus of Brazilian restaurants, as well as being exported to Europe and the United States. With parrotfish being fished, the algae that they used to feed on have started to proliferate freely on the reefs and to occupy the space of the corals. “This change in preferential species for fishing began five years ago on the coast off Bahia and has been disseminated over the whole of the Northeast”, explains Beatrice, a specialist in fish population dynamics.

She has managed to mobilize ten biological and oceanographic researchers from four states – Pernambuco, Rio de Janeiro, Bahia and Ceará – who saved time and energy by relying on the voluntary work of 30 fishermen and di-

vers, trained to assist in the collection of the data, following the methodology for analysis of Reef Check, an international organization that monitors the health of the reefs in 150 countries. This was how, in a relatively short time – from March 2002 to March 2003 –, they assessed five of the seven largest Brazilian reef formations, all in the region of the Northeast, the only one in the country with shallow warm waters, suitable for the growth of corals. In groups of two or three divers, armed with pencils and boards for writing underwater, they took note of the species of corals, fish and other marine animals that live in the 52 sample areas of 400 square meters in Abrolhos, in Bahia; on the Coral Coast, between Alagoas and Pernambuco; on Fernando de Noronha, Pernambuco; on Atol das Rocas and Maracajaú, both in Rio Grande do Norte.

The most serious situation is of the reefs located at less than 1 kilometer from the coast, as in the region of Porto de Galinhas, in the south of Pernambuco. “There, the state of the corals in the reefs closest to the beach is terrible”, notes oceanographer Jacques Laborel, from the University of Marseille, in France, the author of one of the most complete descriptions of the Brazilian reefs, done at the end of the 1960s. In October 2002, Laborel returned to Brazil to take part in the commemorations for the 50th anniversary of the Oceanography Department, which he helped to create at the UFPE. He couldn't resist and, at the age of 68, dived into the sea that he had known almost four decades back. Laborel estimated that, close to the beaches, there has been a reduction of 80% in the coral cover of the reefs, compared with what he had observed 40 years before.

“When the damage is great, the reefs are not capable of recovering themselves without assistance”, Castro comments. It is he who is coordinating the project for repopulating the coral reefs, in partnership with Débora Pires, also from the National Museum, Mauro Maida and Beatrice Ferreira, both from UFPE, as well as people taking part in the Friendly Turtle Project and Tamar (Maritime Turtle), intended to preserve turtles and Brazilian marine environ-



Bleaching of the large star:
with warmer waters, coral expels
algae, loses color and dies

From predator to prey: a coney,
which is beginning to
disappear from the reefs



ments. In the initial stage of this project, which has R\$ 350,000 in funding from the National Environment Fund (FNMA), the researchers will be working with the main species responsible for the formation of the reefs, such as the brain corals of the *Mussismilia* genus, found only in Brazil, the large star coral and the small brain coral (*Favia gravida*), a globe of some 10 centimeters whose appearance is reminiscent of a human brain. Both the brain corals and the large stars are fecundated externally at a given time of the year, when they release male and female gametes into the water, where fecundation takes place. The eggs develop into microscopic larvae – called planulae – which swim for some time before fixing themselves on the rocks on the bottom

Fish recover rapidly in fishing-free areas

of the sea and giving rise to new colonies. The small brain coral, though, is a species with internal fecundation. Once a month, the males discharge into the water their reproduc-

tive cells, which penetrate into the body of the females and fertilize them. Next, the female corals release the larvae, which swim for two or three days before fixing themselves on rocks and forming new colonies.

Recruits into the sea - At the same time, Castro and Débora, who since 1996 have been publishing together scientific articles describing the reproduction of the species of the Brazilian coast, intend to develop, in a laboratory in Porto Seguro, Bahia, a technique for artificial fecundation. The intention is to reproduce in captivity corals with external fecundation, like the *Mussismilia braziliensis*, which forms colonies with the aspect of a giant mushroom, of up to 1 meter, found only at Abrolhos. “In one year, we intend to take the first recruits, the individual colony formers, to the reefs of Porto Seguro”, Débora reckons. If it works in Porto Seguro, where the reefs are more preserved, the researchers should set off to repopulate the more damaged reefs, such as those of the Coral Coast. “Taking care of the

health of the corals is a task for governments, as provided for in the Convention on Biodiversity, signed at the Rio-92”, Castro comments. “As we know that the government has its limitations, we will try to meet part of this need in another way.”

But this is not the only way to prevent the reefs from disappearing. Measures that are apparently simpler, such as the creation of prohibited zones for fishing, tourism and the extraction of other living beings contribute, albeit in an indirect fashion, to the recovery of the reefs. This is what is revealed by studies from the Coastal Reefs Project, a program for preserving the reefs of the Coral Coast, coordinated by Mauro Maida, from UFPE. In the experimental branch of this project, which enjoys the participation of Ibama, of the state environmental bodies of Pernambuco and Alagoas, and US\$ 1.75 million in finance from the Inter-American Development Bank (IDB), Maida’s team is assessing the evolution of two areas of 5 square kilometers each – one in Tamandaré and the other in Paripueira –, classified by an Ibama regulation as zones forbidden for fishing and tourism.

In the course of one year, the researchers carried out 43 counts of the spe-

cies of marine animals and of the number of individuals found in the areas of restricted access and compared them with the results of 52 surveys carried out in two areas of reefs where fishing was permitted. The density of fishes, octopuses and lobsters in the demarcated sector has become four times greater than that observed in the open area, reveals the analysis done by Maida, Beatrice and oceanographer Fabiana Cava. The concentration of fishes, for example, was one individual per square meter in the forbidden zones, while in the open zones there was one fish in each 4 square meters. Even species rarely seen in Tamandaré, like itajaras, started to frequent the area free of fishermen. “We also noticed a modification in the behavior of the fish, which in this sector became less aloof to our presence”, says Fabiana. The Brazilian researchers are not the only ones to advocate this alternative to prevent the corals from being destroyed.

The need for establishing forbidden zones for fishing and extraction of living beings appears to be an international consensus, since fishing at levels higher than those supported by nature is the main cause of the loss of reefs – the estimate is that 3.5 tons of fish a year are extracted from each square kilometer of reef in Brazil. “In spite of the seriousness of the growing threat of pollution, of diseases and of coral bleaching”, comments John Pandolfi, in August’s *Science*, “our results show that the ecosystems of the coral reefs will not survive more than a few decades if they are not immediately protected from human exploitation.”

In the same issue of the magazine, Terence Hughes, from Australia, did a forecast for the next 50 years of the increase in the temperature of the oceans and of the rise in the rate of carbon dioxide dissolved in seawater, which makes the structure of the corals fragile. He concluded that if these problems continue to proceed at the current rate, the coral reefs are going to face, in the next five decades, a change in the marine environment so swift as the one they have passed through in the last 500,000 years. Accordingly, they may really even disappear, should the rate of environmental change exceed the capacity of the corals for adapting to the new environment.

THE PROJECTS

Monitoring Brazil’s Coral Reef

COORDINATOR

BEATRICE PADOVANI FERREIRA – UFPE

INVESTMENT

R\$ 99,907.00 (Probio)

Living Coral Project

COORDINATOR

CLOVIS BARREIRA E CASTRO – UFRJ

INVESTMENT

R\$ 348,167.00 (FNMA)

Coastal Reefs Project

COORDINATOR

MAURO MAIDA – UFPE

INVESTMENT

US\$ 1.75 million (IDB)



PHOTOGRAPH BY LEO FRANCIANI

Pioneer study: voluntary divers assess the health of the reefs



PHOTOGRAPH BY LEO FRANCIANI

The itajara, a fish that weighs up to 400 kilos, and the *Mussismilia*, brain coral, below, to be created in the laboratory



PHOTOGRAPH BY BEATRICE PADOVANI FERREIRAUFPE

Burning beauty: specimens of the branching fire coral, with branches that cause burns



PHOTOGRAPH BY LEO FRANCIANI



PHOTOGRAPH BY BEATRICE PADOVANI FERREIRAUFPE