Universidade de Aveiro Departamento de Biologia
Ano 2015

Isabel Maria Sousa Lima Marques da Silva

Os impactos ecológicos e sociais da co-gestão das pescas. Estudo de caso do Norte de Moçambique.

Fisheries co-management: Ecological and social impacts. A case study of Northern Mozambique.

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Fisheries co-management: Ecological and social impacts. A case study of Northern Mozambique.

Tese apresentada à Universidade de Aveiro para cumprimento dos requisitos necessários à obtenção do grau de Doutor em Biologia e Ecologia das Alterações Globais, realizada sob a orientação científica da Doutora Maria Ana Azeredo de Dornelas, *Lecturer* na School of Biology da University of St. Andrews e a coorientação do Doutor Amadeu Mortágua Velho da Maia Soares Professor Catedrático do Departamento de Biologia da Universidade de Aveiro

Apoio financeiro da FCT através da bolsa doutoral SFRH/BD/51413/2011

Ao meu Avô, que me ensinou que o mar é melhor que uma aspirina
e ao meu Pai, de quem herdei o ”vício” do mar

o júri

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agradecimentos

Foi em 2000, a primeira vez que pus o pé em Moçambique, e logo me apaixonei pelo Oceano Índico. Nessa altura sonhava que um dia iria morar e trabalhar numa dessas praias de areia branca e mar azul. Nem todos os sonhos se concretizam, mas com um pouco de loucura e perseverança, o meu realizava-se. Cheguei a Moçambique em Fevereiro de 2006, por um ano como voluntária num projecto de conservação, na paradisíaca ilha de Vamizi, mas fiquei por mais 8 anos… O mar e as pessoas que vivem do mar, fascinaram-me e despertaram-me a curiosidade. Primeiro, captaram a minha essência: chamaram-me Kerera, o pargo, o peixe que não pára. Em seguida,” levantaram-me” feitiço. Segundo as lendas da costa Swahili, quem comer o Namui (caranguejos dos coqueiros ou gigante) não sai mais das ilhas. Eu não comi, mas fui obrigada a partir uma pinça do animal para libertar um dedo que esta dilacerava sem largar. Daí em diante o destino estava traçado, não mais podia deixar o mar e as ilhas das Quirimbas. Durante todo este tempo fui estudando tantos os peixes como as pessoas. Num país tão pobre como Moçambique, não é possível conservar o meio marinho sem as pessoas que dele vivem. Não basta educar, mas também é preciso desenvolver mecanismos de gestão adaptados às realidades locais e do país. Foi nesta encruzilhada, entre mar e gente, que surgiu o meu interesse pela co-gestão das pescas e, com o tempo, esta tese.

Não queria deixar de agradecer:
Aos meus dois pilares, o Fernando e a Helena.
Aos meus supervisores: à Maria sempre perto, apesar de estar longe, ao Professor Amadeu, por me ter aberto portas onde outras se tinham fechado.
À Faculdade de Ciências Naturais da Universidade do Lúrio por me ter acolhido e facilitado o trabalho.
Aos meus co-autores dos artigos científicos que integram esta tese, Sergio Rosendo, Nick Hill, Hideyasu Shimadzu, Laura Antão, Fernando Morgado e Pedro Pires.
Ao “lodge” de Vamizi por todo o apoio durantes os anos de recolha dos dados.
À Fundação Calouste Gulbenkian e ao Oceanário de Lisboa pelo apoio dado na publicação do 2ºcapitulo, através do Projecto de 2010 Galardão Gulbenkian/Oceanário de Lisboa “Conhecer para Preservar a Biodiversidade Marinha de Pemba (Cabo Delgado, Moçambique)—Ordenação Sócio-Ambiental para a Sustentabilidade”.
Ao WWF pelo apoio financeiro ao 3º capítulo.
Ao IIP (Instituto de Investigação Pesqueira) por ter cedido os dados do 4ºcapítulo.
Aos Projectos OSOL e SPACES e à Dra Bibiana Nassongole pelo apoio logístico no 6º capítulo
A todos os que, no sector das pescas em Moçambique, me têm ajudado durantes este anos e que, directa ou indiretamente, também contribuíram para esta tese, Manuel Daniel, Beatriz Isidoro, o “essencial” Garret, Henriques Bustani, os membros dos conselhos comunitários de pescas e os pescadores.
A todos: Muito obrigada.

palavras-chave

Co-gestão, Pesca, Quirimbas, Santuários, Conselhos Comunitários de Pesca (CCP),

resumo

A co-gestão, ou gestão participativa das pescas, consiste em devolver, ou abrir, à comunidade a gestão das pescas. Este trabalho, realizado no norte de Moçambique, analisou os impactos ecológicos e sociais da implementação da co-gestão das pescas. Primeiro foram encontradas e fotografadas 198 espécies ictíicas e produzido um guia de identificação de peixes de cabo delgado, essencial para quem trabalha no meio marinho. De seguida, o *efeito de transbordamento* foi detectado num santuário comunitário, para peixes herbívoros mas não para carnívoros, ao fim de seis anos. Para avaliar os efeitos da co-gestão na pesca foram analisadas as capturas de toda a província, não foram encontradas diferenças na diversidade de espécies capturadas, mas foi detectado um aumento do tamanho dos peixes: mais pequeno nos centros de pesca sem CCP, (Conselhos comunitários de Pesca) maior nos centros de pesca com CCP e maior ainda nos centros de pesca com gestão mais eficiente. Ao mesmo tempo foram detectadas nas capturas tamanhos maiores nos centros de pesca mais longe dos mercados. Para além dos efeitos ecológicos e nas pescas, também foi analisado o ponto de vista de quem vive a co-gestão. Os factores socioeconómicos que mais influenciam as suas percepções são a idade e a riqueza. Por último, segundo os membros dos CCP´s, as principais realizações dos CCP são na área da fiscalização e na criação de áreas de conservação. As principais dificuldades são a falta de meios de transporte para a fiscalização e a falta de reconhecimento da autoridade dos CCP's, tanto entre a população como na articulação com as autoridades locais.

Esta tese foi pioneira em Moçambique, ao avaliar os efeitos dos santuários comunitários e os efeitos dos CCP nas pescarias, assim como ao revelar qual o perfil dos apoiantes da co-gestão e dos santuários marinhos. Finalmente, fez-se um levantamento dos problemas que efectivamente enfrentam as comunidades, no campo na implementação da co-gestão

keywords Co-management, fisheries, Quirimbas, sanctuaries, Fishing Council (CCP)

abstract Co-management, or participative management of fisheries, consists of returning or opening to the community the management of fisheries. This work, carried out in northern Mozambique, analyzed the ecological and social impacts of the implementation of co-management of fisheries. Firstly 198 species of fish were found and photographed and a guide to identification of species - essential to who works in the marine environment – was produced. Following, the spill-over effect was identified in a marine sanctuary. It occurred after 6 years and only for herbivore fishes and not to the carnivores. In order to evaluate co–management of fisheries effects, the captures of the entire province were analyzed. No differences were found in the diversity of the species caught, but an increase of the fish size was detected: this size was smaller in the fishing centers with no CCP (Community Fishing Councils), slightly bigger in the fishing centers with CCP and even bigger in the fishing centers with a more efficient management. At the same time it was observed that the size of the fish caught is bigger in the fishing centers further away from the markets. In addition to the ecological effects and the effects on fisheries, it was also analyzed the point of view of those who live the co-management. The socioeconomic factors that have a stronger influence in their perceptions are the age and the wealth. Finally and according to the CCP members, their main achievements are in the fisheries inspection and in the creation of conservation areas. Their main difficulties are the lack of means of transportation and the lack of recognition of the CCP's authority; both among the population and in the coordination with local authorities. This thesis pioneered in Mozambique in assessing the effects of Community sanctuaries and the effects of CCP on fisheries as well as by revealing the profile of the supporters of co-management and marine sanctuaries. Finally, an assessment of the matter of fact problems that the communities have to face when implementing co-management was also made.

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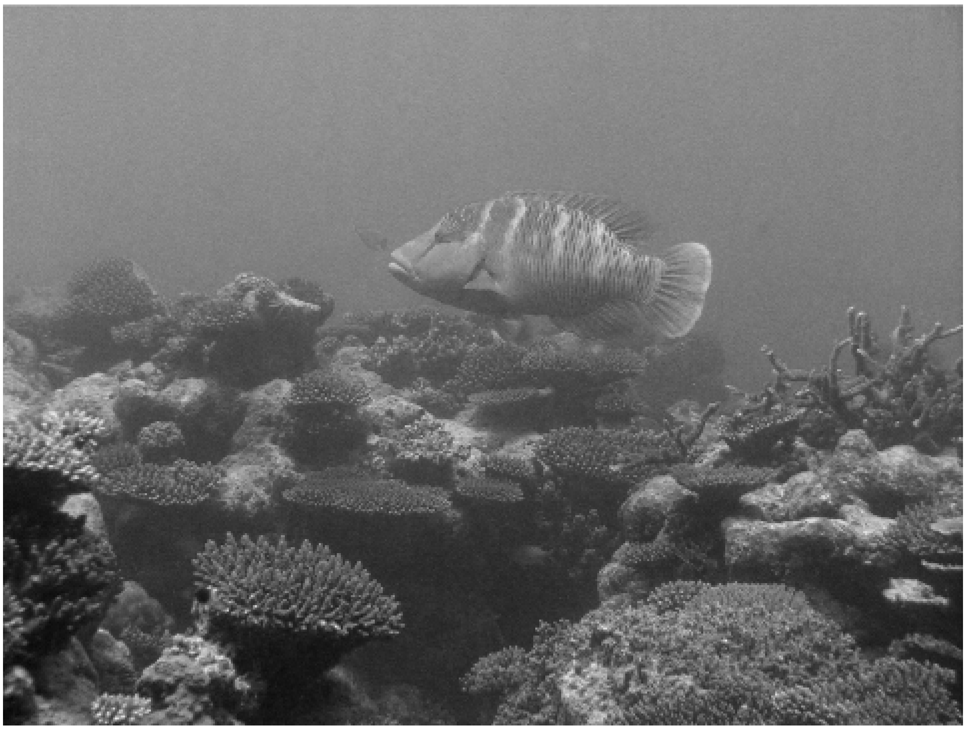
1. Objective and general introduction



"Indigenous technical knowledge of rural Africans indicates that they have sophisticated understandings of environmental processes such that no longer should rural Africans be seen as degraders of the environment but as local heroes."

In *Hulmes & Murphree (1999)*

1.1 Thesis objectives

In 2011, after working for 5 years as a marine biologist in the Palma district of Cabo Delgado province, it was clear to me that a basic and thorough scientific knowledge of the marine environment and its socioeconomic constraints was urgently needed in order to provide a solid basis for future environmental decisions. Too many years of war, exclusion, bad roads and under-development had taken Cabo Delgado province off the research map. This thesis originated from the undertaking of extensive field work and I am happy to see that even now, when an "avalanche" of research is in course for the impact assessments of the gas and harbor developments, few studies rely on scientific data covering such a large span of years, since very few started before this "thirst" for knowledge and development began.

This thesis originated from the extensive field work (9 years) done by the researcher in Cabo Delgado province since 2006. This work was a mix of ecological, fisheries and community development, which contributed directly and indirectly with ideas, data, and knowledge to this thesis.

The objectives of the thesis are:

- To improve the fish identification tools for Cabo Delgado province
- To study the possibility of spillover from a co-management reserve
- To analyze the evolution of fisheries along a gradient of co-management implementation
- To analyze the perceptions of people living with co-management and marine reserves
- To access the main problems and achievements of co-management in Cabo Delgado province

This first chapter gives an introduction to the social, political and religious history of northern Mozambique, spanning the pre-colonial Swahili culture, colonial and post-colonial politics, the influence of Islam, and the effects of the devastating anti-colonial war, followed by an equally devastating civil war. A brief description is given here of how this history has shaped the coastal populations, their complex ethnicity, their relation with governance and the way they explore marine resources. This is extremely important in order to understand the context in which co-management has developed. Otherwise it would be impossible to understand how poverty, exclusion, low education and low school attendance in the coastal villages of Cabo Delgado has shaped this particular mindset.

Chapter two fills a critical gap in fisheries science in the province: a lack of information on the finfish population and the existence of slightly different types in East Africa compared to those in Southern Africa or the Red Sea. An important amount of ecological work has been done in the south of Mozambique. This started at Inhaca Field Station, founded in 1951 on Inhaca Island, 30km from Maputo, and has been maintained in a more or less continuous way until today by

Eduardo Mondlane University. In contrast the first research in the north of Mozambique was done by Frontier-Mozambique, a project undertaken by the MICOA (Ministry for the Coordination of Environmental Affairs, Mozambique) and the Society for Environmental Exploration, UK, with financial support from the Darwin Initiative (Department of Environment, UK) in 1996-1998. This research was conducted in the south of the Quirimbas archipelago and lay behind the creation of Quirimbas National Park in 2004. Besides this, only two other projects have been implemented: Transmap, an EU-funded research project to generate scientific knowledge to inform the spatial design of a transboundary MPA (marine protected area) network in coastal Eastern Africa, that lasted from 2005 to 2008; and the Maluane Conservation Project, active since 1998, at Vamizi island (through which income from tourism is fed into conservation). Presently known as Vamizi Conservation Project, the latter was founded by the ZSL (Zoological Society of London), continued by the WWF (World Wide Fund for Nature) and is presently run by the IUCN (International Union for Conservation of Nature), which also contributes to social and environmental research in the north of Mozambique. The fish identification book *Diving in a different universe. Fish of the Coral Reefs of Pemba Bay* was the first to identify the fish species of northern Mozambique and to photograph some of their more typical morph types, such as the *Chaetodon interruptus (*before *Chaetodon unimaculatus interruptus*) (Smith & Heemstra, 1986) and the yellow teardrop butterfly fish, which is white in the rest of the Indian Ocean and known as the *Chaetodon unimaculatus* (p. 194). As such, it is an important inventory of the fish diversity of the province and a building block for a basic understanding of the diversity of the local socio-ecosystems.

Chapter three is the result of almost 10 years of ecological research and community work on Vamizi island, prior to (2003), at the outset of (2006) and after (2012) the implementation of the co-management strategy on Vamizi island and the Fisheries Sanctuary. In 1998, a partnership between the private sector, local communities, authorities and a conservation organization (ZSL) was established with the objective of ensuring the sustainable conservation of coastal biodiversity and socio-economic development of local communities using upmarket tourism as a financing tool. Underwater visual surveys (UVS), using the same methods, were done in 2003, 2006 and 2012 and helped to delineate and monitor the sanctuary (non-taking community reserve) created in 2006. This researcher not only organized and participated in this survey in 2006 and 2012 but was also responsible for developing the local strategy with the government, Maluane and the communities. This body of research is the first of its kind ever done in a reserve in Mozambique or globally, since studies conducted in reserves comparing data from periods before, at the beggining and well after their creation are very rare

Chapter four was born from a long-lasting collaboration between the Fisheries Research Institute (IIP) and this researcher, which involved the promoting and building of monitoring capacity in fisheries in the north of Mozambique. Fisheries catch data from the IIP, for the entire province in 2010-2012, and the sizes and species at 78 fishing centers along the entire coast of Cabo Delgado were analyzed. Both, diversity of catches and sizes, were related to the distance to the nearest town (measuring the influence of market proximity) and to the existence (or absence) of co-management arrangements in the different fishing centers. This research was done using different tools (species abundance distributions [SADs]) that are commonly used (diversity indexes) and GLM (generalized linear models) instead of size spectra. Moreover, this was the first time that this kind of analysis had been done in Mozambique for an entire province and for co-management.

Co-management is, by definition, the devolution of the power of managing fisheries to the communities. Hence, it is imperative to analyze how people see co-management and reserve arrangements, and identify socioeconomic characteristics that make people more prone to support these management arrangements. The aim of chapter five is to answer the questions: How are perceptions shaped by the background of people? What is the profile of a co-management supporter? These are some of the variables that we analyzed. Implementation and development of co-management models can only be effective if it takes into account what the people think (perceptions).

Improving co-management practice requires engaging in dialogue with stakeholders. Chapter six was the result of a workshop with the CCPs - the organizations responsible for the implementation of co-management. In this workshop, some of the results of this thesis, especially the spillover effect of community reserves, were discussed. The principal difficulties and main achievements were debated. This chapter is especially important because implementation of the co-management is discussed by the people that are in the field implementing it. From the exchange of different experiences among CCP members from a diverse range of CCPs, and also between CCP members and researchers, there emerge several important recommendations for the implementation of co-management in Mozambique. These include, namely, the implementation of capacity-building actions for CCP and government officials responsible for co-management and a broader awareness about co-management. Also a very important recommendation was the importance of finding sustainable financing mechanisms for co-management.

Lastly, in chapter seven, conclusions are drawn from all the previous chapters. We discuss what this thesis has brought for co-management and discuss it in the Mozambique context.

1.2 The northern Mozambique context

1.2.1 The coast before the arrival of the Portuguese – the Swahili Coast

When Vasco da Gama landed on Mozambique Island in 1498, he reported that it was governed by a sheikh who answered to the Sultan of Kilwa (Quiloa in Portuguese). Ceramic evidence dates their arrival to around the twelfth century (Bonate, 2010).
The Kilwa Sultanate stretched across the entire length of what is now called the "Swahili Coast", from the small island of Kilwa, in the south of Tanzania, to Inhambane, including Mozambique Island, Angoche and Sofala, which controlled the gold and ivory trade. The Sultanate of Kilwa was founded in the 10th century by Ali ibn al-Hassan, a Persian prince from Shiraz. His family ruled the Sultanate until the year 1277. It was replaced by the Arab family of Abu Moaheb until 1505, when it was toppled by the Portuguese invasion (Chittick, 1965). At that time, the sultanate was already fragmented into smaller states, many of which became protectorates of the Sultanate of Oman.

Regardless of this fragmentation, Islam was widespread along the northern coast of Mozambique when the Portuguese arrived and the Muslim elite, or more precisely the Shirazi clans, managed to retain control of the coastal regions through an old business strategy: marrying local women. In the long term, the result was the mixing of Arabic and Persian traders with local cultures that resulted in the Swahili culture. In northern Mozambique, the Macua culture existed before the arrival of Islam. It was matrilineal and this facet was maintained by the Muslim Shirazi clans. In contrast, the rest of the Swahili coast was patrilineal. In the north of Mozambique, people claim matrilineal clanship, with mahimo or maloko (pl.; sing. *nihimo* or *nkolo* in Emakhuwa, *lihimo* in Ekoti) descending from a common female ancestor symbolically identified as emukulo (womb) or nipele (a breast) (Bonate, 2006). The matrilineal lineage gave power to the newcomers and opened the door into the hinterland.

1.2.2 Colonialism and "effective" colonization: 1910-1975

The Mozambique sultanates maintained control over Islam and had intimate political, economic and kinship relations with the Swahili world, which also extended to Comoros and Madagascar. In 1505, however, the Portuguese occupied Kilwa, Mozambique Island, Sofala, and Cuama (Bonate, 2010). Soon after, the Portuguese added Quelimane, Inhambane and Bazaruto islands to their control. The Portuguese conquest led to a gradual elimination of Swahili enclaves in central and southern Mozambique, which however continued to exist in the north, especially on the coast stretching from Pebane to Palma. After their initial confrontations with the Muslims, the Portuguese decided, for survival and business purposes, not to interfere with the affairs of the Muslims in the region. Even the work of Catholic evangelization was weaker and less widespread than expected from a country that proclaimed its aim as that of spreading the Catholic faith (Wójcik, 2014).
Some sultanates, such as the sultanate of Tungi (in Tungi bay facing Cabo Delgado, near what is today Palma) and the sultanate of Angoche (Figure 1), were never destroyed. Their relations with the Portuguese in some cases were regulated through the recognition of European sovereignty, either paying a symbolic tribute or more often than not receiving a pension from the Portuguese crown (Bonate, 2007).

The slave trade kept the Portuguese on the coast and created amicable relations with the Muslim populations. However, under pressure from the European abolitionist movement, Portugal signed the Vienna Treaty with Great Britain in 1815. Consequently, in 1836, Sá da Bandeira Decree, followed by the Decree of 1842, prohibited the exporting of slaves. Mozambique Island and Quelimane, from where slaves used to be exported, became difficult destinations for *negreiros* (slave traders). Hence, by 1847, many Portuguese settlers on Mozambique Island had relocated to Angoche. Seizing this opportunity in the 1850s, Angoche's rulers decided to enter the slave trade (de Mattos, 2012). Most probably, Tungi did the same, but there is less information available (Adamowicz, 2013).

After 1895 and until the beginning of the twentieth century, the Portuguese were forced to undertake military campaigns to take "effective occupation" as a consequence of the European nation's scramble for Africa, the 1884-1885 Berlin Conference and the 1890 British proposal on future borders with the Portuguese in Africa (Bonate, 2005). It was only in 1910, after several failures, that an end was finally put to the Angoche sultanate and the slave trade when a systematic and well-organized operation killed and imprisoned several big chiefs (Bonate, 2005). The Tungi sultanate, which still maintained relations with the rulers of Zanzibar, was defeated in 1887 by a military operation, after mediation by the English and Germans (who were also interested in the region) with the Zanzibar crown (Adamowicz, 2013).

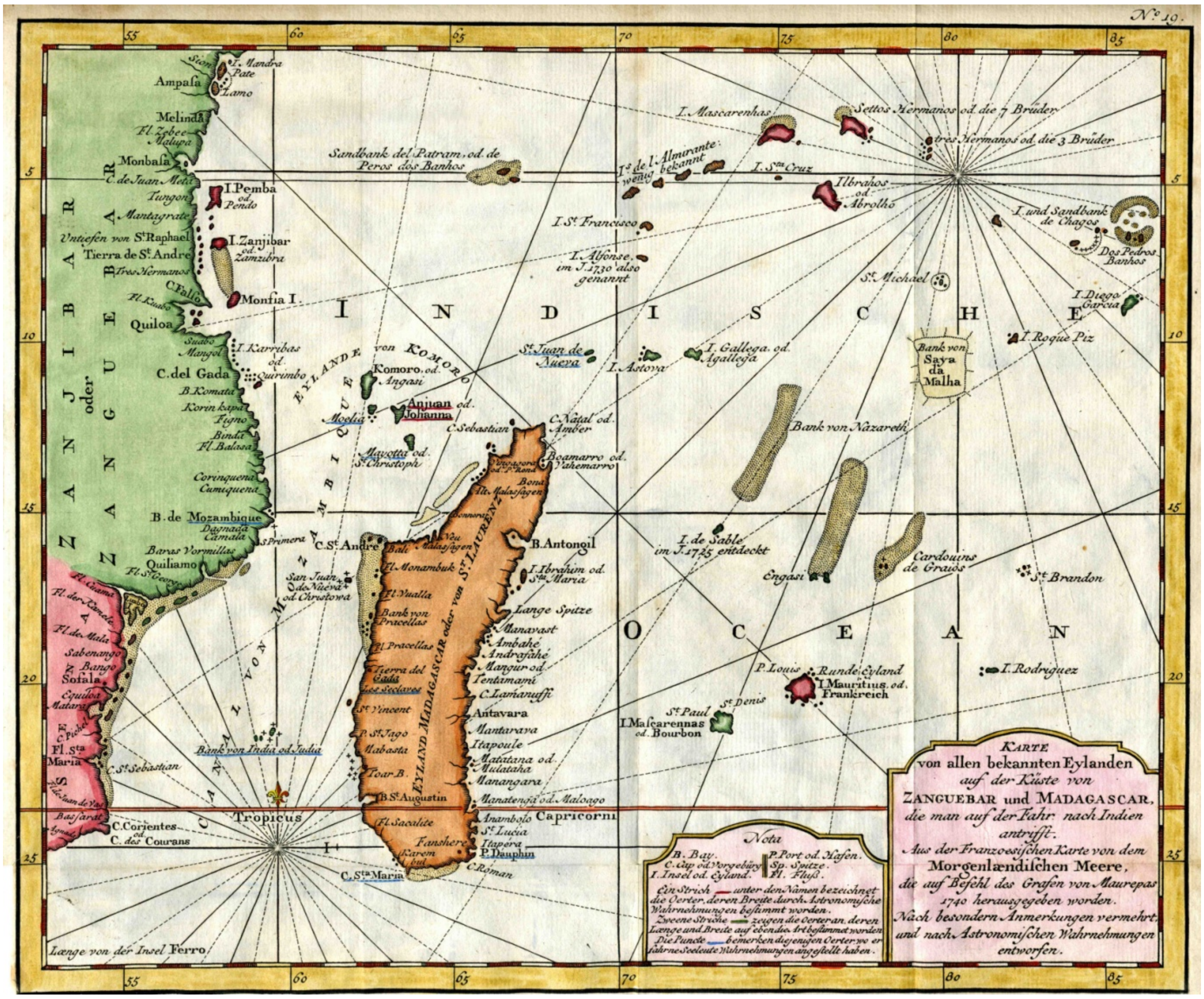


Figure 1 – Map of Mozambique, Zanzibar, Madagascar, Indian Ocean, Bellin, Leipzig, 1748

Following "effective occupation", the Portuguese began implementing policies of forced labour, taxation and arbitrary punishment. Together with the 1907 Portuguese Administrative Reform, these policies laid the basis for a system known as "*Indigenato*". This reform discriminated between the legal rights and civil status of the Africans and the European Portuguese (Bonate, 2005).

The *Indigenato* policies prevented African Muslims from northern Mozambique being assimilated into the Portuguese administration at two levels. First, due to the need to be able to read and write in Portuguese, which would have involved attending a rudimentary school where the

Catholic catechism was compulsory and where, in most cases, they would have been given new Catholic names in place of their Muslim ones (Wójcik, 2014). Second, because the vast majority of them lived under the *Indigenato* rule of the old Shirazi clans that provided most of the *régulos* (local chiefs) within the new colonial administrative system. The power of these *régulos* was built upon Islamic and African traditions of chieftainship (Bonate, 2007). The Islamic cultural and business elite that had ruled the northern Mozambique coast for centuries not only could not access Portuguese education but also saw its madrassas and mosques persecuted. In 1961, Portugal reviewed the *Indigenato* policy, but it was already too late for the Macua and Kimwani Muslims in the north to integrate into the colonial system. Meanwhile, and despite their strong connection to Zanzibar and Tanganika through family, religion, constant migration and a common language (Bonate, 2009), they were never truly accepted into the liberation movements.

The colonial war marked the last years of Portuguese occupation (1964-74). The effects were especially hard in north Mozambique. The first gunshots of the war were fired in the village of Chai, in the province of Cabo Delgado, on 25th September, a date now commemorated as a public holiday. Guerrilla forces of the Mozambique Liberation Front or FRELIMO (Frente de Libertação de Moçambique) occupied the interior of the province. The Portuguese were concentrated along the coast, with strongholds in the coastal towns of Pemba and Mocimboa da Praia. The Portuguese forced the population to concentrate in bigger villages that were easier to control, a process known as villagization. Curiously enough, FRELIMO also used the same method during the civil war. This villagization would have profound negative effects by eroding the traditional management systems.

Pre-independence history partly explains the self-marginalization that is still a feature of the northern coastal population today. Poor education, due to low school attendance, means that very few people speak Portuguese and consequently very few administrative positions are held by Kimwani and coastal Macua Muslims (Silva Cruz, 2015; Wójcik, 2014).

1.2.3 Independence and civil war,

After independence in 1975, the FRELIMO movement took control of the country and established one-party rule over Mozambique.

"In the first years following independence, especially in 1977, Frelimo adopted Marxism and so-called 'scientific socialism' and sought to eliminate a wide variety of social practices and beliefs deemed 'obscurantist,' 'backward' and thus contrary to the modernist 'revolutionary norms', including initiation rites, traditional healing and ceremonies of ancestral supplication, all at the base of the legitimacy and authority of an African chieftainship" in Bonate (2010).

Northern Mozambique's coastal Muslims were forbidden from worshipping in their mosques which resulted in further isolation from schooling and society (Wójcik, 2014). RENAMO (another political party) started a civil war against the one-party regime and a majority of the northern coastal population supported them, mostly in order to conserve their religion and traditions.

During the civil war, refugees flooded the coast in an attempt to flee the fighting in the interior. The coastal villages, which had already been transformed by the colonial laws combining several small villages into bigger ones that were easier to control, started to receive new people from different ethnic backgrounds and religions. Collectivization and common villages were implemented and traditional leaders were sometimes displaced and lost. To make matters worse, some of these villages were surrounded by guerrillas, forcing people to abandon the fields and to rely on fishing (Santos, 2010). Fishing absorbed most of the displaced workforce and provided food security to the weakened population, functioning as a "safety valve" (Béné, Hersoug, & Allison, 2010).

"The coast has become a place of refuge for those excluded, ostracized and expelled from their historic role" Conceição (2006) in *Wócjk (2014)*

1.2.4 The free market and the peace agreements

By the early 1980s, 80-90% of the population depended on subsistence agriculture and fishing for its livelihood (Menezes, Eide, & Raakjær, 2011). In September 1984, Mozambique joined the International Monetary Fund (IMF) and officially opened its centralised planned economy to the free market, completely transforming the fisheries sector.

In 1992, after 16 years of civil war, the government and the guerrilla groups signed a cease-fire agreement. More than one million refugees who had fled abroad returned home to Mozambique. Although some refugees that had fled to the coast of Mozambique during the war returned to their place of origin inland, many stayed (Bryceson & Massinga, 2002). The lack of education was severe in coastal areas and, therefore, limited employment opportunities beyond fishing. The lack of education may seem like a conscious decision to live outside a state that first forbade their beliefs and then adopted a policy of mere toleration, but the lack of health centers, water wells and the very bad roads were a consequence of the years of war. Thus, the northern Mozambique coast remained a place for people who distrusted the state and one of "scattered" ethnicity. The residence pattern was mobile – with people moving by sea - and there was a social structure able to adapt to the needs of those as poor as themselves (Silva Cruz, 2015). During the war, the intensive use of resources in the very populated area of Nampula province caused overexploitation and even more migration. This fishing migration was to the northern province of Cabo Delgado, where isolation during the war had preserved the resources. The Kimwani people, who are also Muslim, welcomed the Macua fishermen. Peace also saw the return of fishermen from Tanzania, which had received Mozambican refugees, and they too started to fish and trade in Mozambique (Wiomsa, 2011).

In 2002, the Quirimbas National Park (PNQ) was set up and transformed migration patterns by restricting fishing in certain zones. Tourism began to develop inside the park and outside, especially in the beautiful and idyllic Quirimbas islands. Beach access was restricted and, in most of the islands, the fishermen were forced to leave, to free up space for tourism development. In 2012, the biggest marine reserve on the African continent was created in the Primeiras and Segundas archipelago in Nampula Province. This new reserve is thought to have further encouraged migration to Cabo Delgado province.

In 2008, oil and gas seismic exploration started in Cabo Delgado province leading to the discovery in the following years of the third biggest gas reserves in the world. A giant LNG (liquefied natural gas) plant is planned for the Afungi peninsula, in Palma district near the border with Tanzania. Meanwhile, the coastal villages of Palma, Mocimboa da Praia and the provincial capital Pemba have already been flooded with migrant workers, ranging from barmen to engineers, of various backgrounds from the southern provinces of the country. These are substantially more highly educated than the northern coastal people, thus increasing the risk of social segregation (Silva Cruz, 2015). Big environmental changes are also expected, from the clearing of lands to the construction of big ports, an increase in boat traffic, and an increase in demand for fish and horticultural produce. As such, the importance of this thesis is now greater than it was when work started on it: without proper management of fishing resources and the empowerment and involvement of local people, fish resources in this region are doomed to over-exploitation.

1.3 Fisheries and co–management in Mozambique: the case of northern Mozambique

1.3.1 The state of the fisheries and their overall importance in Mozambique

The Mozambique fisheries sector, including aquaculture, represented 2.8% of GDP in 1996 but only 1.6% in 2013 (Mozambique National Bank). From being Mozambique's second biggest export in the 1989s, fish products now only account for around 1%. Nonetheless, 11.9% of the country's population lives in the 1,586 coastal fishing centers, while many more people live in other coastal villages. If we look at the province of Cabo Delgado in particular, 27.8% of the population lives in the coastal districts. Cabo Delgado is home to the largest number of fishing centers in the country, at 14%. Of the 400,000 fishermen and other people working in fisheries in Mozambique, only 13% are from Cabo Delgado; the largest number are from Nampula. In Cabo Delgado, 53% of fishermen do not have a boat, whereas the national figure is 44.8%. Of these, 53.5% are gleaners (*recolectores*), 11.3% divers, 17.1% liners, and 12.9 spears, whereas the respective percentages for the nation as a whole are 41.3%, 6.2%, 23.2% and 5.6%. Among fishermen with boats, the most important gear used is the spear (32.3%), followed by the fishing line (21.8%) and the seine net (19.2%). At national level, the gillnet is the most commonly used gear (38.6%), followed by lines (26.2%) and then trawlers (18.8%) (República de Moçambique, 2013). What this shows is that the fisheries in Cabo Delgado are very different from the rest of the country. They are characterized by small fishing centers and by the use of low technology with little impact on the environment, but also by high value fishing for octopus and lobsters (spear). Cabo Delgado also has 65 Community Fishing Councils (CCPs), a number only surpassed by Inhambane province with 93. The fact that Cabo Delgado has fewer CCPs probably reflects the isolation of its fishing centers, which makes it difficult to implement new CCPs and to build their capacity (República de Moçambique, 2013).

Fisheries may not carry much weight within Mozambique's economy, but they have a very important social role. They give work and food security to a huge number of people who, due to their low education and isolation, have no access to other sources of food. Simultaneously, while the country develops other areas of production, fisheries need to become more productive but also to manage their limited resources more efficiently before they are irreparably over exploited.

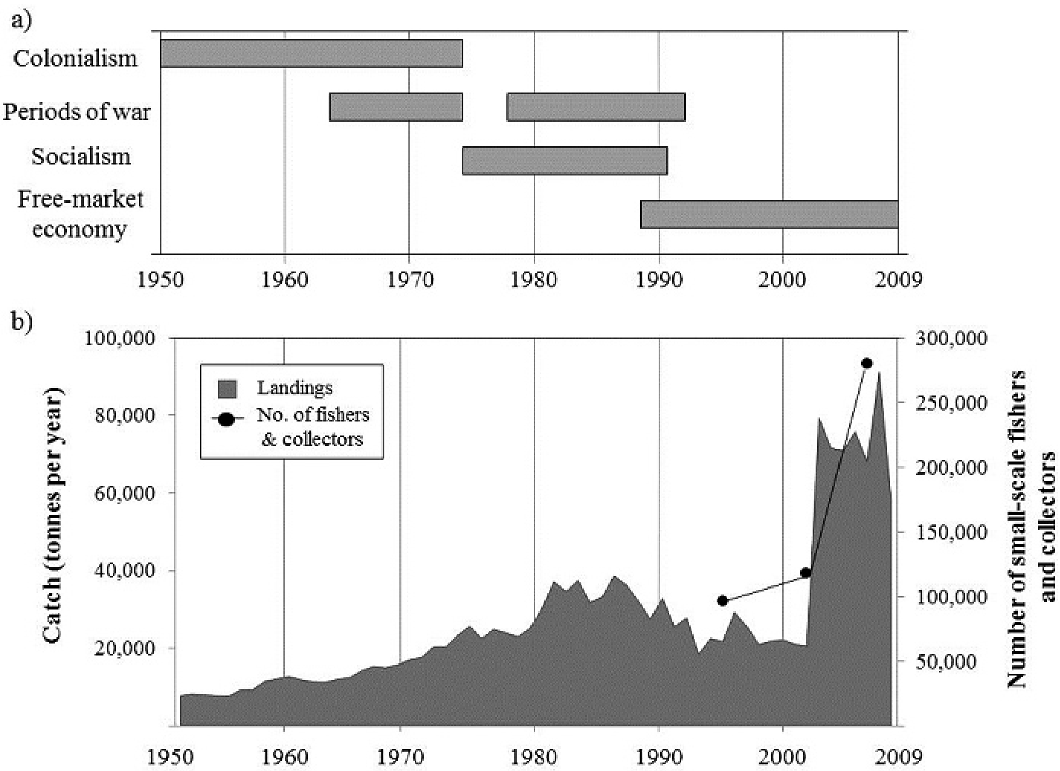


Figure 2 - (a) Periods of socioeconomic change affecting coastal fisheries. (b) Total landings for 1950–2009 and total number of small-scale fishers in Mozambique (Blythe, Murray, & Flaherty, 2013)

1.3.2 The evolution of fisheries in Mozambique

The Portuguese did not develop an industrial fishing fleet and trawling was prohibited under Mozambique's colonial law. Recognizing the export potential of a shrimp fishery, the Portuguese authorities removed the ban on trawling in 1965 (Jacquet & Zeller, 2007). A small industrial fleet then flourished in Mozambique and large processing and freezer plants were built along the coast (Menezes et al., 2011), with the catch growing steadily during this time (Figure 2).
When independence came in 1975, the fishing infrastructure, sellers and boats were abandoned by the Portuguese. The independent government nationalized all industries, including the fisheries, but at the same time invested in the fishery industry. It formed joint ventures with several private companies from Spain, and Norway, and negotiated fishing rights in exchange for aid from the Soviet Union. By the '80s, shrimp was the biggest catch and the country's second largest export after cashew nuts (Jacquet & Zeller, 2007). The government also invested in *combinados pesqueiros*, bodies responsible at the local level for buying and selling all fishery products and distributing fishing gear in the aim of developing artisanal fishing. They were involved in experimenting with new technology and informing fishers about the latest fishing

techniques; distributing fishing gear; purchasing, storing and transporting fishing products; distributing fish products; and in providing technical assistance in repairs and offering maintenance (Figure 2). After adhering to the International Monetary Fund's policies, the centralized planned economy came to an end and Mozambique developed into a free market, with the closure of the *combinados pesqueiros*. When the last support for the fisheries, the *combinados*, was removed, the lack of infrastructure in coastal communities became apparent. Fishermen were unable to produce more because they did not have the necessary electricity to preserve the fish. Drying was only feasible during the dry season, normally the least productive season. There were no roads to export the products. It was very difficult to buy fishing gear because shops were scarce and all previous gear had been supplied by the *combinados*. Basic infrastructure, such as health centers, a water supply, schools and financial services, was completely lacking. In the following years, several big fisheries projects (Figure 4) were implemented by the National Institute for Small-scale Fishery Development (IDPPE) to address this issue. In order to solve these problems, new facilities were created to fill the void left by the *combinados*. Figure 3 presents the updated network of institutions and their relationships:

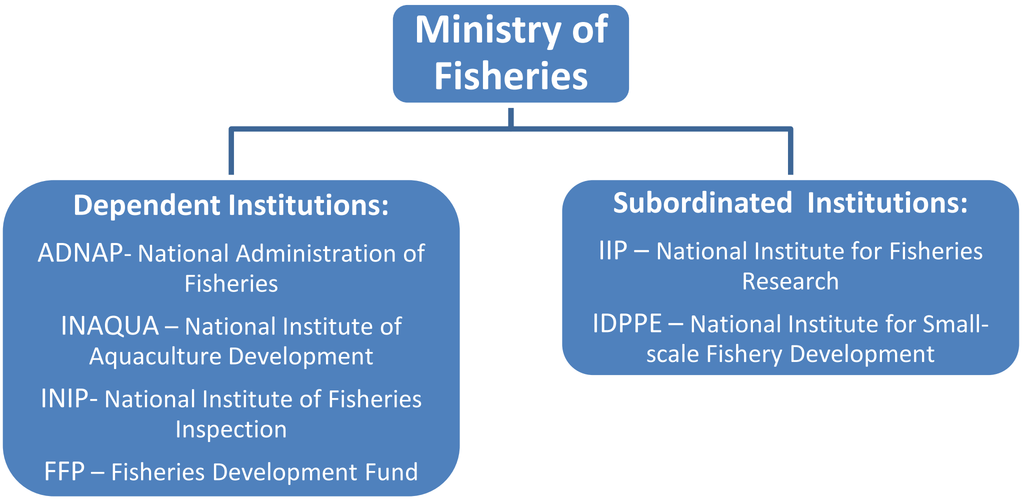


Figure 3 – Dependent and subordinated institutions of the Ministry of Fisheries in Mozambique

1.3.3 Co-management (co-gestão)

"A co-gestão ou gestão compartilhada pode ser definida como uma parceria em que as comunidades de utilizadores, o governo e outros interessados partilham a responsabilidade e a autoridade das pescarias" in (República de Moçambique, 2010)

"Co-management or shared management is defined as a partnership where user communities, the government and other interested parties share responsibility and authority with regard to fisheries"

Despite reports referring to some level of sharing in the management of marine resources in the '80s, co–management was only adopted by the government in the *Plano de co-gestão das pescarias* (Plan for co-management of artisanal fisheries) (Sá, 2011). In 2003, the Marine Fisheries Regulation (REPMAR), Decree No. 43/2003 of 10 December (BR No. 50 – I Series), stated that co-management was the "preferred means of managing the fisheries" (République de Moçambique, 2003). In the following years, several pieces of legislation would "cement" this approach (Table 1).

Table 1 - Policies and legislation that led to the decentralization of natural resources management in Mozambique (Menezes, Smardon, & Almeida, 2009)

- 1990 Constitution - reduces the role of the state and recognizes the significance of the communal and private sector in decentralized management and benefits.
- Master Plan. State Secretariat of Fisheries. 1995 And the Fisheries Policy. Decree n 16/96, May 28^{th}, Boletim da Republica, *I Serie*, n 21. Promotes participation of the fishing communities in planning and management.
- Conflicts with industrial fisheries, tourism and conservation parks, and increased theft in the villages led to the organization of fisheries co-management committees in 1998.
- Marine Fisheries Regulations. Resolution 16/96, May, 28^{th}, Boletim da Republica, *I Serie* n 21, was amended in 1998 at the request of local communities. In the Southern Nampula, the mandatory beach seine size was altered from 38mm to 12mm. after consultation with artisanal fishermen. The main objective of this alteration was the replacement of mosquito net in the beach seines. The 12mm would allow them to catch small pelagic, such as sardine and anchovy, thus maintaining their main livelihood.
- The Land Policy of 1995 and the Land Law of 1997 (with Regulations of 1999) - guarantee rights for local communities to land through the introductions of leasehold titling for both private and communal sectors, develop conflict resolution mechanisms and introduces rights to benefit from land use or local management.
- The Forestry and Wildlife Law of 1999 and Regulations - promotes the participation of local communities in planning, management and benefits from natural resources.
- The Municipalities Law of 1998 –promotes decentralized local authority
- The Decree 15/2000 of 2000 - relates to the roles of community leaders (can be traditional leaders) in local government.
- The Decentralization Law. Law no. 8/2003, of 19 May.
- Press information about the Community Fisheries Council Statutes of April 12^{th} 2006. Published in BR Nº. 27, II Série, July 5^{th} 2006. Approves the Statutes of the Fisheries Community Councils (CCP) which recognizes the management of fisheries resources through local organizations
- Ministerial Decree Nº. 49/2007, of February 2007. Approves the Community Fisheries Council Regulations (CCP). Published in BR Nº. 21, I Série, 24 Maio 2007

The Fisheries Master Plan I (PDP I) (1995-2005) was the first document to acknowledge the existence of a centralized fishery management system that was completely maladjusted. At the time, it was detected that fishery regulations were poorly implemented and that there was complete ignorance among the population and fishers about their contents. Added to this problem was the fact that all control measures and the application of the regulations were absent in the majority of the fishing centers. The proliferation of forbidden and destructive gear was prevalent. Social and economic changes – the adherence to the IMF policies in 1984 followed by the peace agreements in 1992 – had made the centralized fisheries management system completely obsolete. The beginning of the transformation was possible with the support of the International Fund for Agricultural Development (IFAD), which has supported several fisheries projects over recent years in Mozambique (Figure 4).

Figure 4 - Projects financed or co-financed by IFAD (IFAD, 2010)

These projects have increased monitoring of the fisheries, improved technology and, together with other development funds, increased the road network and electricity and water supply (IFAD, 2010). All of them were implemented with the aim of increasing fisheries production and revenue. But these same measures demanded increased management of the resources and this was provided by supporting the implementation of co-management (IFAD, 2010).

Some of the reasons pinpointed by the government for the adoption of co-management are (Sá, 2011):

1) The incapacity of the fishing administration to have a presence everywhere
2) The difficulty of solving local disputes
3) To need to provide the capacity to defend the primary access of communities to the fishing grounds
4) The government's need to implement decentralized policies

Co-management was organized by law as described in Figure 5 (Républica de Moçambique, 2003), with the main actors being:

Administrador do distrito (District administrator) – This is the focal figure in district fisheries management after the decentralization of the public administration. In the absence of guidance, the district administrator's responsibilities are several, varying with the relative importance that fishing has in a particular district and the experience and knowledge of the incumbent and his staff on fishing-related issues.

SDAE, Serviço Distrital de Actividaes Económicas (District Service for Economic Activities) – This service has incorporated the previous fishing administration. It is headed by a director who is directly subordinated to the district administrator. Besides fishing, the director takes care of all the existing economic activities in the district, including issues relating to land (agriculture, livestock, forestry, and wildlife), tourism, mining, transport, etc. Given the importance of farming in rural areas, this is usually the SDAE's main concern, a fact which gains even further importance from the fact that a large number of managers and technicians originate from this sector.

Comité de co-gestão distrital (Co-management District Council) - This is an advisory body for issues relating to fisheries management in the districts. It is chaired by the administrator himself and by members of the provincial government, representatives of public entities present in the district, and district technicians of public bodies involved in administration or in development issues and management of district fisheries, as well as representatives of all the CCPs, fishermen's associations and any other legal or individual entity involved in fishing in the district deemed important enough to participate. Its composition is determined on a case by case basis, taking into account the reality of each district. This body should be used to: gauge the opinion of various stakeholders, harmonize interests and resolve conflicts. Its recommendations should be considered in decision-making by the district administrator. Unfortunately, it is very seldom used because there are insufficient funds to call all of these participants when needed.

Conselho Consultivo Distrital (District Consultative Council) – This is a consultative body. It gathers the members of the district government and the most influential public and private actors in the district from all business and social sectors. It is most often here that fisheries issues are discussed, since the Co-management District Council rarely meets due to financial constraints.

CCP - Conselho Comunitário de Pesca (Community Fishing Council) – These have been promoted by the IDPPE since the second half of the '90s within the artisanal fisheries projects in southern

Nampula, sponsored by IFAD, as well as others that followed afterwards. Initially, these bodies were primarily aimed at the promotion of artisanal fisheries development but gradually the dynamics of the reality of artisanal fisheries brought management issues to the foreground. After decentralization, the CCPs increased their involvement in the licensing and inspection of industrial fishing. These developments are very diverse, depending on local initiatives, and do not follow a general design or framework.

Other Important actors within co-management are:

Polícia marítima, lacustre e Fluvial (Maritime Police)

Administração/delegação Marítima (Marine Delegation)

Áreas protegidas aquáticas (Protected Marine Areas)

Associações de pescadores e outros pequenos produtores (Fishing associations)

Líder comunitário (Community leader)

Tourism Facilities

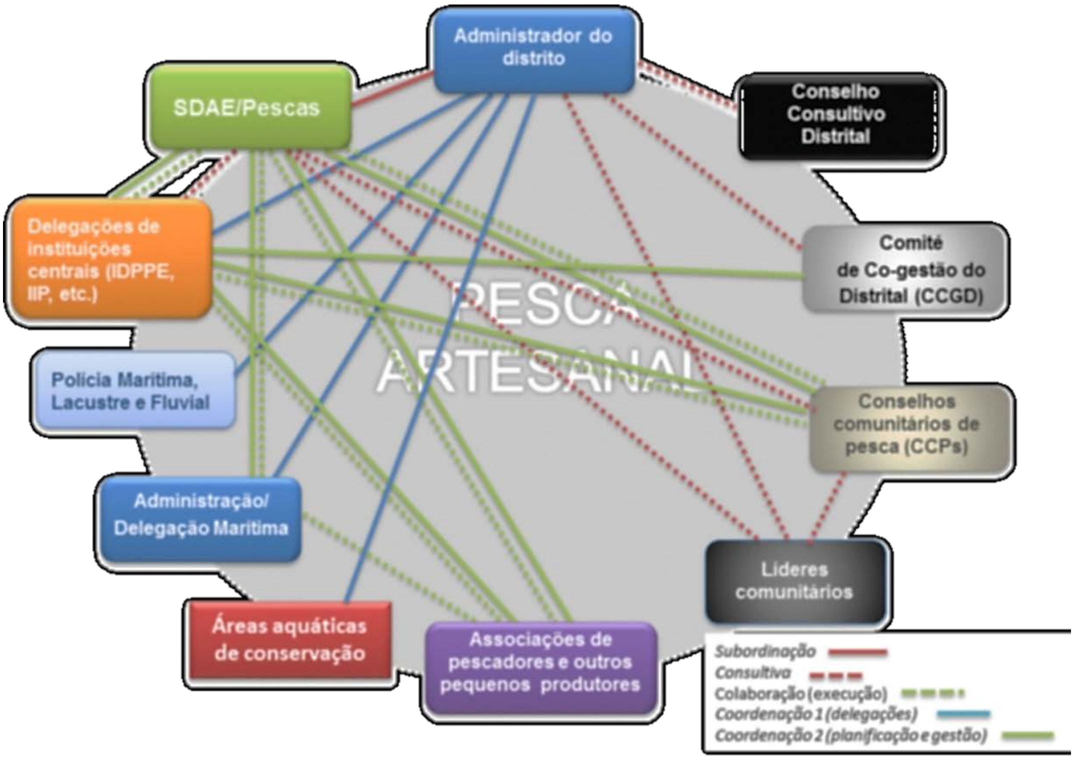


Figure 5 - Co-management structure in Mozambique, showing the interconnections between bodies (REPÚBLICA DE MOÇAMBIQUE, 2012)

The main objectives of co-management as set out in the law are (Sá, 2011):

a) To ensure responsible management
b) To ensure the right to fish
c) To promote community involvement in planning and enforcement of fishery rules
d) To promote the capacity building of fishers
e) To provide a healthy environment that includes all types of fishing and fishers.

The main advantages of co-management as advocated by the fisheries administration (República de Moçambique, 2012):

1) A system which is participatory, democratic, responsible, transparent and autonomous
2) More economically sustainable in the long term
3) The granting of the biggest share of functions to the community, freeing the government
4) The implementation of local fishery plans
5) Greater legitimacy of the management measures
6) Greater efficiency

At the same time, some dangers or disadvantages have been recognized:

a) Large upfront costs
b) Large risks of inefficiency
c) The costs do not always offset the gains
d) Resistance from the fisheries administration
e) Fishers, sellers and others from outside the community can resist the new measures
f) The need for consensus in decision-making can prolong the process beyond a reasonable timespan
g) Co-management can be considered very expensive because it takes a long time to implement
h) It can be used by leaders or wealthier people in their own favor.

The results of co-management will demonstrate whether the model is a useful one. Adaptation and the shaping of the law and mechanisms of co-management to the respective needs will rise from its extensive use. The hope is that it will provide much needed support for the sustainable use of fisheries resources.

1.4 Final remarks

It was intended to introduce co-management in the context of Mozambique's history, with a greater focus on the northern provinces where the cases studies in this thesis were conducted. It was important to give an idea of the level of instability and convulsion in Mozambique's history that has shaped the coastal populations, the fishery centers and the exploitation of fisheries resources in the north. It was important to clarify the ethnic and religious background of northern Mozambique to understand the low levels of educational attainment and inclusion in government initiatives that the IDPPE and others faced when attempting to implement co-management. This is also important from the perspective of understanding some of the positions, actions and reactions of coastal people to the new developments in northern Mozambique. This will definitely shape not only the co-management of fisheries in the north, with new partners and problems, but it will also change the country forever.

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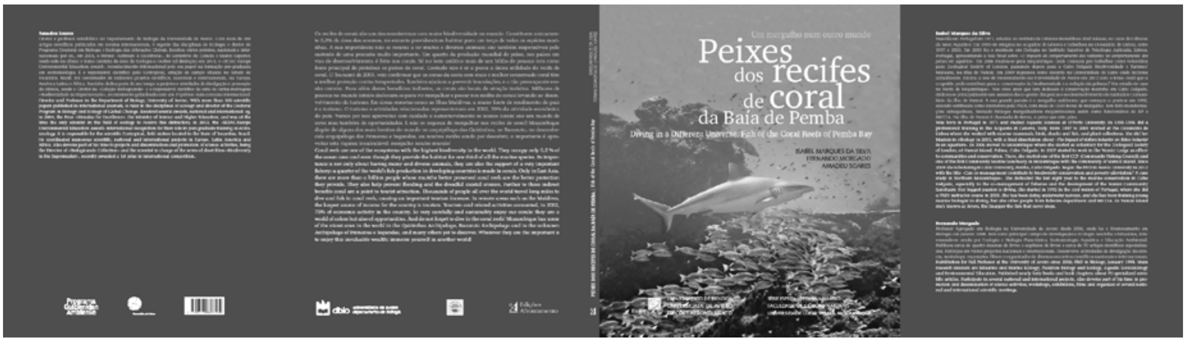
2. Diving in a different universe. Fish of the coral reefs of Pemba bay



Da Silva I. M., Morgado F., Soares A. (2015) Peixes dos recifes de coral da Baía de Pemba. Um mergulho num outro mundo/Diving in a Different Universe. Fish of the Coral Reefs of Pemba Bay. Colecção Biologicando, Edições Afrontamento.

2.1 Abstract

"Diving in a Different Universe. Fish of the Coral Reefs of Pemba Bay" is a book containing 198 species of fish from Pemba Bay and Cabo Delgado province in Mozambique. It was the result of 8 years of diving in the coral reefs, sandy areas and seagrass of the Quirimbas archipelago. In addition to being an identification guide, this book aims to be a tool for raising awareness of the underwater biodiversity of northern Mozambique.

2.2 Introduction

Surveying, mapping, taxonomic characterization, and naming of the marine fish fauna are essential to fishery science. While in the northern hemisphere "everything is known" and the exercise is redundant, in a country like Mozambique, especially in the north, most of the work has yet to be done. Fish stocks are being exploited before the species have been properly identified. It is difficult to advance with conservation plans and management when there is only very little knowledge about the species and subpopulations that are being fished and it is hoped to manage. In co-management, it is no less important that the monitoring is done with proper identification of the species fished or wrong conclusions can be extracted from the monitoring exercises and wrong advice provided to the co-management institutions like the CCPs. In this case, distrust can arise between those doing the monitoring and the fishers/co-management institutions.

Fish identification guides can also be useful for tourism facilities, schools and universities. Their educational role will be easier if they use better and more modern material.

2.3 Methods

This book was the result of 8 years of diving by the author on the Quirimbas archipelago in Cabo Delgado province, Mozambique. Evidence of the presence of fish species was photographically recorded and the photos were archived. To be archived, photographs had to meet a minimum level of quality for use as identification. Minimum quality was defined as: appropriate focus, fish not too distant from the camera, balanced luminosity and colors, and full body visible and parallel to the camera. Photos which met the minimum quality were renamed to show the scientific name of the fish in the photo (maintaining the original number) and filed in a folder according to the family they belong to. All photos in raw format were kept together in a folder with the date and place of the dive. Most of the places also have GPS coordinates. Each of these folders also includes scenic photos with landscapes that allowed the description of the habitat. Fish were mainly identified through recourse to an ensemble of books (Fisher et al., 1990; Lieske & Myers, 1994; Smith & Heemstra, 1986; Taquet & Diringer, 2007). Occasionally, identifications were confirmed with FISHBASE (Froese & Pauly, 2000).

2.4 Results

Table 2 shows the species contained in the book "Diving in a Different Universe. Fish of the Coral Reefs of Pemba Bay" (Annex 1).

Table 2 - List of fish species in Cabo Delgado presented in the book (Annex 1).

Scientific name	Author/Date	English	Portuguese	French
Carcharhinus amblyrhynchos	(Bleeker, 1856)	Blacktail reef shark	Tubarão cinzento de recife	Requin gris de récif
Carcharhinus albimarginatus	(Roppell, 1837)	Silvertip shark	Tubarão de pontas brancas de recife	Requin pointes blanches de récife
Taeniura lymma	(Forsskål, 1775)	Ribbontail stingray	Raia de pintas azuis	Pastenague à taches bleues
Dasyatis brevicaudata	(Hutton, 1875)	Short-tail stingray	Raia	Pastenague
Himantura fai	(Jordan & Seale, 1906)	Pink whipray	Raia	Raie fouet
Gymnothorax favagineus	(Bloch & Schneider, 1801)	Laced moray	Moreia leopardo	Muréne léopard
Gymnothorax javanicus	(Bleeker, 1859)	Giant moray	Moreia gigante	Muréne javanaise
Heteroconger hassi	(Klausewitz & Eibl-Eibesfeldt, 1959	Spotted garden-eel	Enguia de Jardim	Hétérocongre tacheté
Gymnothorax flavimarginatus	(Rüppell, 1830)	Yellow-marginated moray	Moreia de margens amarelas	Murène marbrée
Rhinomuraena quaesita	(Garman, 1888)	Ribbon moray	Moreia fita	Murène ruban
Plotosus lineatus	(Thunberg, 1787)	Stripped eel catfish	Peixe-gato ou patunas	Poisson-chat rayé
Saurida gracilis	(Quoy & Gaimard, 1824)	Gracile lizardfish	Peixe lagarto ou banana	Poisson-lézard
Synodus jaculum	(Russel & Cressey, 1979)	Lighthouse lizardfish	Peixe lagarto	Poisson-lézard
Synodus variegatus	(Lacepède, 1803)	Variegated lizardfish	Peixe lagarto	Poisson-lézard tacheté
Kyphosus cinerascens	(Forsskal, 1775)	Blue sea chub	Preguiçosos	Calicagère bleu
Gnathanodon speciosus	(Forsskal, 1775)	Golden trevally	Xaréu dourado	Carangue royale jaune
Caranx melampygus	(Cuvier, 1833)	Bluefin trevally	Xareu azul	Carangue bleue
Gymnosarda unicolor	(Ruppell, 1836)	Dogtooth tuna	Atum dentudo	Thon dents de chien
Sphyraena jello	(Cuvier, 1829)	Pickhandle barracuda	Barracuda	Barracuda jello
Sphyraena qenie	(Klunzinger, 1870)	Blackfin Barracuda	Barracuda de barbatana negra	Barracuda à nageoires noires
Echeneis naucrates	(Linnaeus, 1758)	Live sharksucker	Remora	Rémora
Bothus sp		Flounder	Solha	Turbot
Monodactylus falciformis	(Lacepéde, 1801)	Full moony	Lunados	Poisson Luné
Myripristis adusta	(Bleeker, 1853)	Shadowfin soldierfish	Peixe soldado	Soldat pourpre
Myripristis berndti	(Jordan & Evermann, 1903)	Blotcheye soldierfish	Peixe soldado	Soldat à grosses écailles
Myripristis kuntee	(Valenciennes, 1831)	Shoulderbar soldierfish	Peixe soldado	Écureuil
Sargocentron praslin	(Lacepède, 1802)	Dark-striped squirrelfish	Peixe esquilo	Écureil
Sargocentron spiniferum	(Forsskal, 1775)	Sabre squirrelfish	Peixe esquilo	Écureil à grandes mâchoires

Scientific name	Author/Date	English	Portuguese	French
Aulostomus chinensis var	(Linnaeus, 1766)	Chinese trumpetfish	Peixe trompetas	Poisson-trompette
Corythoichthys flavofasciatus	(Roppell, 1838)	Network pipefish	Marinhas	Syngnathe à traits jaunes
Hippocampus kuda	(Bleeker, 1852)	Spotted Seahorse	Cavalo-marinho	Hippocampe d'estuaire
Aeoliscus punctulatus	(Bianconi, 1854)	Speckled shrimpfish	Peixe lápis	Poisson-couteau
Solenostomus cyanopterus	(Bleeker, 1854)	Ghost pipefish	Cavalo-marinho fantasma	Poisson-fantôme robuste
Pterois miles	(Bennett, 1828)	Devil firefish	Peixe leão	Rascasse volante
Synanceia verrucosa	(Bloch & Schneider, 1801	Stonefish	Peixe pedra ou rascasso	Poisson-pierre ou Synancée
Scorpaenopsis diabolus	(Cuvier, 1829)	False stonefish	Peixe pedra ou rascasso	Poisson-scorpion diable
Scorpaenopsis oxycephala	(Bleeker, 1849)	Tassled scorpionfish	Peixe escorpião ou rascasso	Poisson-scorpion à houppes
Taenianotus triacanthus	(Lacepéde, 1802)	Leaf scorpionfish	Peixe folha	Poisson-feuille
Antennarius commerson	(Lacepède, 1798)	Giant frogfish	Peixe-sapo de Commerson	Antennaire géant
Pseudoanthias squamipinis	(Peters, 1855)	Sea goldie	Canários do mar	Anthias comum
Pseudanthias evansi	(Smith, 1959)	Yellowback anthias	Canários do mar	Anthias bicolore
Epinephelus lanceolatus	(Bloch, 1790)	Giant grouper	Garoupa gigante	Mérou lancéolé
Epinephelus tukula	(Morgans, 1959)	Potato grouper	Garoupa batata	Mérou patate
Epinephelus fuscoguttatus	(Forsskal, 1775)	Brown-marbled grouper	Garoupa de mármore	Mérou marron
Epinephelus hexagonatus	(Forster, 1801)	Starpotted grouper	Garoupa de manchas estreladas	Mérou mélifère
Epinephelus spilotoceps	(Schultz, 1953)	Foursaddle grouper	Garoupa de 4 riscas	Mérou quatre selles
Epinephelus polyphekadion	(Bleeker, 1849)	Camouflage grouper	Garoupa camuflada	Mérou camouflage
Epinephelus flavocaeruleus	(Lacepéde, 1802)	Blue-and-Yellow grouper	Garoupa azul e amarela	Mérou faraud
Cephalopholis miniata	(Forsskal, 1775)	Coral hind	Garoupa de coral	Vieille étoilée
Cephalopholis argus	(Schneider, 1801)	Peacock hind	Garoupa de coral	Prude ou Vieille cuisinier
Variola albomarginata	(Baissac, 1953)	White-edged lyretail	Garoupa de cauda branca	Croissant queue blanche
Variola louti	(Forsskal, 1775)	Yellow-edged lyretail	Garoupa de cauda amarela	Croissant quele jaune
Plectropomus laevis	(Lacepéde, 1801)	Blacksaddled coral grouper	Garoupa de listas pretas	Babone ou mérou sellé
Gracila albomarginata	(Fowler & Bean, 1930)	Maked grouper	Garoupa	Mérou bord rouge
Paracirrhites arcatus	(Cuvier, 1829)	Arc-eye hawkfish	Peixe falcão	Épervier strié
Paracirrhites forsteri	(Schneider, 1801)	Blackside hawkfish	Peixe falcão	Épervier à tête ponctuée
Caesio xanthonota	(Bleeker, 1853)	Yellowback fusilier	Fuzileiro de crista amarela	Fusilier à dos jaune
Caesio lunaris	(Cuvier, 1830)	Lunar fusilier	Fuzileiro	Caesio à croissant
Pterocaesio tile	(Cuvier, 1830)	Dark-banded fusilier	Fuzileiro de listas pretas	Caesio tricolore
Pterocaesio diagramma	(Bleeker, 1864)	Double-lined fusilier	Fuzileiro de duas linhas	Fusilier à deux bandes jaunes

Scientific name	Author/Date	English	Portuguese	French
Parupeneus trifasciatus	(Lacepéde, 1801)	Doublebar goatfish	Salmonete de duas barras	Capucin manuel
Parupeneus barberinus	(Lacepéde, 1801)	Dash-and-dot goatfish	Salmonete com pintas	Capucin barberin
Parupeneus cyclostomus	(Lacepéde, 1801)	Gold-saddle goatfish	Salmonete de barras douradas	Capucin barbet doré
Mulloidichthys flavolineatus	(Lacepéde, 1801)	Yellowstripe goatfish	Salmonete	Capucin nain ou Capucin carême
Mulloidichthys vanicolensis	(Valenciennes, 1831)	Yellowfin goatfish	Salmonete de barbatanas amarelas	Capucin à nageoires jaunes
Lutjanus bohar	(Forsskal, 1775)	Two-spot red snapper	Pargo vermelho de pintas	Vivaneau chien rouge ou Vara vara
Lutjanus monostigma	(Cuvier, 1828)	One-spot snapper	Pargo de uma pinta	Vivaneau églefin
Lutjanus rivulatus	(Cuvier, 1828)	Blubberlip snapper	Pargo de lábios carnudos	Vivaneau maori
Lutjanus fulvus	(Forster, 1801)	Blacktail snapper	Pargo de cauda preta	Vivaneau à quele noire
Lutjanus kasmira	(Forsskal, 1775)	Common bluestripe snapper	Pargo de listas azuis	Vivaneau à raies bleues
Plectorhinchus gaterinus	(Forsskal, 1775)	Blackspotted rubberlip	Pargo de lábios grossos	Gaterin moucheté
Plectorhinchus flavomaculatus	(Cuvier, 1830)	Lemonfish	Pargo	Gaterin citron
Plectorhinchus orientalis	(Linnaeus, 1758)	Indian Ocean oriental sweetlips	Pargo oriental	Gaterin bagnard
Plectorhinchus playfairi	(Pellegrin, 1914)	Whitebarred rubberlip	Pargo ou Pedra	Gaterin à barres blanches
Macolor niger	(Forsskal, 1775)	Black and white snapper	Pargo ou pedra	Vivaneau plate
Monotaxis grandoculis	(Forsskal, 1775)	Humpnose big-eye bream	Sargo de olho grande	Capitaine bossu ou gueule pavée
Gnathodentex aureolineatus	(Lacepède, 1802)	Striped large-eye bream	Sargo de riscas	Capitaine strié
Lethrinus nebulosus	(Forsskal, 1775)	Spangled emperor	Ladrões ou imperadores	Capitaine blanc
Lethrinus obsoletus	(Forsskal, 1775)	Orange-striped emperor	Ladrões ou imperadores	Capitaine à bandes orange
Lethrinus erythracanthus	(Valenciennes, 1830)	Orange-spotted emperor	Ladrões ou imperadores	Capitaine empereur
Platax orbicularis	(Forsskal, 1775)	Orbicular batfish	Peixe morcego	Platax rond
Chaetodon auriga	(Forsskal, 1775)	Threadfin butterflyfish	Peixe borboleta	Papillon cocher
Chaetodon melannotus	(Bloch & Schneider, 1801)	Blackback butterflyfish	Peixe borboleta	Papillon à dos noir
Chaetodon interruptus	(Ahl, 1923)	Yellow teardrop butterflyfish	Peixe borboleta	Papillon à larme de l’océan Indien
Chaetodon Madagaskariensis	(Ahl, 1923)	Seychelles butterflyfish	Peixe borboleta de Madagascar	Papillon de Madagascar
Chaetodon trifascialis	(Quoy & Gaimard, 1825)	Chevron butterflyfish	Peixe borboleta	Papillon à chevrons
Chaetodon xanthocephalus	(Bennett, 1833)	Yellowhead butterflyfish	Peixe borboleta	Papillon à tête jaune
Chaetodon guttatissimus	(Bennett, 1833)	Peppered butterflyfish	Peixe borboleta	Papillon moucheté
Chaetoddon kleinii	(Bloch, 1790)	Sunburst butterflyfish	Peixe borboleta	Papillon de Klein
Chaetodon bennetti	(Cuvier, 1831)	Bluelashed butterflyfish	Peixe borboleta de Bennett	Papillon de Bennett

Scientific name	Author/Date	English	Portuguese	French
Chaetodon lunula	(Lacepède, 1802)	Raccon butterflyfish	Peixe borboleta	Papillon raton laveur
Chaetodon trifasciatus	(Park, 1797)	Melon butterflyfish	Peixe borboleta	Papillon côtelé indien
Chaetodon vagabundus	(Linnaeus, 1758)	Vagabond butterflyfish	Peixe borboleta	Papillon vagabond
Chaetodon zanzibariensis	(Playfair, 1867)	Zanzibar butterflyfish	Peixe borboleta de Zanzibar	Papillon de Zanzibar
Chaetodon meyeri	(Bloch & Schneider, 1801)	Scrawled butterflyfish	Peixe borboleta de Meyer	Papillon de Meyer
Forcipiger flavissimus	(Jordan & Mc Gregor, 1898)	Longnose butterfly fish	Peixe borboleta narigudo	Poisson pincette à long nez
Hemitauricthys zoster	(Bennett, 1831)	Brown-and-white butterflyfish	Peixe borboleta pirâmide	Papillon pyramide noir
Heniochus acuminatus	(Linnaeus, 1758)	Pennant coralfish	Peixe borboleta	Poisson cocher commun
Heniochus diphreutes	(Jordan, 1903)	False moorish idol	Falso ídolo mourisco	Poisson cocher
Pomacanthus imperator	(Bloch, 1787)	Emperor angelfish	Peixe-anjo imperador	Poisson-ange empereur
Pygoplites diacanthus	(Boddaert, 1772)	Rogal angelfish	Peixe-anjo real	Poisson-ange duc
Pomacanthus chrysurus	(Cuvier, 1831)	Goldtail angelfish	Peixe-imperador de cauda dourada	Poisson-ange à oreille tachée
Pomacanthus semicirculatus	(Cuvier, 1831)	Semicircle angelfish	Peixe-anjo semicircular	Poisson-ange à demi-cercles
Apolemichthys trimaculatus	(Cuvier, 1831)	Threespot angelfish	Peixe-anjo trimaculado	Poisson-ange trois taches
Centropyge bispinosa	(Gonther, 1860)	Twospined angelfish	Peixe-anjo de duas espinhas	Poisson-ange nain à deux épines
Chromis dimidiata	(Klunzinger, 1871)	Chocolatedip chromis	Castanheta chocolate	Chromis à deux couleurs
Chromis ternatensis	(Bleeker, 1856)	Ternate chromis	Castanheta	Chromis à quele d'hirondelle
Chromis opercularis	(Gonther, 1867)	Doublebar chromis	Castanheta com duas barras	Chromis à tache operculaire noire
Abudefduf sparoides	(Quoy & Gaimard, 1825)	False-eye sergeant	Sargento de olho falso	Sergent-major à tache ovale
Abudefduf vaigiensis	(Quoy & Gaimard, 1825)	Indo-Pacific sergeant	Sargento do Indo-Pacífico	Poisson bagnard
Dascyllus aruanus	(Linnaeus, 1758)	Whitetail dascyllus	Castanheta de cauda branca	Demoiselle à trois bandes noires
Pomacentrus caeruleus	(Quoy & Gaimard, 1825)	Caerulean damsel	Castanheta	Demoiselle
Pomacentrus sulfureus	(Klunzinger, 1871)	Sulphur damsel	Castanheta azul	Demoiselle blue
Pomacentrus philippinus	(Evermann & Seale, 1907)	Philippine damsel	Castanheta	Demoiselles des Philippines
Plectroglyphidodon lacrymatus	(Quoy & Gaimard, 1825)	Whitespotted devil	Castanheta do diabo	Demoiselle à points bleus
Plectroglyphidodon dickii	(Lionard, 1839)	Blackbar devil	Castanheta	Demoiselle à barre noire
Neoglyphidodon melas	(Cuvier, 1830)	Bowtie damselfish	Castanheta	Demoiselle noire
Amblyglyphidodon indicus	(Bleeker, 1847)	Yellowbelly damselfish	Castanheta	Demoiselle jaune
Amphiprion allardi	(Klausewitz, 1970)	Twobar anemonefish	Peixe palhaço de Allard	Poisson-clown d'Allard
Amphiprion akallopisos	(Bleeker, 1853)	Skunk clownfish	Peixe palhaço	Poisson-clown mouffette

Scientific name	Author/Date	English	Portuguese	French
Anampses meleagrides	(Valenciennes, 1840)	Spotted wrasse	Bodião pintado de cauda amarela	Labre à queue jaune
Anampses twistii	(Bleeker, 1856)	Yellowbreasted wrasse	Bodião de ventre amarelo	Labre à poitrine jaune
Anampses lineatus	(Randall, 1972)	Lined wrasse	Bodião listado	Labre à tirets blancs
Bodianus anthioides	(Bennett, 1832)	Lyretail anthioides	Bodião de cauda em lira	Labre lyre
Bodianus axillaris	(Bennett, 1832)	Axilspot hogfish	Bodião axilar	Labre à tache axillaire
Cheilinus fasciatus	(Bloch, 1791)	Redbreast wrasse	Bodião de ventre vermelho	Labre maori rayé
Cheilinus undulatus	(Roppel, 1835)	Humphead wrasse	Bodião Napoleão	Napoléon
Coris aygula	(Lacepède, 1801)	Clown coris	Bodião palhaço	Girelle-clown
Coris formosa	(Bennett, 1830)	Queen coris	Bodião rainha	Girelle reine
Coris cuvieri	(Bennett, 1831)	African coris	Bodião africano	Girelle africaine
Epibulus insidiator	(Pallas, 1770)	Sling-jaw wrasse	Bodião de mandibula amovível	Labre traître
Gomphosus caeruleus	(Lacepède, 1801)	Green birdmouth wrasse	Bodião pássaro	Labre oiseau indien
Halichoeres hortulanus	(Lacepède, 1801)	Checkerboard wrasse	Bodião	Labre échiquier
Halichoeres iridis	(Randall & Smith, 1982)	Iris wrasse	Bodião arco-iris	Labre arc-en-ciel
Halichoeres scapularis	(Bennett, 1832)	Zigzag wrasse	Bodião zig-zag	Labre zigzag
Hemigymnus melapterus	(Bloch, 1791)	Blackeye thicklip	Bodião de olho negro	Tamarin bicolore
Hemigymnus fasciatus	(Bloch, 1792)	Barred thicklip	Bodião de barras	Tamarin à bandes
Iniistius pavo	(Valenciennes, 1840)	Peacock wrasse	Bodião pavão	Rason Commun
Labroides dimidiatus	(Valenciennes, 1839)	Bluestreak cleaner wrasse	Bodião limpador	Labre nettoyeur commun
Oxycheilinus mentalis	(Ruppell, 1828)	Mental wrasse	Bodião Mental	Labre mental
Thalassoma amblycephalum	(Bleeker, 1856)	Bluntheaded wrasse	Bodião	Labre ruban à tache rouge
Thalassoma hebraicum	(Lacepède, 1801)	Goldbar wrasse	Bodião de barras douradas	Girelle-paon jaune
Thalassoma hardwicke	(Bennett, 1830)	Sixbar wrasse	Bodião de seis barras	Girelle-paon à taches d'encre
Cetoscarus ocellatus(bicolor)	(Ruppell, 1829)	Bicolour parrotfish	Papagaio de duas cores	Perroquet bicolore
Bolbometopon muricatum	(Valenciennes, 1840)	Green humphead parrotfish	Papagaio de bossa ou gigante	Perroquet bossu
Chlorurus gibbus	(Ruppell, 1829)	Heavybeak parrotfish	Papagaio de bico	Perroquet machoîron
Chlorurus sordidus	(Forsskal, 1775)	Daisy parrotfish	Papagaio	Perroquet marguerite
Hipposcarus harid	(Forsskal, 1775)	Candelamoa parrotfish	Papagaio amarelo de cabeça grande	Perroquet jaune à longue tête
Scarus caudofasciatus	(Gunther, 1862)	Redbarred parrotfish	Papagaio de listas vermelhas	Perroquet à quele barrée
Scarus frenatus	(Lacepède, 1802)	Bridled parrotfish	Papagaio de seis barras	Perroquet à six bandes
Scarus niger	(Forsskal, 1775)	Dusky parrotfish	Papagaio dourado	Perroquet dorade
Scarus prasiognathos	(Valenciennes, 1840)	Singapore parrotfish	Papagaio de Singapura	Parroquet de Singapour
Scarus rubroviolaceus	(Bleeker, 1847)	Ember parrotfish	Papagaio	Perroquet braisé
Scarus scaber	(Valenciennes, 1840)	Fivesaddle parrotfish	Papagaio de cinco listas	Perroquet à cinq selles

Scientific name	Author/Date	English	Portuguese	French
Scarus tricolor	(Bleeker, 1847)	Tricolour parrotfish	Papagaio	Perroquet tricolore
Cirripectes stigmaticus	(Strasburg & Schultz, 1953)	red-streaked blenny	Marachomba	Gobie
Ecsenius sp		Blenny	Bleniídeo	Blennies
Gnatholepis cauerensis	(Bleeker, 1853)	Eyebar goby	Caboz	Gobie
Nemateleotris magnifica	(Fowler, 1938)	Fire goby	Peixe flecha de fogo	Poisson-fléchette de feu
Ptereleotris evides	(Jordan & Hubbs, 1925)	Blackfin dartfish	Peixe flecha de barbatanas pretas	Poisson-fléchette noir
Plagiotremus rhinorhynchos	(Bleeker, 1852)	Bluestriped fangblenny		Blenne à rayures bleues
Acanthurus leucosternon	(Bennett, 1833)	Powderblue surgeonfish	Peixe cirurgião azul	Chirurgien bleu
Acanthurus lineatus	(Linnaeus, 1758)	Lined surgeonfish	Peixe cirurgião zebra	Chirurgien zèbre
Acanthurus triostegus	(Linnaeus, 1758)	Convict surgeonfish	Peixe cirurgião	Chirurgien bagnard
Acanthurus nigricauda	(Duncker & Mohr, 1929)	Epaulette surgeonfish	Peixe cirurgião de cauda negra	Chirurgien à épaulette
Acanthurus blochii	(Valenciennes, 1835)	Ringtail surgeonfish	Peixe cirurgião de Blooch	Chirurgien de Bloch
Acanthurus dussumieri	(Valenciennes, 1835)	Eyestripe surgeonfish	Peixe cirurgião de risca no olho	Chirurgien couronné
Acanthurus nigrofuscus	(Forsskal, 1775)	Brown surgeonfish	Peixe cirurgião castanho	Chirurgien brun
Ctenochaetus binotatus	(Randall, 1955)	Twospot surgeonfish	Barbeiro de duas manchas	Chirurgien à deux points
Naso brevirostris	(Cuvier, 1829)	Spotted unicornfish	Rufia ou Unicórnio malhado	Licorne pointue
Naso hexacanthus	(Bleeker, 1855)	Sleek unicornfish	Unicórnio cinzento	Licorne grise
Naso lituratus	(Forster, 1801)	Orangespine unicornfish	Unicórnio de espinha laranja	Licorne de spine orange
Naso vlamingii	(Valencienne, 1835)	Bignose unicornfish	Rufia ou Unicórnio narigudo	Licorne à gros nez
Paracanthurus hepatus	(Linnaeus, 1766)	Palette surgeonfish	Cirurgião palete	Chirurgien palette
Zanclus cornutus	(Linnaeus, 1758)	Moorish idol	Ídolo Mourisco	Idole maure
Zebrassoma scopas	(Cuvier, 1829)	Twotone tang	Canivete acastanhado	Chirurgien voile brun
Zebrassoma desjardinii	(Bennett, 1836)	Indian Sail-fin tang	Canivete veleiro do Índico	Chirurgien voile indien
Siganus sutor	(Valenciennes, 1835)	Shoemaker spinefoot	Peixe coelho sapateiro	Cordonnier
Siganus stellatus	(Forsskal, 1775)	Brown-spotted spinefoot	Peixe coelho estrelado	Cordonnier marguerite
Balistapus undulatus	(Park, 1797)	Orange-lined triggerfish	Peixe-porco de linhas laranjas	Baliste strié
Balistoides conspicillum	(Bloch & Schneider, 1801)	Clown triggerfish	Peixe-porco palhaço	Baliste-clown
Balistoides viridescens	(Bloch & Schneider, 1801)	Titan triggerfish	Peixe-porco titã	Baliste titan
Melichtys indicus	(Randall & Klausewitz, 1973)	Indian triggerfish	Peixe-porco do Índico	Baliste indien
Odonus niger	(Ruppell, 1836)	Red-tooth triggerfish	Peixe-porco de dente vermelho	Baliste bleu
Rhinecanthus aculeatus	(Linnaeus, 1758)	White-banded triggerfish	Peixe-porco picasso	Baliste picasso clair
Sufflamen bursa	(Bloch & Schneider, 1801)	Boomerang triggerfish	Peixe-porco	Baliste carène

Scientific name	Author/Date	English	Portuguese	French
Sufflamen chrysopterum	(Bloch & Schneider, 1801)	Halfmoon triggerfish	Peixe-porco	Baliste à gorge bleue
Oxymonacanthus longirostris	(Bloch & Schneider, 1801)	Harlequin filefish	Peixe-livro	Poisson-lime à taches orange
Xanthichthys auromarginatus	(Bennett, 1832)	Gilded triggerfish	Peixe-porco	Baliste à bord jaune
Ostracion meleagris	(Shaw, 1796)	Whitespotted boxfish	Peixe caixa	Poisson-coffre pintade
Arothron mappa	(Lesson, 1831)	Map puffer	Peixe balão mapa	Poisson-ballon griffonné
Arothron nigropunctatus	(Bloch & Schneider, 1801)	Blackspotted puffer	Peixe balão	Poisson-ballon jaune
Arothron hispidus	(Linnaeus, 1758)	White-spotted puffer	Peixe balão de manchas brancas	Poisson-ballon à taches blanches
Canthigaster valentini	(Bleeker, 1853)	Valentini's Sharpnose Puffer	Balão valentino	Canthigaster à selles
Canthigaster bennetti	(Bleeker, 1854)	Bennett's sharpnose puffer	Balão de Bennet	Canthigaster de Bennett
Canthigaster smithae	(Allen & Randall, 1977)	Bicolored toby	Balão de duas côres	Canthigaster bicolore
Canthigaster solandri	(Richardson, 1845)	Spotted sharpnose	Balão manchado	Canthigaster tacheté
Diodon liturosus	(Shaw, 1804)	Black-blotched porcupinefish	Peixe-porco com espinhos	Diodon à longues épines

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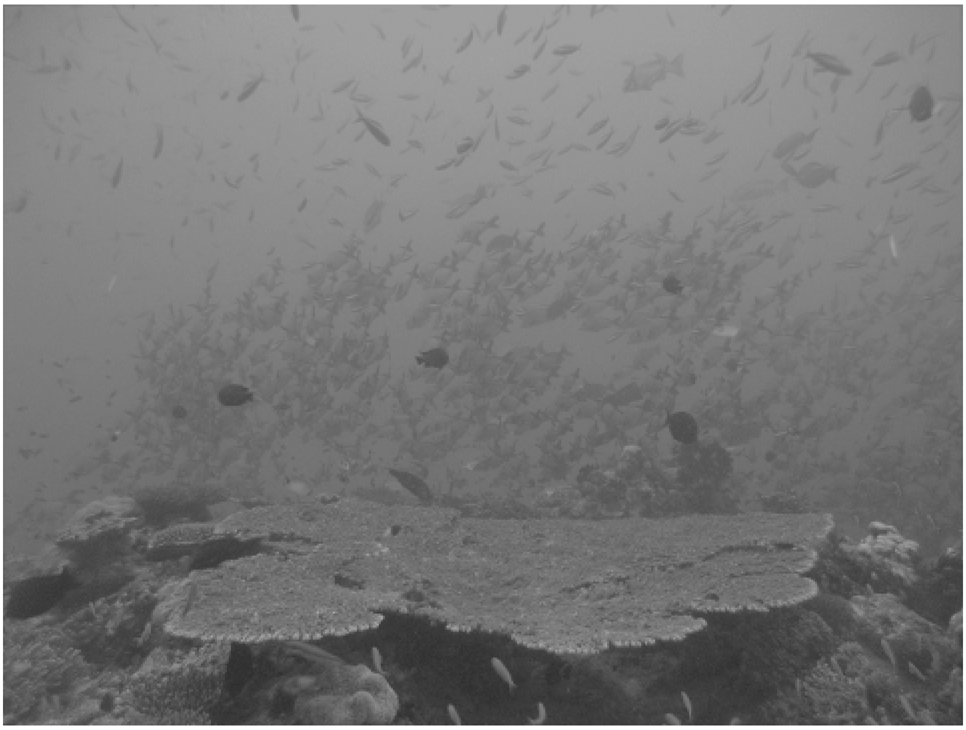
3. Spillover effects of a community-managed marine reserve



da Silva, I.M., Hill, N., Shimadzu, H., Soares, A.M.V.M., Dornelas, M. (2015) Spillover Effects of a Community-Managed Marine Reserve. PLoS ONE 10(4): e0111774. doi:10.1371/journal.pone.011177

3.1 Abstract

The value of no-take marine reserves as fisheries-management tools is controversial, particularly in high-poverty areas where human populations depend heavily on fish as a source of protein. Spillover, the net export of adult fish, is one mechanism by which no-take marine reserves may have a positive influence on adjacent fisheries. Spillover can contribute to poverty alleviation, although its effect is modulated by the number of fishermen and fishing intensity. In this study, we quantify the effects of a community-managed marine reserve in a high poverty area of northern Mozambique. For this purpose, underwater visual censuses of reef fish were undertaken at three different times: 3 years before the marine reserve was established (2003), at the time it was established (2006) and 6 years after it was established (2012). The survey locations were chosen inside, outside and on the border of the marine reserve. Benthic cover composition was quantified at the same sites in 2006 and 2012. After the reserve had been established, fish sizes were also estimated. Regression tree models show that the distance from the border and the time after reserve establishment were the variables with the strongest effect on fish abundance. The extent and direction of the spillover depends on trophic group and fish size. Poisson generalized linear models show that, prior to the reserve being established, the survey sites did not differ, but, after 6 years, the abundance of all fish inside the reserve had increased and caused spillover of herbivorous fish. Spillover was detected 1km beyond the limit of the reserve for small herbivorous fishes. Six years after the establishment of a community-managed reserve, the fish assemblages had changed dramatically inside the reserve, and spillover is benefitting fish assemblages outside the reserve.

3.2 Introduction

The world's oceans are subject to myriad threats including overexploitation of species, coastal development, land-based pollution, energy practices, aquaculture, land use and transformation, water use, shipping practices, and climate change (Birkeland, 2004; Burke, Reytar, Spalding, & Perry, 2011; Hughes et al., 2003). These threats, coupled with continued growth of the human population and migration to coastal areas, are driving unanticipated, unprecedented and complex changes to the world's oceans (Halpern et al., 2003). Marine Protected Areas (MPAs) are one of the most often advocated management options to protect oceans from these threats. They are one of the easiest management approaches for non-specialists to grasp, making MPAs an alluring alternative to complex arrays of management tools (Gell & Roberts, 2003; Roberts, Bohnsack, Gell, Hawkins, & Goodridge, 2001). MPAs also represent a more holistic approach to management. However, their design is often more political and social than based on ecological and fisheries science (Halpern, 2003), and can be implemented in situations of limited information (Sanchirico, 2000). MPAs are widely used, and their use is likely to increase in the future. For example, several large-scale marine reserves, the size of California or bigger, were declared around the world to fulfill the goal of 10% of oceans protected as MPAs by 2020, as proposed by the Convention on Biological Diversity. Since 1990, MPAs have increased in number by 58% and in extent by 48% (Bertzky et al., 2012).

An MPA can have different zones, including: No-take areas, where fishing is prohibited or restricted (e.g. only some gear types allowed); buffer zones; and zones reserved for different activities like sport fishing or aquaculture (Lubchenco, Palumbi, Gaines, & Andelman, 2003). Larger MPAs allow different zoning for different activities, providing spatial separation of incompatible human activities and reducing conflict among stakeholders (Day, 2002). The most restrictive MPAs are Marine Reserves (MRs), normally dedicated to the protection of biodiversity and ecosystems. To maximize the benefits to fisheries, networks of several small MRs tend to work better than fewer, bigger MRs, but if the goal is conservation a smaller number of larger MRs is better (Hastings & Botsford, 2003).

MPAs can be established with different goals. They are a central tool for ecosystem-based management, conferring protection on species and habitats from fishing within their borders and also issuing control measures for pollution, gas and oil exploration, and coastal development (Halpern, Lester, & McLeod, 2010; Hooker & Gerber, 2004; Worm et al., 2009). They are implemented for biodiversity conservation and to protect certain zones for underwater tourism, which has become very important for many island and coastal countries (Graham et al., 2011; ISRS, 2004). However, the most common, and most controversial, goal of MPAs is to enhance fisheries (Foale & Manele, 2004; Halpern & Warner, 2003; Jones, 2002; Mccay & Jones, 2011; T. R. McClanahan & Mangi, 2000; Russ, Alcala, Maypa, Calumpong, & White, 2004; Sanchirico, 2000; Willis, Millar, Babcock, & Tolimieri, 2003) through the export of larvae and adults from the protected areas into the surrounding unprotected areas (Christie et al., 2010). Despite the potential benefits of MPAs, prohibiting extractive uses can have socio-economic costs such as the loss of income from fishing, and/or the increased costs of having to fish further away (Adams, Mills, Jupiter, & Pressey, 2011 ; Klein, Steinback, Scholz, & Possingham, 2008). It can be difficult to defend these costs, especially when they are imposed on extremely poor communities where local inhabitants rely on the fish they catch as their only source of protein (Fenner, 2012; Rosendo, Brown, Joubert, Jiddawi, & Mechisso, 2011), unless there are unequivocal gains in terms of enhanced fisheries or other forms of poverty alleviation.

Inside MRs, full protection from fishing usually leads to a rapid increase in density and biomass of previously exploited populations. Species richness increases, alongside the size of individuals, and the age structure of fish populations (Gell & Roberts, 2003; Halpern, 2003; Halpern & Warner, 2003; Micheli, Halpern, Botsford, & Warner, 2004). Dividing species into targeted and non-targeted reveals that only target species tend to increase significantly in number within MRs; non-target species tend to remain the same or even decrease (McClanahan & Arthur, 2001; McClanahan & Mangi, 2000; Micheli et al., 2004), due to an increase in predators inside the MR. MRs foster habitat recovery from fishing disturbances and allow different assemblages of species and habitat improvement (for example increased coral cover) (Gell & Roberts, 2002). In the Caribbean, MRs have been shown to enhance the recovery of coral reefs (Mumby & Harborne., 2010; Selig & Bruno, 2010) by preventing the overfishing of herbivorous fishes that keep the substrate free for new coral recruits.

MPAs can generate conflicts between users (e.g. fishermen vs. others) and between objectives (e.g. conservation vs. fisheries). Opponents contend that many MPAs are just “paper parks”, impossible to properly enforce, or that they simply displace fishing effort to zones without effective management (Hilborn, 2013). Others insist that while efforts to increase the size and number of MPAs must continue, solutions that stabilize the size of the human population and our demands on biodiversity need to be found and implemented (C. Mora & Sale, 2011). One of the main benefits proclaimed is the enhancement of fisheries around the areas of protection: they increase fish abundance inside the protected area and eventually this effect extends outside. However, whether MPAs truly enhance fisheries remains controversial (Foale & Manele, 2004; Halpern & Warner, 2003; Jones, 2002; Mccay & Jones, 2011; McClanahan & Mangi, 2000;. Russ et al., 2004; Sanchirico, 2000; Willis et al., 2003).

Fisheries can profit from two different processes after the initial recovery inside the MR: the export of propagules (recruitment effect), and the export of adults (spillover effect) outside of the MR (Abesamis, Russ, & Alcala, 2006; Bohnsack, 1993; Chapman & Kramer, 1999; Russ & Alcala, 1996). Additionally, fish from MRs are relatively naïve to fishing and therefore more easily fished (Januchowski-Hartley, Graham, Cinner, & Russ, 2013). The intensity of these effects, both inside and outside the MR, depends on: 1. Location: MRs with similar habitats inside and outside the border maximize spillover (Ashworth & Ormond, 2005; Roberts, 2000); 2. Size: bigger reserves are preferable for conservation effects, but smaller MRs increase the border/area ratio and hence the spillover (Roberts, 2000); 3. Duration of the protection: abundances build up first inside the MR before spillover starts to happen (Claudet et al., 2008); 4. Isolation: whether the MR is isolated or part of a network (where the appropriate spacing between MRs is crucial); 5. Connectivity: exchange of larvae between the protected areas is especially important for conservation efforts (Palumbi, 2004; Roberts, Halpern, Palumbi, & Warner, 2001). All these variables mean that the benefits of MRs are not always immediately detectable.

The dimensions and "visibility" of the spillover effect are critical to the acceptance of MRs by fishermen (Gell & Roberts, 2003). However, the effects of MRs can take from as little as 3 years (Babcock et al., 2010; Polunin & Roberts, 1993) to several decades to be detectable (Babcock et al., 2010). Spillover can take even longer to detect, and the length of this period also varies among studies (McClanahan & Mangi, 2000; Roberts, Bohnsack et al., 2001; Russ & Alcala, 1996). The spillover effect can differ from one taxonomic group to another and it also depends on whether the species is targeted by fishermen outside the MR (Gell & Roberts, 2002). In general when fishing intensity is low, the difference between the MR and outside areas is not significant (Ashworth & Ormond, 2005). Depending on all these factors, the spillover effect can be traced to 200-300m (Abesamis & Russ, 2005; Roberts, Bohnsack et al., 2001) or even 500m to 1-2km (McClanahan & Mangi, 2000) from the MR border. Spillover can either be masked or reinforced by habitat variables (Chapman & Kramer, 1999) or by the amount of exploitation suffered before the MR was implemented (Simon Jennings, 2001). Additionally, lack of compliance and enforcement can render MRs inefficient (Cressey, 2011; Dulvy, 2013; Hilborn, 2013). Also, high fishing intensity just outside the MR border, known as "fishing the line"(Kellner, Tetreault, Gaines, & Nisbet, 2007), can mask the spillover effect, and increase the relative differences in fish abundance between the MR and the unprotected surrounding areas. Occasionally, the existence of an MPA attracts fishermen from other regions increasing fishing effort around it and contributing to the masking of the spillover effect (Hilborn, 2013). This 'attraction' phenomenon is common in community-managed areas where legal ownership is hard to establish (Cinner, 2005).

Spillover is the key to an MR being accepted as a fisheries-management tool. The strength and visibility of spillover effects are the main criteria by which local communities assess the success of an MR. This study is dedicated to the detection of these effects from a small, community-managed MR. Our main questions are: Does the MR affect fish abundances? Can we detect spillover? Are there differences in spillover between trophic groups or fishes of different sizes? In a very remote and poor area such as the location of our study (Vamizi Island, Mozambique), the information gathered is crucial to allow Mozambican Government representatives and co-management institutions to assess the effectiveness of small community marine reserves in enhancing and supporting nearby fisheries (Samoilys et al., 2007; Zeller, Stoute, & Russ, 2003).

3.3 Material and Methods

3.3.1 Study site

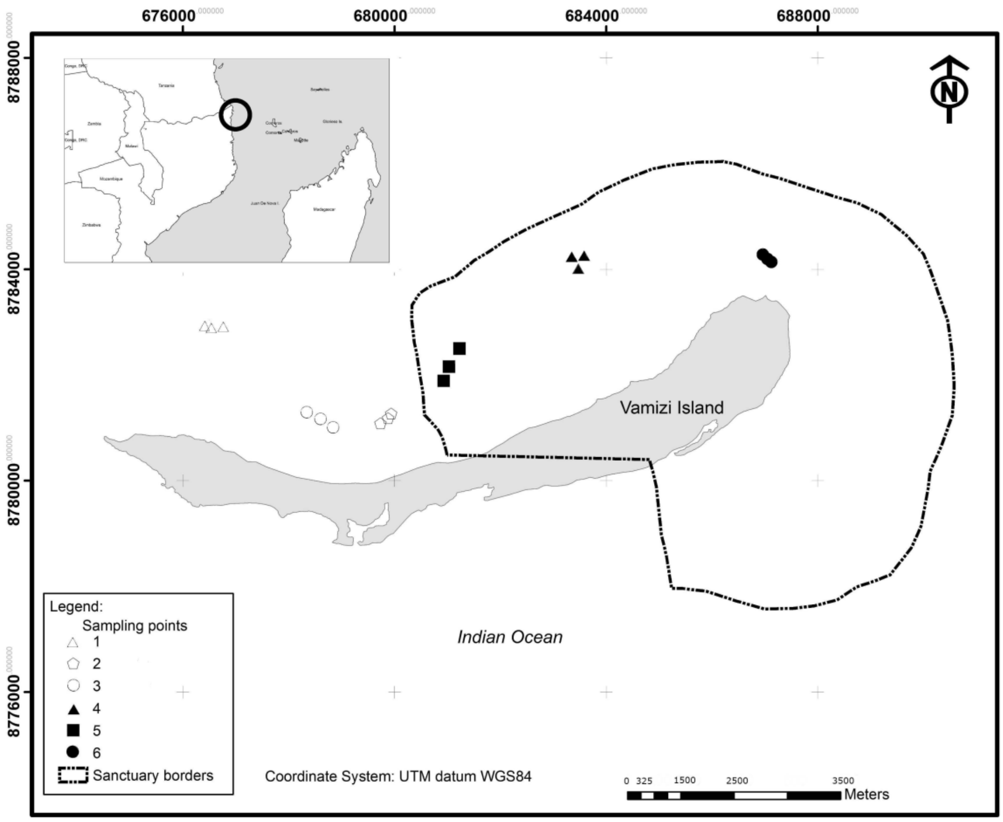


Figure 6 - Map of Vamizi Island and location in Mozambique. Locations 1 ,2 and 3 outside the MR. Locations 4, 5 and 6 inside the MR

Vamizi is a 48 km2 island located in the Quirimbas archipelago in northern Mozambique (Figure 6), 40 km south of the Tanzanian border. The island has a permanent population of around 1500 people, which doubles in the dry season due to the annual migration of fishermen from Nacala, located in the adjacent southern province (Wiomsa, 2011). The island is far from urban centers and the region is largely undeveloped. On the east side of the island, an ecotourism lodge has been promoting conservation since 2000. Between December and March, the prevailing winds are from the north; the rest of the year they are from the south. To the north, Vamizi's lagoon finishes in a reef crest, leading to a wall which drops down 200-500 m in eastern locations, and a slope to the same depths in the west. The south side of the island has a gentle slope into shallow reef flats of seagrass, macroalgae and coral bommies. On the north side, coral forms a continuous barrier of live cover of between 30-60% and dominated by Acropora species (Hill et al., 2009).

In 2006, a 38 Km2 marine reserve was created by the community around the east point of the island, within which fishing is not permitted. The west point of the island around the villages was excluded from the marine reserve. The community enforces the no-take status with support from the lodge. In 2011, WWF (The World Wide Fund for Nature) began running a conservation project for the lodge, promoting the engagement of both the lodge and the communities with the marine reserve.

3.3.2 Sampling design

To quantify the effect of the MR, the state of reef communities was assessed using an underwater visual census (UVC) at sites inside and outside the MR (Figure 6). Sites with similar wind, current and topographic characteristics were selected to facilitate comparisons between treatment (inside the MR) and control (outside the MR) locations. Surveys were conducted at two sites in 2003 (before MR establishment), at four sites in 2006 (during establishment) and at six sites in 2012 (6 years after establishment). In 2012 more sites were surveyed near the border of the MR to enable quantification of the spatial extent of the spillover effect (figure 1). UVC is an indirect way of assessing spillover, as it does not involve tagging fish or tracking fish provenance. However, it is a reliable, non-destructive method with an established track record for detecting the effects of MRs (Abesamis et al., 2006; Chapman & Kramer, 1999). All of the 2012 surveys were conducted at 10m depth because surveys in 2003 and 2006 had shown no significant differences between two initial survey depths. Fish abundance data was collected in all years, but in 2006 and 2012 benthic variables (see below) were also collected.

At each site we quantified fish abundance, benthic cover and rugosity. Fish abundance is predicted to change directly as a result of the establishment of the MR. Quantifying benthic habitat and rugosity is important in order to control the effect of benthic variables on fish abundances allowing us to disentangle the effects of the MR and habitat factors. The positions of the survey sites along the border allow tracking of the changes in fish abundances along the gradient of the MR, and detection of spillover. UVCs (English, Baker, & Wilkinson, 1997) of reef fish were conducted to estimate the abundances per 250 m2 of the herbivorous fish families Acanthuridae and Scaridae, and of the piscivorous families Lutjanidae, Haemulidae, and Serranidae (only groupers). Acanthuridae and Scaridae were chosen because of their ecological importance (Obura & Grimsditch, 2009). The piscivorous families were chosen as the most important indicators of overfishing (Russ, Stockwell, & Alcala, 2005). Fishes were identified to genus and counted along 50 m by 5 m transects by following a transect line following a contour. Fish were counted within 2.5 m on either side of the line. Each site had a nested design with 3 replicates and each replicate consisted of 3 transects, adding up to a total number of 18 transects in 2003, 36 in 2006 and 54 in 2012. To ensure standardization of transect width, 2.5 m of tape was shown to the divers at the beginning of each survey dive. Some of the techniques of Samoilys and

Carlos (Samoilys, 1997) were followed to count the fishes: the larger mobile fishes were counted first, then the smaller ones, and fishes that re-entered the transect area were not counted. In 2012 we also estimated the size of all the fishes surveyed by assigning them to size categories. At the beginning of each dive, the observer was shown lengths of 10, 20, 30, 40 and 50 cm, at a distance of 2.5 m (Samoilys, 1997). Additionally, the recording slate had size categories marked. The 10 cm size categories are easy to use (McClanahan & Kaunda-Arara, 1996), and comply with methods commonly used in the Western Indian Ocean (McClanahan & Graham, 2005). Length was converted to biomass using length-weight relationships in Fishbase (Froese & Pauly, 2000). Small numbers in each size category of piscivorous fishes prevented analyses of these data. Abundances were pooled into two functional groups for analysis: Piscivorous vs. Herbivorous.

Benthic cover was quantified following approaches commonly used in the Western Indian Ocean, to facilitate regional comparisons (Obura & Grimsditch, 2009). Specifically, we used photo transects consisting of photos taken in 20 m transects with 2 photos per meter, one on each side of the transect (i.e. 40 photos per transect) to avoid pseudoreplication. The sampling design was similar to that previously described for the fishes: each site had 3 replicates, each replicate 3 transects, and each transect 40 photos. Photos were analyzed with CPCe 3.2, Coral Point Count w/ excel extension from NCRI. This software gives the mean cover for several benthos categories based on 10 random points for each photo. Each random point is inspected and classified as hard coral, soft coral, dead coral with algae, recent dead coral, macroalgae, coralline algae, other invertebrates, and sand, rubble or pavement. Rugosity was estimated by measuring the contour of the reef under a portion of 5 m of the transect line. The value was then divided by 5 m, and used as the index of reef complexity (McClanahan & Shafir, 1990) and was only measured in 2012. Benthic cover estimates and rugosity estimates allow for control of differences in complexity among sites, and hence to identify situations where the faunistic differences between the locations are caused by differences in the habitat.

3.3.3 Data analysis

Data were categorized as benthic cover variables, fish abundance variables (numerical abundance and biomass for herbivorous fish), or time /spatial traits (MR years/distance to the border). Fish abundance was the response variable and all the other variables were assessed as predictors of fish abundance.

Regression trees were used to identify the most important predictor variables. Regression trees consist of a series of binary splits of the response variable based on the values of the predictor variables (we did not transform the predictor variables). They are constructed by recursively partitioning the data set of fish abundances into two subsets based on the optimal split among all possible splits, where optimality is defined as the reduction of the mean squared error. Since we cross-validated the results (10 fold), the optimal tree is the one with the smallest cross-validated relative error (CVRE) or the smallest size plus one standard deviation (Legendre, 2012). The output is a tree diagram with the branches determined by the splitting rules based on the predicator variables: MR years, distance to the border, benthic cover variables and rugosity. Regression trees identify differences in fish abundance and the location of changing points for these differences. Two regression trees were constructed splitting fish abundance (herbivorous and piscivorous) by all the benthic variables, distance and years. Using the results of the regression tree, we built several generalized linear models (GLMs) with the abundance of fish as a function of year and distance to the reserve boundary with appropriate breakpoints for each year (Table 3 and Table 4).

Table 3 – Summary data of the multivariate regression tree constructed based on herbivorous fish abundances. We present the values for: the CVRE (cross-validated relative error), the number of splitting nodes and variable prediction values for each node.

Regression tree	**CVRE**	**Number splitting nodes**	**1st Node**	**2nd Node**	**3rd Node**	**4th Node**
Abundances of herbivorous fishes *All variables	0.342	3	Y=9	D=-1.55	D=-0.95	
Abundances of piscivorous fishes * Distance * Years	0.0833	1	D=4			

D=distance; Y=years

Table 4 – AIC (Akaike information criterion) values for GLMs with different breakpoints. The model with lowest AIC is chosen.*

	AIC
herbivorous fish	
2006	
model without breakpoint	297.3*
model with breakpoint of dis=-1.55	297.59
model with breakpoint of dis=-0.5	299.51
model with breakpoint of dis=3.6	299.28
2012	
model without breakpoint	972.23
model with breakpoint of dis=-1.55	712.86*
model with breakpoint of dis=-0.5	933.07
model with breakpoint of dis=3.6	917.33
Piscivorous fish	
2006	
model without breakpoint	418.08
model with breakpoint of dis=-1.55	345.76
model with breakpoint of dis=-0.5	322.81*
model with breakpoint of dis=4	327.66
2012	
model without breakpoint	1471.4
model with breakpoint of dis=-1.55	1446.7
model with breakpoint of dis=-0.5	1456.6
model with breakpoint of dis=4	1359.5*

Dis=Distance

Assuming a Poisson distribution for the fish abundance, Z_y, of year y, we fitted a generalized linear model (GLM) with a break point. Each GLM models how the mean abundance $E[Z_y]$ of each year changes according to the distance, x, to the reserve boundary:

$$E[Z_y] = exp[\beta_0 + \beta_1 x I(x \leq x^*) + \{\beta_2 + \beta_3(x - x^*)\} I(x > x^*)],$$

where x^* is the breakpoint and $I(A)$ is an indicator function taking 1 when A is true, or 0 otherwise. This non-linear model is therefore discontinuous at the change point (x^*).

The best model for the year and trophic group was chosen using AIC (Akaike information criterion). The total number of individuals per 250 m2 transect of each of the two functional groups was modeled as a Poisson random variable. All the model parameter estimates used to construct the graphic representation are presented with their standard error (Table 5).

Table 5 – β value estimates and respective standard error for the GLM models.

Herbivorous model

Year	β_0 **(std. error)**	β_1 **(std. error)**	β_2 **(std. error)**	β_3 **(std. error)**	$x*$
2003	3.272 (0.046)	0.004 (0.012)	-	-	-
2006	3.478 (0.031)	-0.037 (0.007)	-	-	-
2012	3.323 (0.167)	-0.363 (0.046)	1.986 (0.170)	0.003 (0.006)	-1.55

Piscivorous model

Year	β_0 **(std. error)**	β_1 **(std. error)**	β_2 **(std. error)**	β_3 **(std. error)**	$x*$
2003	1.505 (0.111)	0.003 (0.029)	-	-	-
2006	-0.213 (0.381)	-0.426 (0.105)	-3.268 (0.771)	0.898 (0.091)	-0.5
2012	1.403 (0.088)	0.431 (0.030)	2.336 (0.128)	-0.079 (0.035)	4.0

The benthic cover data were analyzed with non-metric multidimensional scaling (NMDS) to evaluate the homogeneity of the habitat between the inside and outside of the marine reserve. NMDS was used, since the data are proportional and thus non-independent, and zeros were frequent. NMDS represents the set of objects along a predetermined number of axes while preserving the ordering relationships among them. We used Gower distances and expanded scores based on the Wisconsin square root of the data. The goal of this analysis is to investigate if the benthic characteristics of the sites vary consistently as a function of the distance to the reserve boundary and/or time since reserve implementation. As such, it provides an additional exploratory indication of the effects of the habitat as potential driver of fish abundances. All the data are presented in Supplementary Table S1. All analyses were carried out in R (Team, 2008) with the following packages: vegan for the NMDS (Oksanen, Kindt, & O'Hara, 2005), mvpart for regression trees (De'Ath, 2006), and car for the GLMs (Fox et al., 2009).

3.4 Results

In the herbivorous fish abundance tree, four branches appeared, the first node indicating that in 2009 (the mid-year between 2006-2012) herbivorous fish abundance started to increase, followed by nodes at distances of -1.55 and -0.95 km (outside the reserve). Herbivorous fish abundance substantially increased towards the MR (Figure 7). The points -1.55 and -0.95 km are the mid-points between sampling sites where a break occurs. None of the benthic variables appeared in the nodes of the trees (Table 3).

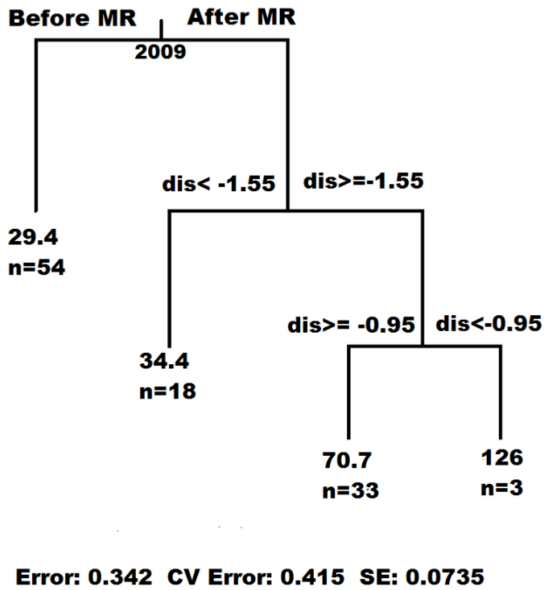


Figure 7 - A multivariate regression tree was built based on herbivorous fish abundances. For each node the mid-point value of the split is reported, and on each leaf the number of observations (n) on that leaf.

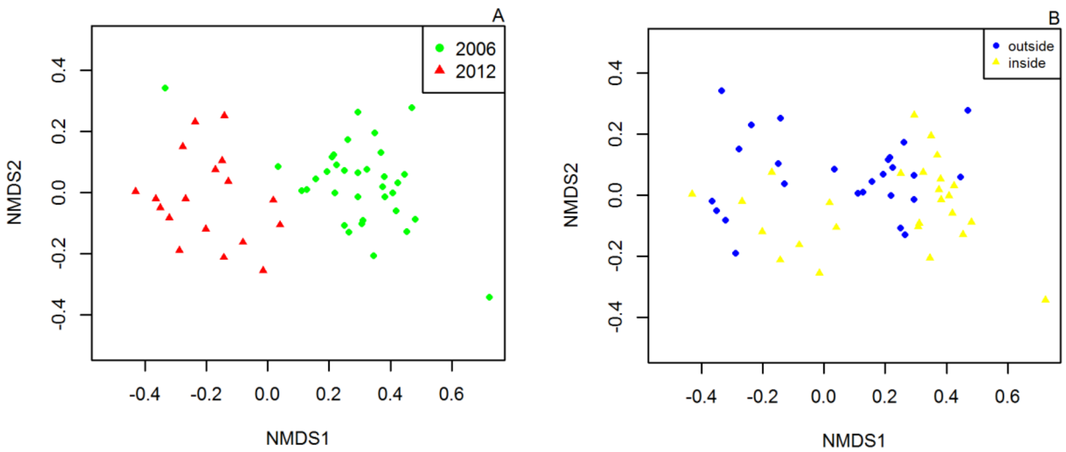


Figure 8 – Non-metric multidimensional scaling (NMDS) of the benthic observations by: a - year of observations; b - distances to the border (negative values outside the border, positive values inside the border)

The regression tree analysis for the piscivorous fish abundance produced a tree with only 2 branches and one node (Table 3), dividing abundances of fishes at 4 km distance from the border, well inside the MR boundaries, while the variable years did not appear in any node, nor did any of the benthic variables. The abundances of piscivorous fishes are only very different well inside the border of the MR.

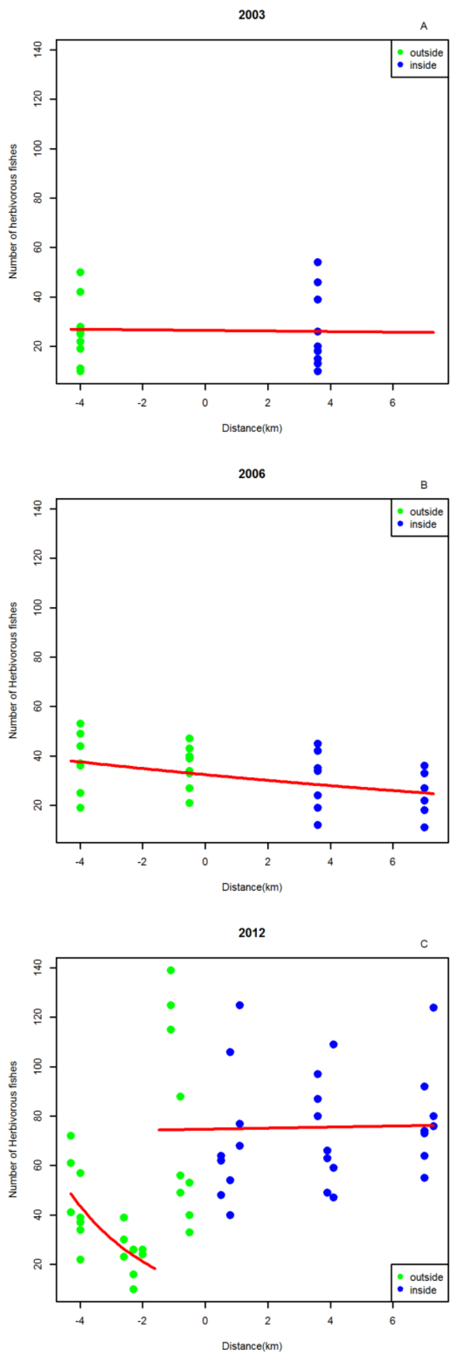


Figure 9 – GLM summary for herbivorous fish abundance. Points with negative distance are situated outside the MR and points with positive distance are situated inside the MR. The red line reflects model predictions. A- 2003. B- 2006. C- 2012.

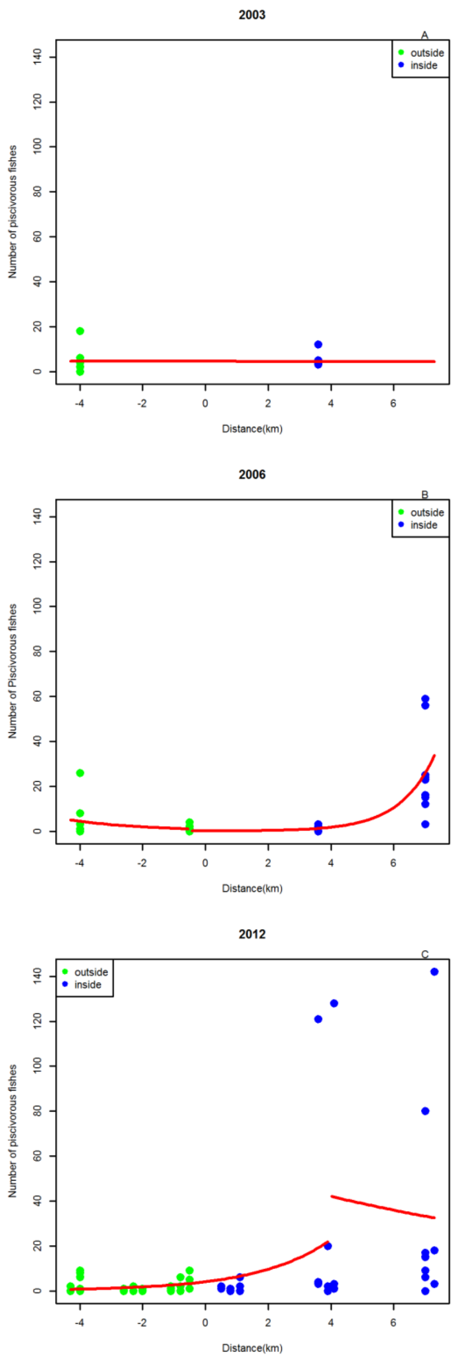


Figure 10 – GLM summary for piscivorous fish abundances. Points with negative distance are outside the MR and points with positive distance are inside the MR. The red line reflects model predictions. A- 2003. B- 2006. C- 2012

To consolidate the results of the regression tree, we compared sites according to benthic cover variables using NMDS (Figure 8). No aggregation by distance from the MR boundary (Figure 8A) is apparent from the ordination, but different years appear to segregate with regards to their benthic cover (Figure 8B). NMDS stress for this model is 0.139.

We used the results from the regression tree to build three GLM models of fish abundance for each year as a function of distance to the MR border. The models had either no breakpoint, or a breakpoint outside the reserve at 1.55 and 0.5 km from the border (dis=-1.55 and –0.5), and inside the reserve at 4 km (dis=4) from the border (Table 4). Figure 9 shows that for herbivorous fish abundance, only in 2012 did model selection favor a model with a breakpoint, with the break point at -1.55km (Figure 9C). The 2006 model with lowest AIC did not have any break points (Figure 9A and Figure 9B), and no breakpoints were apparent in 2003 either. For the piscivorous fish, GLM models show that 2003 data also have no distinguishable breakpoint (Figure 10A), while for 2006, the models with a break point at -0.5 and 4 km from the border did have very similar (lower than no breakpoint, but not a big difference) AICs (Table 4) and the lower AIC model was represented (Figure 10B). Finally, in 2012 the model that best fitted the data was the one that used the splitting node of the multivariate regression tree, located 4 km inside the reserve (Figure 10C). All the parameter estimates of the models used are given in Table 5 with their standard error.

The biomass of herbivorous fishes peaked at the border zone (Figure 11) and inside the MR. The smallest size classes are responsible for the higher biomass at the MR border (for sizes 10-20 cm and 21-30 cm). Large herbivorous fish only occur well within the reserve boundaries.

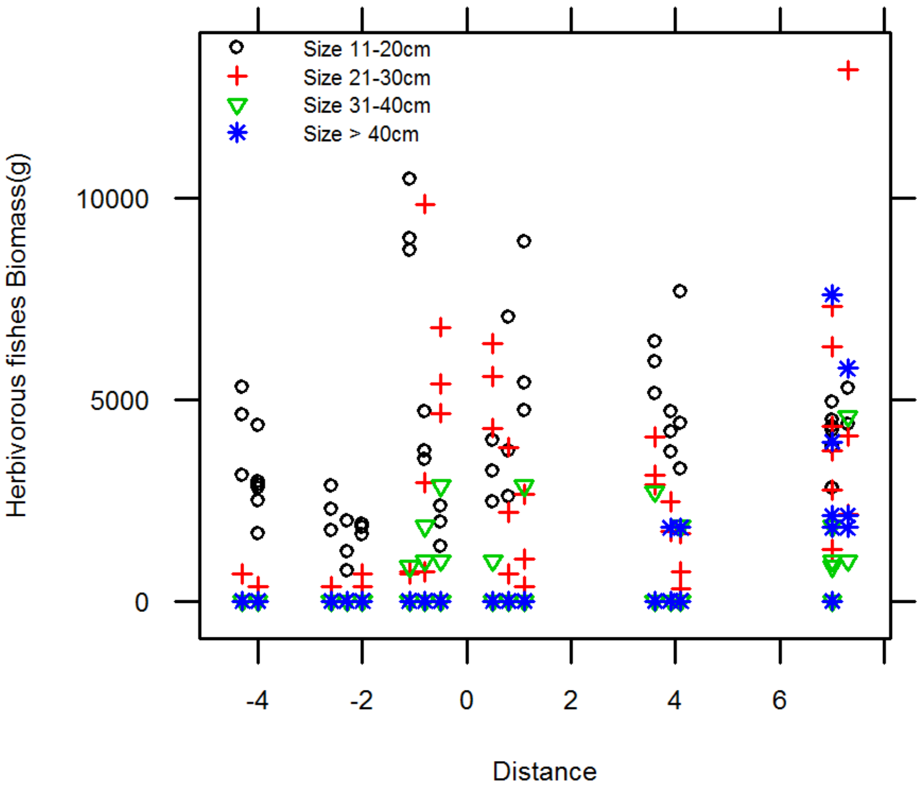


Figure 11 - Scatter plot of the biomass of herbivorous fish by size. Negative distances are outside the MR, positive distances are inside the MR and 0 is the border of the MR.

3.5 Discussion

Our data showed the existence of a significant and consistent effect in all trophic groups on the abundance and distribution of reef fishes in the Vamizi marine reserve. Based on the regression tree splits, six years after its establishment, both herbivorous and piscivorous fish are more abundant inside the reserve than outside, where no difference existed before. Additionally, spillover was detected in the herbivorous fish functional group, but not in the piscivorous group, which is only more abundant well within the reserve. Most importantly, fish abundance outside the reserve has not decreased in relation to its abundance prior to the reserve being established, despite the concentration of fishing pressure.

Our Before-After-Control-Impact sampling design and the analysis of benthic variables confirm that habitat differences were not responsible for the variation in fish abundances. Based on the regression tree results, our analysis relies on the assumption that the habitat is uniform, so that the differences in the abundance of fish can be attributed to the establishment of the reserve. However, protection could have changed the habitat and influenced reef fish abundances since MR establishment. For that reason we included benthic variables in the study. There is conflicting evidence in previous studies: in some, habitat accounts for part of the variation (Chapman & Kramer, 1999; Lizaso et al., 2000; McClanahan & Arthur, 2001), in others habitat had no effect (Abesamis & Russ, 2005). These apparent differences are likely caused by the specific characteristics of each study site. Nevertheless, McClanahan (1997) has stated that reef structure has less influence on reef fish abundances than management, and our findings agree with this. Our NMDS plots are in accordance with the results from regression trees, showing apparent differences between the years (due to management) but not between different distances (due to habitat differences). Moreover, evidence suggests that habitat homogeneity around the reserve enhances spillover, increasing the distance from the border at which it is detectable.

Recovery from fishing is often different for piscivorous and herbivorous functional groups. Recovery will also depend on which fish are targeted by fishermen (Abesamis & Russ, 2005). In Vamizi island both piscivorous (especially groupers) and herbivorous fish (especially parrotfish) are targeted by fishermen. Results from other studies found that recovery of predatory fishes was the largest effect of marine reserve establishment, while the response by herbivorous fish was weak (McClanahan, Muthiga, & Coleman, 2011). In some cases, spillover was detected for predatory species only (Russ & Alcala, 2011), while others found that the predators have a slower response and that they eventually reduce their herbivorous prey (Graham, Evans, & Russ, 2003; Micheli et al., 2004; Molloy, McLean, & Côté, 2009). McClanahan et al. (2007) found that different groups react differently: Scaridae and Labridae increase rapidly, Balistidae and Acanthuridae slower, and some predators may never recover. The results vary between studies, and few are focused on spillover, the majority of studies tending to concentrate on fish recovery inside the reserve. We predict that, with time, the spillover effect for herbivorous fish will change relative to the extent of piscivorous spillover. Similar changes were revealed for the recovery of fishes inside MRs by other authors in analogous studies (Obura & Grimsditch, 2009).

Herbivorous fish size results indicate that smaller-sized fishes are responsible for the spillover effect in 2012. We suggest that an increase in predators and agonistic relations within the protected area drove the smaller individuals out of the reserve, a pattern already detected in other studies (Abesamis & Russ, 2005). This interpretation would reconcile our findings – more small fishes on the border of the reserve – with the literature, namely regarding the higher number of larger fishes and predators inside MRs (Ashworth & Ormond, 2005; Mumby et al., 2006). Another explanation could be that the larger Scaridae are too big to be eaten by the predators, meaning that the smaller fish within the reserve are predated upon more heavily and consequently their numbers are lower. An alternative possibility is that herbivorous fishes are the first to recover and hence the first to be detected in terms of spillover effects. This is supported by McClanahan and Mangi (2000) who point out that Scaridae (one of the most abundant herbivorous groups) are the fastest recovering group inside reserves. Herbivorous fishes are of great importance to reef health maintenance, keeping algae from competing for space with corals. Good numbers of herbivores are a sign of reef resilience to climate change (Obura & Grimsditch, 2009). In the context of MPAs, protection and recovery of herbivorous fishes is of major importance to the conservation and recovery of coral cover and health (Mumby et al., 2006; Mumby & Harborne., 2010).

Our study reports a larger area of spillover than most other studies. We found a spillover distance of more than 1 km outside of the reserve, which contrasts with the distance values of 300-350 m reported by some authors (Abesamis & Russ, 2005; Abesamis et al., 2006), or the 500 m reported by others (Stobart et al., 2009, Ashworth & Ormond, 2005; McClanahan & Mangi, 2000). One of the reasons for this larger spatial extent of spillover could be the homogeneity of the habitat around the border of the MR, a characteristic previously highlighted as a multiplier factor of the reserve's effects (Forcada et al., 2009). In the presence of low fishing pressure, a 1.2 km spillover distance has been occasionally reported (Ashworth & Ormond, 2005; McClanahan & Mangi, 2000). Nonetheless, other studies that found a very light spillover effect and only for a few meters, attributed the weak spillover to "fishing the line" (Kellner et al., 2007; Stobart et al., 2009). However, even observing heavy "fishing the line" around Vamizi MR, the spillover effect could still be detected.

The regression tree results reveal changes in fish abundances since the designation of the Vamizi reserve (less than 6 years). These findings are consistent with the literature which reports time intervals from establishment to detection of as little as 3 years (Claudet, Pelletier, Jouvenel, Bachet, & Galzin, 2006; Halpern & Warner, 2002; Russ et al., 2005), although in some cases it has taken decades before recovery is detected (Micheli et al., 2004). This recovery could be explained by the initial state of the Vamizi MR, which was not severely depleted because only light fishing (involving fewer than 120 fishermen) had occurred, or by the strong compliance to the marine reserve restrictions. Our 2003 data, from before establishment of the MR, support the former explanation (Hill et al., 2009). Fishing pressure was light outside the reserve (stronger on the border of the MR) in the sense that fisheries around Vamizi are mainly artisanal and subsistence, not using trawling or mosquito nets as in mainland Mozambique. Meanwhile, fishermen numbers did increase in Vamizi from the original 120 in 2003 to approximately 131 in 2006, and 159 in 2012, but this does not necessarily imply a large increase in fishing pressure, because the increase was mainly in speargun and line fishing for just a few days a week and only involved catches of 0-20 kg a day, as opposed to the 20-180 kg a day by those using gillnets and seine nets whose number did not increase in this area. Moreover, compliance with the marine reserve rules was variable (but better than most MRs) and also only migrant fishermen tried to fish in the MR. This is confirmed by another study in which Vamizi MR was classified as having variable compliance levels (McClanahan, Graham, Wilson, Letourneur, & Fisher, 2009).

Most of the controversy surrounding MPAs concerns the benefits to fisheries. MPAs have shown improved fish abundances inside the protected areas, but less is known about the spillover effect, which was the main focus of our work. We show that habitat homogeneity is important for spillover, that spillover can be achieved in 6 years and that it is different across the different trophic groups. Vamizi marine reserve has variable compliance levels and reasonable enforcement of fisheries laws, and spillover was still detected. We suggest that small community marine reserves must be well placed (with homogenous habitat around the border), should have good enforcement and the fishing activities around the MR need to be well managed (controlling fishing effort and fishermen numbers) to achieve best performance in terms of enhancing the fisheries through spillover.

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4. Co-management and market forces drive size of fishery landings

da Silva, I.M., Antão, L., Soares, A.M.V.M., Dornelas, M. (2015) Co-management and market forces drive size of fisheries

4.1 Abstract

1. Co-management is typically based on agreements between governments and local communities to share the responsibility of resource management.
2. The implementation of community-based co-management for fisheries has been going on in Mozambique since 2003. The first evaluation of the ecological effects of co-management, using the Cabo Delgado province as a case study, is presented here.
3. The existing 78 fishing centers were classified according to their management situation, and the distance to the nearest town. Several diversity metrics were compared for each management level and some effects on community structure and diversity of reported landings detected, specifically in terms of species abundance distribution. The type of management affected the sizes of fish caught, with more active management leading to larger fish.
4. Furthermore, the distance to markets had a strong effect on sizes, with more remote fishing centers having larger individuals, indicating that markets alongside management are a strong driver of the size of fishes caught by artisanal fisheries.
5. Co-management in the north of Mozambique has a positive effect on maintaining larger sizes of fish caught, but markets are a powerful influence and with the predictable development of the region can potentially undermine co-management benefits.

4.2 Introduction

Fisheries provide an important food source worldwide and artisanal fisheries are the only source of food and income for millions of people living on the coast (FAO, 2014). Similarly to other fishery types, artisanal fisheries are overexploited (Pauly et al., 2002; Watson & Pauly, 2001; Worm et al., 2009). Free access to fisheries and increasing fish prices can drive fish stocks to over exploitation and collapse (Bjørndal & Conrad, 1987).

Increasing fish consumption alongside declining fisheries resources creates a poverty trap due to lack of alternatives to fishing (T. R McClanahan, Allison, & Cinner, 2013). In addition, fisheries are threatened by climate change, pollution (Hughes et al., 2003), excessive numbers of fishermen, pressure from the markets, mismanagement and lack of management altogether (Worm et al., 2009). Consequently, the livelihoods of vulnerable human populations are at risk as fish is often the cheapest and most accessible source of protein for these people (Brashares et al., 2004). Managing fisheries sustainability is critical especially for developing countries where populations rely heavily on fisheries resources for subsistence. Specifically, understanding the effects of different levels of management and of market forces on fisheries ecology is of vital importance, not only to the survival of millions of people, but also to the sustainability of marine habitats and fished species/populations.

Garrett Hardin's influential article "The Tragedy of the Commons" (Hardin, 1968) dooms common resources to failure: each user ignores the costs for the others, exploiting the resource until exhaustion. Hardin's statement has been used by many to rationalize central government control of common-pool resources (Ostrom, Burger, Field, Norgaard, & Policansky, 1999). Nevertheless, stable communities evolved institutional arrangements that have sustained common resources successfully for centuries (Dietz, Ostrom, & Stern, 2003). These governance structures are now being framed in national policies or reproduced in other areas. Namely, after a period of centralized management fisheries empowered by Hardin´s ideas and socialism, a transition to a more decentralized management is currently underway, in an effort to deliver better outcomes for both people and ecosystems (Cinner, Daw et al., 2012). Co-management is being implemented by governments across the Western Indian Ocean, in a collaborative effort between governments and civil society groups, engaging fishing communities in these management arrangements. It is critical that the consequences of this change for ecosystems and resources are scientifically evaluated to allow evidence-based adjustment of management to each local reality and active adaptation of the co-management system (Wamukota, Cinner, & McClanahan, 2012). Very few studies have assessed the effects of co-management; most of the assessments are geographically restricted and contain gaps, both empirical and theoretical, on the evaluation of co-management (Cinner, McClanahan et al., 2012; Evans, Cherrett, & Pemsl, 2011; Wamukota et al., 2012). Regardless, numerous governments and international NGOs are investing in this sort of governance framework. Here, we present the first assessment of the co-management of fisheries in Mozambique, comparing the effects of the different levels of co-management in place in the province of Cabo Delgado in northern Mozambique on the diversity and size of fish in landings.

Markets are known to drive the exploitation of resources (Brown, 2000), and open access resources, such as fisheries, are particularly affected by market pressure and/or urbanization (Aswani & Sabetian, 2010;Cinner, Graham, Huchery, & MacNeil, 2012; Stallings, 2009). The influence of markets can be assessed either by the distance of the fishing areas to the nearest town (Brewer, Cinner, Fisher, Green, & Wilson, 2012; Brewer, Cinner, Green, & Pandolfi, 2009; Cinner, Graham et al., 2012; Cinner, Marnane, McClanahan, & Almany, 2006), the density of human population (Cinner, Graham et al., 2012; Camilo Mora et al., 2011) or by using an index of development (Brewer et al., 2009). Market forces are important drivers of fishing practices. Higher fish prices can support more expensive fishing practices with motorized boats, covering wider distances, using more sophisticated gear and tracking mechanisms. Under very low fish stock situations, higher fish prices increase the vulnerability of the stocks, by increasing the demand (Bjørndal & Conrad, 1987). Hence, the role markets play in fisheries ecology must be considered concurrently with the effects of management practices.

Total catch data alone is not a good indicator of the state of fisheries (Pauly, Hilborn, & Branch, 2013), especially in coral reef fisheries where a multidisciplinary approach is needed. Ecological indicators of targeted populations, exploitation and broader socio-economic fishery indicators are needed to assess the state of fisheries (Clua et al., 2005). In this study, we are going to explore three of the most commonly used exploitation indicators: species diversity, trophic level and fish sizes.

The impact of fisheries on the diversity of landings remains controversial, particularly in the tropical context of multispecies fisheries where complexity is enhanced. Bianchi, Gislason et al. (2000) and Piet & Jennings (2005) reported no change in the diversity of fish caught by bottom trawlers from several different world regions, from Mozambique to the North Sea, under different fishing intensities. Roger & Ellis (2000) detected changes in the species composition when analysing a data set from British coastal waters during the 20th century from a low to an intense fishing situation, but diversity remained unaltered. Rice & Gislason (1996) report size-dependent compensatory dynamics: large-fish diversity decreases, while small-fish diversity increases, from low to high fishing intensity situations. This variability in the effects of fishing on diversity metrics warrants the investigation of more nuanced metrics of community structure.

Species abundance distributions (SAD) represent the relative abundance of the species in a community. SADs are an essential pattern for community ecology and an important synthetic measure of biodiversity and community structure (Magurran, 2004; McGill et al., 2007). Moreover, because species are not labelled, SADs allow species abundance patterns for different communities to be compared (McGill et al., 2007). Numerous models have been proposed to explain the uneven distribution of species abundances hoping that this would shed some light on the mechanisms structuring the underlying communities (Magurran, 2004; McGill et al., 2007). For instance, the appearance of more than one mode when plotting SADs on a logarithmic scale has been proposed as an indicator of non-equilibrium communities (Ugland & Gray, 1982), and of species asymmetries, e.g. species with different habitat preferences (Magurran & Henderson, 2003) and different aggregation or dispersal rates (Alonso, Ostling, & Etienne, 2008; Dornelas & Connolly, 2008). Furthermore, environmental heterogeneity has also been shown to lead to multimodal SADs (Dornelas, Moonen, Magurran, & Bàrberi, 2009). Thus multiple modes in SADs may be indicative of the structure of the communities and of environmental factors affecting species abundances. To our knowledge SADs have never before been used in fisheries assessments. Here we assess how SADs change as a function of different management types and increasing distance to markets.

Size is probably one of the best indicators of the state of fisheries resources. It is typically analysed as size spectra: a histogram of the number of individuals across size classes, (Graham, Dulvy, Jennings, & Polunin, 2005; Pope, Rice, Daan, Jennings, & Gislason, 2006; Rice & Gislason, 1996). Size is important for ecosystem functioning because it drives metabolic rates (Kleiber, 1932) and trophic chains (Jennings, 2001). It is also important economically because it drives the market price of fish (Pinnegar, Jennings, O´brien, & Polunin, 2002), making it a very good indicator of the state of the fisheries (Shin, Rochet, Simon Jennings, Field, & Gislason, 2005). The size of the fish caught tends to decrease with increasing fishing effort (Ault, Smith, & Bohnsack, 2005; Ault, Smith, Luo, Monaco, & Appeldoorn, 2008; Bianch et al., 2000; Chapman & Kramer, 1999; Dulvy, Freckleton, & Polunin, 2004; Graham et al., 2005). Nevertheless, Murawski & Idoine (1992) point out that the aggregate size composition in fisheries is conservative, and that size-based trophic interrelationships tend to buffer fish production at length against perturbations to particular species and/or length components in highly complex food webs. Closely connected with size, trophic level can be impacted by fisheries, an effect commonly referred to as "fishing down the food chain" (Pauly, Christensen, Dalsgaard, Froese, & Jr, 1998; Pauly & Palomares, 2005). The trophic level of the fish caught decreases with increasing fishing effort. This effect is well known and occurs both in temperate and tropical areas (Jennings, Greenstreet, & Reynolds, 1999; Jennings et al., 2002). Ultimately, size estimation is an easily trained technique, and especially valuable in assessing reef catches when the reliability of species identifications is uncertain (Graham et al., 2005).

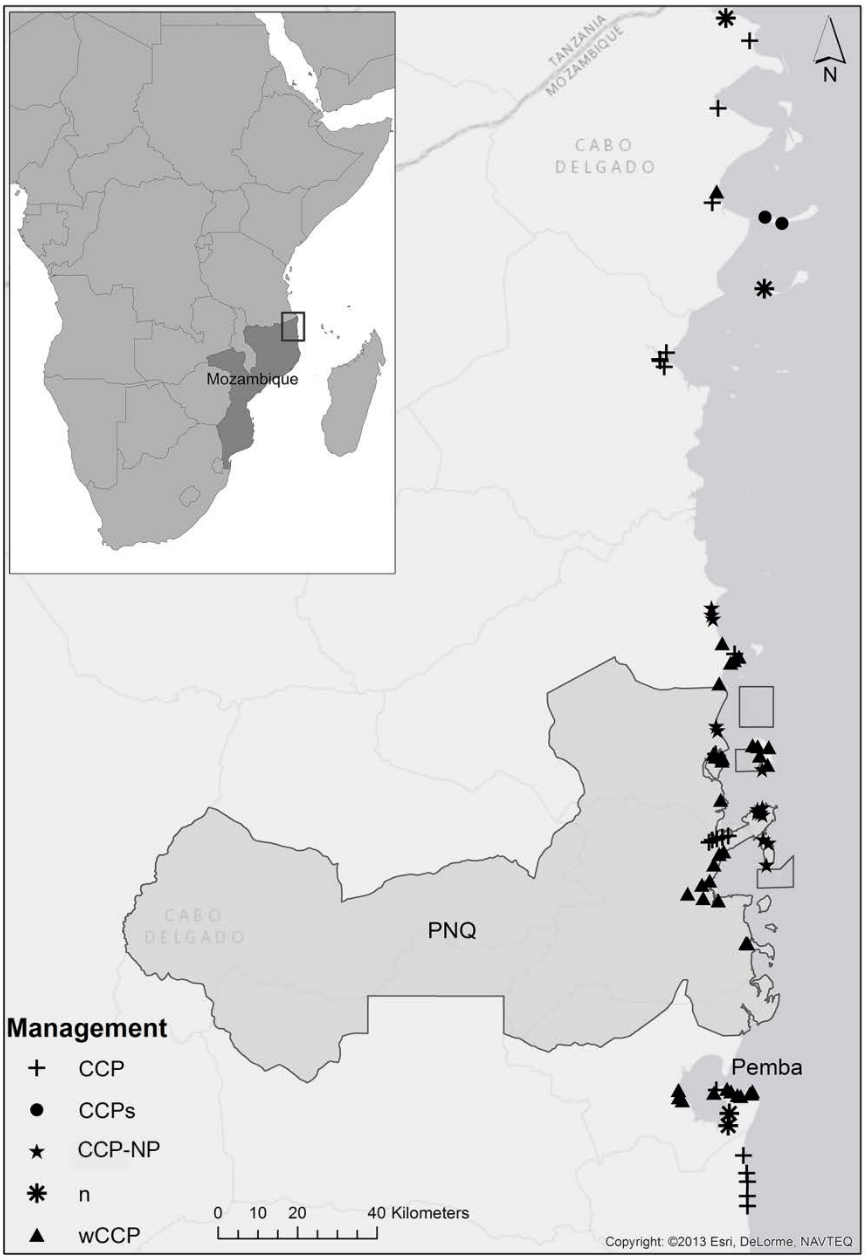

Figure 12 – Map of Cabo Delgado province with the 78 fishing centers analyzed. Quirimbas National Park (PNQ) and the provincial capital, Pemba.

This study aims to quantify the effects of co-management and distance to markets on fisheries landings. Specifically, we want to answer two questions: 1) does diversity of fish in catches change with management type or distance to markets?; and 2) are sizes of fish in catches changing with management type or distance to markets? This study represents a new application of macroecological methodology to fisheries research. We predicted that no effects of co-management and market forces on diversity would be detected based on the literature, but we hoped that the SAD methodology might uncover subtle changes in the resource structure. We expected impacts on fish size from both the management type and the distance to markets.

4.3 Methods

4.3.1 Study area and co-management

The study locations for this work are set along the north coast of Mozambique in Cabo Delgado province (Figure 12). Along these 400 km of coast stretches the Quirimbas archipelago, with 33 islands surrounded by coral reefs and separated from the mainland by seagrass and mangroves. The main fisheries are artisanal and support mostly subsistence fishing. Traditionally, because most fish are not consumed locally – they are dried and sold further inland and to nearby provinces – smaller-sized fish are preferred and all fish species have similar commercial value. However, since 2012 the demand for tuna and other larger fishes has started to increase due to a significantly higher number of foreigners coming to the region.

There are 78 fishing centers with different levels of co-management. Co-management was implemented in Mozambique in 2003 by the fisheries law (Républica de Moçambique, 2003), following some successful experiences of co-management in Angoche and Inhambane (Lopes & Gervasio, 1999). The management unit in the villages is the *Conselho Comunitário de Pesca* - CCP, or fishing council. In Cabo Delgado province, CCPs started to be implemented in 2006. The National Park of Quirimbas (PNQ) was proclaimed in 2002 and the first CCPs were implemented there in 2008. CCPs are responsible for managing the fisheries of their area in representation of the government. The councils enforce Mozambican fisheries laws but they can also implement additional rules, such as establishing sanctuaries (no-take zones) and specifying restrictions on gear or fishermen numbers, and can also impose fines on offenders.

The fishing centers were classified according to their CCP and respective level of protection. Five levels of management with decreasing levels of protection were defined by the technicians of the *Instituto de Pesca de Pequena Escala* (IDPPE), or Small-Scale Fisheries Institute, responsible for the CCPs, together with the first author of this study. The first level – "CCPs" – is a CCP with a sanctuary area which is supported by a lodge or an NGO. The second level – "CCP-NP" – is a council supported by the National Park of Quirimbas or located near a sanctuary within the Park. A "CCP" is the third level and is a standard working fishing council, carrying out meetings, patrols and applying fines for violations. Councils were considered "wCCP" ("weak") if: 1) they were approved but not working; 2) were formed only in 2012 and hence have had limited activity; and 3) had fishing centers that were located far away from the main office of the fishing council, for CCPs that have large areas of jurisdiction. In all these situations we considered that fisheries law and CCP regulations were likely to be limited or unenforced. Finally, fishing centers with no CCP were classified as "N", and have the lowest level of co-management and protection (Supporting Information 1 and Figure 12).

Additionally, fishing centers were classified according to their distance to Pemba, the nearest and only town in the entire province, as a surrogate for the distance to the markets. Google Earth ™ was used to calculate the distance by road from each fishing center to Pemba; four categories were considered: ≤100 km, 100-200 km, 200-300 km and >300 km (Supporting Information 1).

4.3.2 Data

The dataset analyzed is based on the sampling system for artisanal fishing from the Cabo Delgado branch of the *Instituto de Investigação Pesqueira* (IIP) and refers to the fish species caught and their sizes in the 78 fishing centers. Data was collected 2-4 years after the establishment of the CCPs. The temporal data series from 2010-2012, available in the ACCESS database "PescArt do IIP" for species and respective sizes by fishing center, was used. Data collection, recording and processing followed the IIP methodology, the aim being to produce data for the government on the state of activity and to allow management decisions to be taken (Baloi, Afonso, Premigi, & Volstad, 2007). Data was checked for duplicates, species with zero abundance or fishing centers with no entries, which were corrected prior to analysis.

Each fish species entry was classified in terms of family, trophic level and habitat according to FishBase (Froese & Pauly, 2000). Trophic level was discretized by approximation to the next integer: 2 – herbivorous; 3 – low carnivorous; and 4 – middle carnivorous. The list of species and their classification can be seen in Supporting Information 2.

4.3.3 Analysis

Habitat

Fisheries may be associated with a specific habitat (Armstrong & Falk-Petersen, 2008). However, because the fishing centers in this study cover a wide area, fisheries are likely to occur in several habitats. To verify whether the fish species caught were related to a particular habitat, we calculated the percentage of fish caught according to their preferential habitat: reef, seagrass and a mix of the two (Froese & Pauly, 2000) for each fishing center. A three dimensional plot was built where each axis represented the percentage of individuals associated with each habitat type and each point is a fishing center.

Diversity analysis

We estimated multiple metrics of diversity for the landings under each type of management and each distance to the nearest town class. Specifically, we used PIE evenness (probability of inter-specific encounter), which shows how evenly abundance is distributed among species (Hurlbert, 1971), the McNaughton dominance index, which gives us the relative abundance of the most abundant species (McNaughton, 1968), and exponential Shannon (Jost, 2006). The metrics were calculated after rarefying our sample due to the different sample sizes for each management and distance to nearest town (Gotelli & Colwell, 2001).

SAD

We produced species abundance distributions by pooling species abundances data over fishing centers according to: 1) each year; 2) different levels of management; and 3) distance to the nearest town classes. In order to compare the abundance structure of fish landings we quantified the shape of SADs by testing for the existence of multiple modes. We fitted mixtures of 1, 2 and 3 Poisson Lognormal distributions (PLN) (Bulmer, 1974; Pielou, 1969) and a logseries distribution (R. A. Fisher, Corbet, & Williams, 1943). Functions to fit the PLN mixtures and to calculate maximum likelihood estimates (MLE) were adapted from (Dornelas & Connolly, 2008) using the dpoilog function from poilog package (Grøtan & Engen, 2008). All the analyses were performed in R (R Core Team, 2013). The R function nlminb was used to perform numerical optimization and obtain best-fit parameters for each model, initializing the parameter searches from multiple starting values to maximize the chances of finding the global maximum likelihood estimate (Dornelas & Connolly 2008; Connolly & Dornelas 2011). Model performance was assessed using the second order Akaike's information criterion for small sample sizes (AICc) (Burnham & Anderson, 2002) and Bayesian information criterion (BIC) (Schwarz, 1978). AIC and BIC are model selection tools that provide quantitative relative support for alternative models, by finding a compromise between parameter uncertainty and goodness-of-fit. A minimum difference of two between alternative models is indicative of support for the model selected (Burnham & Anderson, 2002). As different model selection tools might give different results, we additionally performed a parametric bootstrap analysis and calculated likelihood ratio tests (LRT). While AIC is known to overestimate the number of distributions in mixture models, BIC tends to underestimate them (McLachlan & Peel 2000; Henson et al. 2007), hence we performed these analyses only for the cases where AIC_c selected a multimodal distribution with strong support, but BIC did not. For each case, 100 parametric bootstrap samples were used, by randomly generating species abundance values from a zero-truncated 1PLN density function parameterized using the model's maximum likelihood estimates (Connolly et al. 2009). We fitted the PLN mixtures and calculated the likelihood ratios for each SAD. Then we calculated the empirical LRT from the real data and compared it with the frequency distributions of the likelihood ratios expected from a single PLN, comparing 1PLN vs 2PLN and vs 3PLN. Finally, we followed a simplified decision algorithm designed to accommodate AIC_c, BIC and LRT results: when AIC_c and BIC do not agree, if LRT results support AICc, the model selected by AIC_c is assumed to be correct, otherwise we assume the model selected by BIC.

Size Analysis

We used a general linear model (GLM) to test the potential influence of management and distance to the nearest town on the size of the fish in the catches. Interaction between management and distance to the nearest town was included in the model. A multinomial logit model was used to test the potential influence of management and distance to the nearest town on the trophic level of the fish in the catches. The packages MASS and nnet (Venables & Ripley, 2002) from R (R Core Team, 2013) were used for GLM and the multinomial models, respectively. We calculated the mean trophic level for each fishing center by management type. To ensure that differences among fisheries centers were not due to differences in sample size, we implemented bootstrap resampling, generating 100 samples for each different management type and distance to the nearest town (Efron and Tibshirani 1994).

Additionally, individual histograms of size were built pooling data for each year sampled, trophic level, management type and distance to the nearest town class in order to assess if the size distribution frequencies varied. We used an mclust package (Fraley & Raftery, 2012) to perform gaussian mixture modelling (GMM) to the size data. Mclust implements maximum-likelihood estimation for mixtures of a finite number of normal distributions, allowing models with different number of components to be compared using BIC (Fraley & Raftery, 2002, 2007).

We estimated the number of components and the mean size per cluster. To ensure that our results were not due to differences in sample size, we generated 100 samples for each different sub-community through a bootstrap procedure, in order to compare the mean and standard deviations.

4.4 Results

In total, 99,253 individuals representing 257 unique species were analysed (Table 6 and Supporting Information 2). The species richness by distance to the nearest town was highest in "<100" and "> 300", 185 and 143 respectively (Table 6c). Overall, the fish composition of the fishing centers by habitat is diverse, with no division of the fishing center landings by habitat in the 3-dimensional (one dimension for each habitat) representation of the fishing center landings (Supporting Information 3).

Table 6 - a) Number of species (S) and number of individuals (N) by year; b) Number of species (S) and number of individuals (N) by management; c) Number of species (S) and number of individuals (N) by distance to the nearest town.

a)

Year	**N**	**S**
2010	19223	161
2011	34075	161
2012	45955	168

b)

Type of management		**N**	**S**
1	CCPs	3893	64
2	CCP-PN	14729	54
3	CCP	29853	141
4	wCCP	44615	186
5	N	6163	54

c)

Distance to the nearest town	**N**	**S**
Dist ≤ 100	37159	185
100 < Dist ≤ 200	14668	59
200 < Dist ≤ 300	19815	83
Dist > 300	27611	143

4.4.1 Diversity

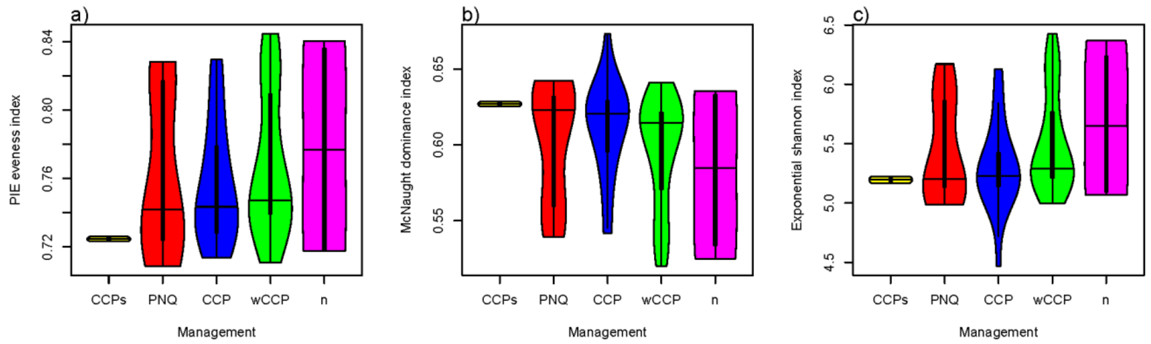

Figure 13 – Diversity index by management: a) Pie Evenness; b) McNaught dominance; c) Exponential Shannon

There were no detectable differences in exponential Shannon, PIE or McNaught Dominance among management types (Figure 13).

4.4.2 SAD

The species abundances distributions for each year were best represented by one PLN distribution according to both BIC and AICc (supplementary information 5). Visually, the SADs for each year were very similar (Supporting Information 4) and we found no evidence of year to year variation in SADs for the Cabo Delgado fisheries (fitting details and best fit parameters can be seen in the Supporting Information 4).

Regarding SAD analysis by management level, BIC selected one PLN for all the levels, whereas AIC selected a mixture of PLNs for some levels, but without enough support for multimodality except for level "N". The subsequent LRT for this case confirmed that for this SAD a mixture of 3PLN does have strong support. Figure 14 shows the SADs with the fitted curves for each type of management. The position of the modes is very consistent among management types, except for level "N" (Figure 14 and supporting Information 4). Model selection for SADs for each distance class also yielded different results for AICc and BIC, with AICc selecting multimodal distributions for the lowest and the highest distance classes with strong support, while BIC selected one PLN or logseries as best model. Again, for both cases, LRT supports AICc model selection, with strong support for a multimodal distribution. We detected differences in the position of the modes and parameter estimates (Figure 15, Supporting Information 4), with the differences being more striking for the lowest and the highest distances.

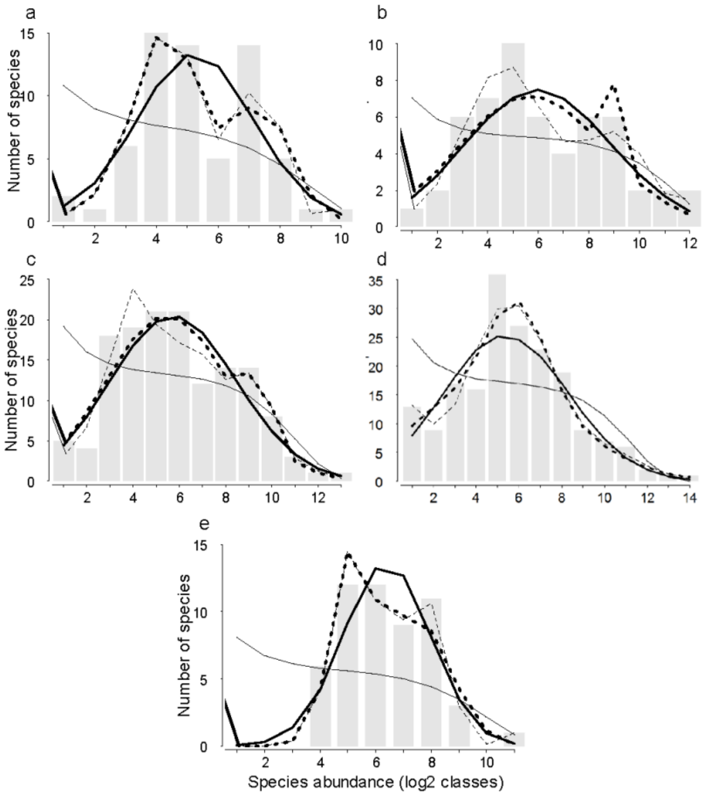

Figure 14 – SADs for management type with the best-fit curves: a) CCPs, b)CCP-PN, c) CCP, d) wCCP, e) n. Solid line for logseries, boldline for 1PLN, bold dotted line for 2PLN and dashed line for 3PLN

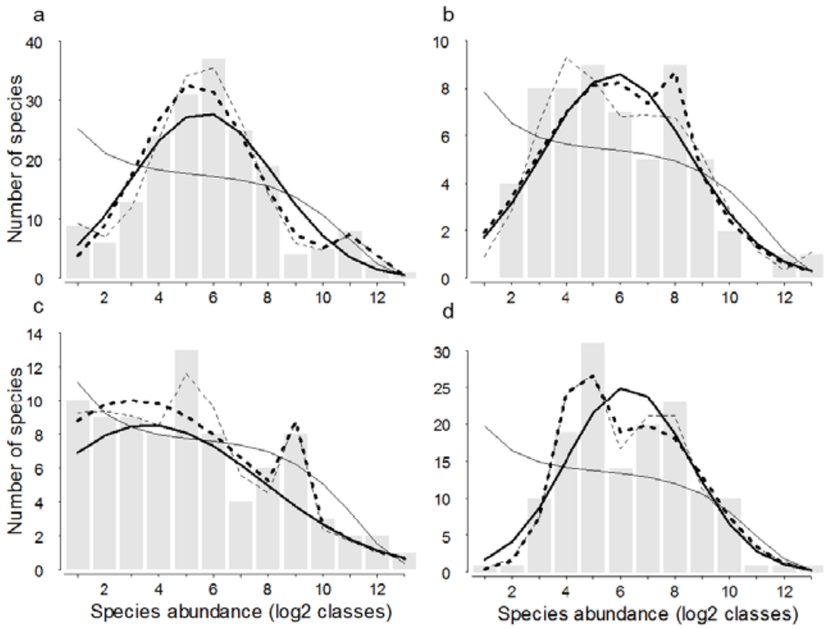

Figure 15 – SADS for distance to the nearest town classes with the best-fit curves : a) <100km, b) 100-200km, c) 200-300km and d) >300km. Solid line for logseries, bold line for 1PLN, bold dotted line for 2PLN and dashed line for 3PLN.

4.4.3 Sizes

The size histogram for each year (Figure 16) is very similar and shows no difference between the years. In contrast, size histogram analyses indicate that both management type (Figure 17) and distance class (Figure 19) affect the sizes of fish caught. Size histograms with probability density functions estimated via GMM (right side of Figure 17) revealed that higher management levels (CCPs, CCP-PN and CCP) exhibit longer tails in the right-end of the distribution, i.e. yield bigger sizes (Figure 17 a,b,c). In contrast, wCCP and N histograms reveal peaks in small sizes and no tails on the right (Figure 17 d,e). Mclust results indicated best models with 5 to 8 clusters, but without a clear pattern between number of clusters and the management gradient. For the three higher management levels, more individuals (cluster with higher density) had higher mean sizes, while for wCCP and N a higher proportion of individuals had lower mean sizes (highlighted in grey in Supporting Information 5).

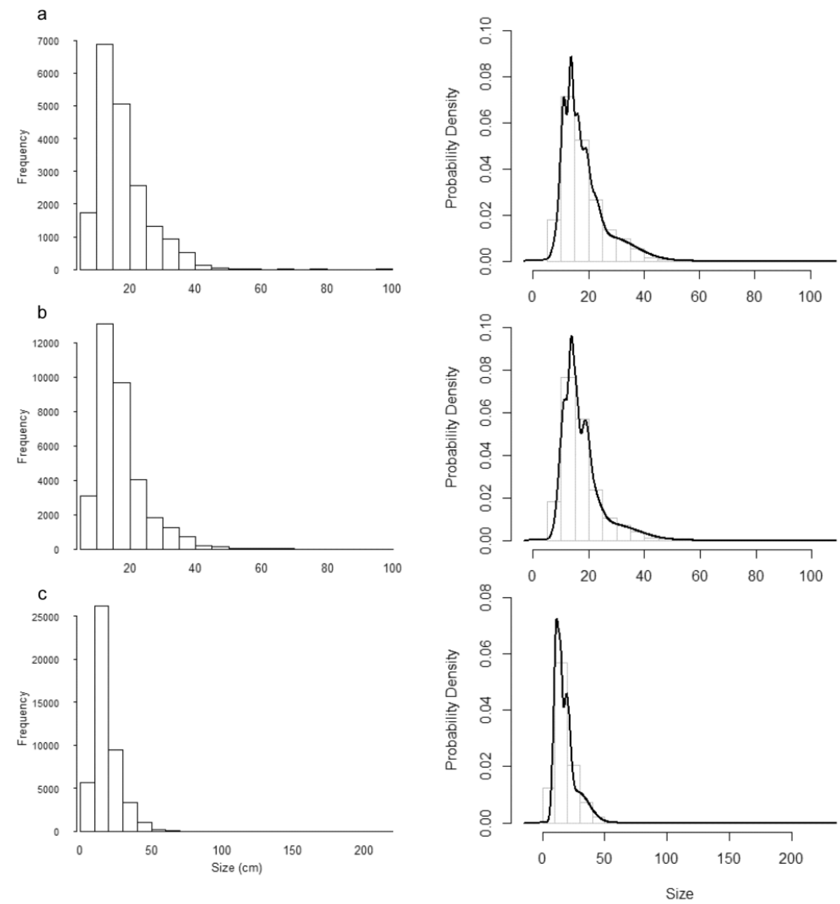

Figure 16 – Size histograms of the fish samples by years: a) 2010; b) 2011; c) 2012. Panel on the right shows solid black lines representing the probability density functions estimated via GMM using Mclust.

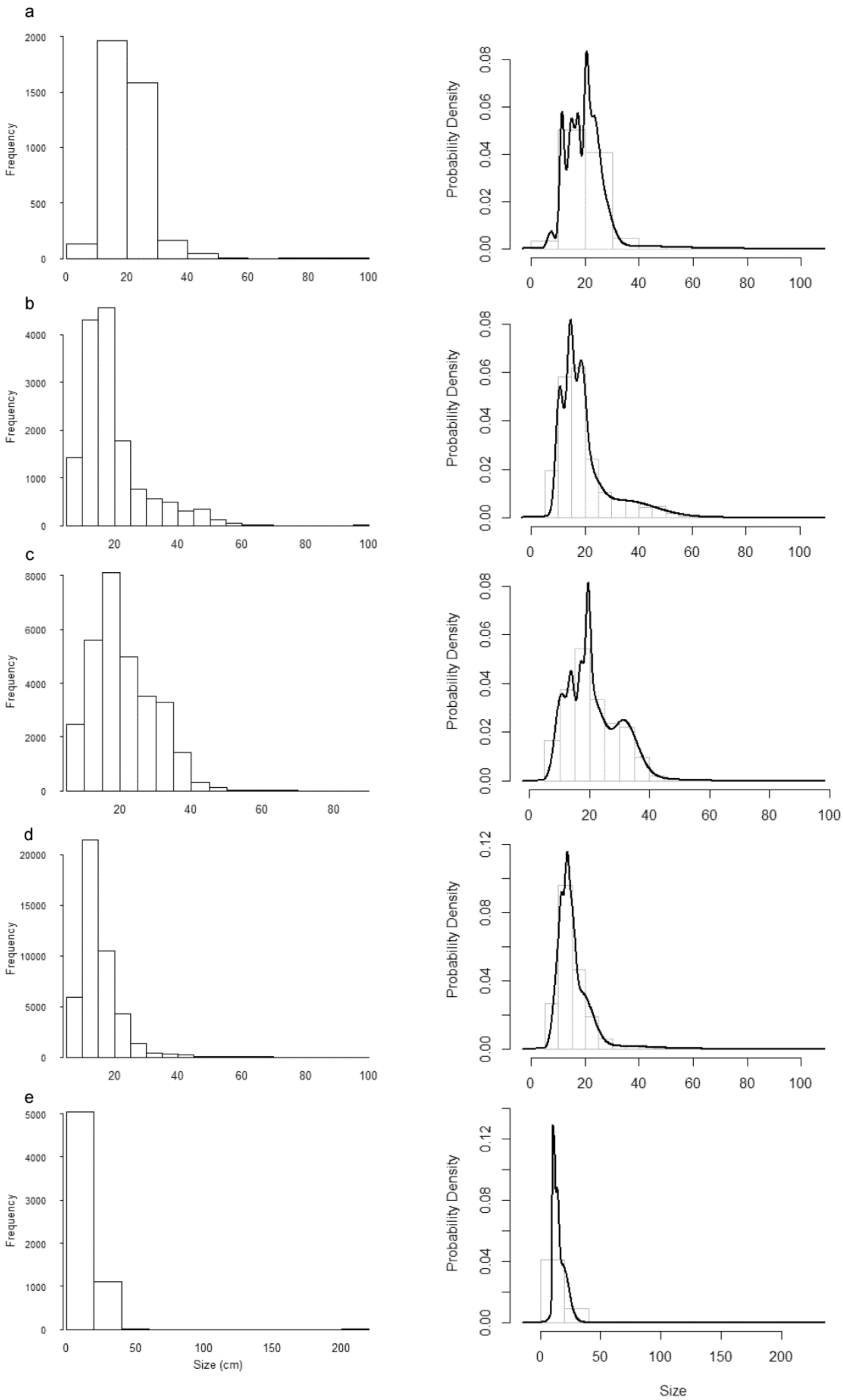

Figure 17 – Individual size distribution histograms for each management level: a)CCPs, b) CCP-NP, c) CCP, d) wCCP, e) n. Panel on the right shows solid black lines representing the probability density functions estimated via GMM using Mclust.

These results are robust to sample size differences, as the patterns are largely consistent for bootstrapped resampled data (Figure 18), with CCP having the biggest sizes though similar to CCP-PN and followed by CCPs. By far the lowest sizes refer to wCCP and N.

The GLM also reported significant differences for each one of the management types ($p < 2e-16$). Results of all the parameters of the equation of the GLM model can be found in Table 7.

For the effects of market forces, the size histogram of the highest distance class (the farthest away from town - >300 km) showed a right-end pronounced tail, corresponding to the biggest sizes. Furthermore, this tail decreases as distance classes approach the town, with no tail for the <100 km class (Figure 19). Here Mclust results indicated best models with 6 to 7 clusters. There is a clear size gradient with the distance classes, with the "<300 km" class having the higher proportion of individuals in the biggest mean size cluster, followed by the "200-300 km" class, "200-100 km" class and finally the "<100km" with the lowest mean size (Supporting Information 5). The results of bootstrapping by distance classes (Figure 20) support the above results, showing a clear decline from the farthest away fishing centers with the biggest sizes, to the nearest fishing centers with the smallest sizes.

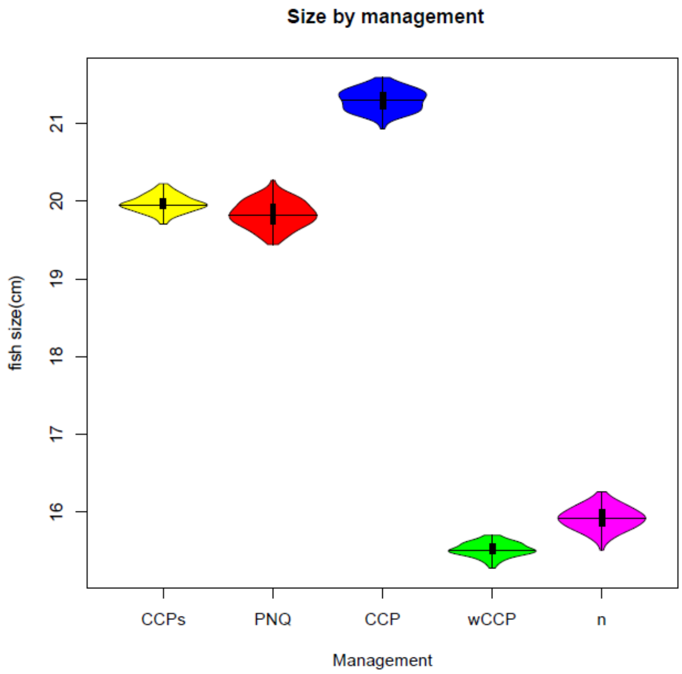

Figure 18 – Average fish size by level of management after a bootstrapping of 100 samples for each level.

If we analyse the number of fish in each trophic level by management type, we have a higher number of fish and a bigger variation in the herbivores between all the management types (Figure 21). We have less fish but an increase in trophic levels being caught in low and middle carnivorous fish (Figure 22). The multinomial model also gives significant differences for all the levels of management, showing that differences in trophic level between management types and classes of distance are important (Table 8).

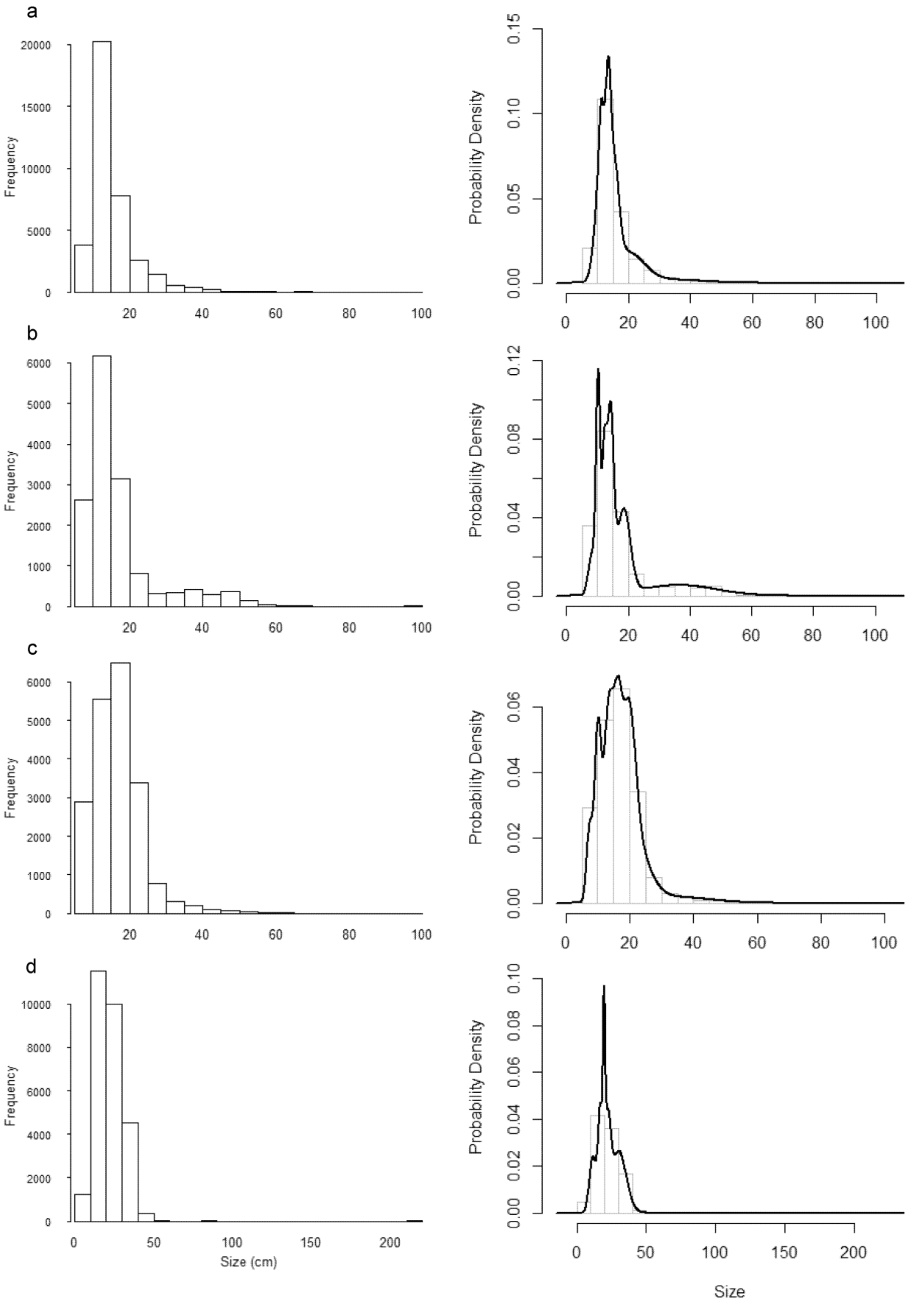

Figure 19 – Individual size distribution histograms for distance to the nearest town classes: a) <100 km, b) 100-200 km, c) 200-300 km and d) >300 km. Solid black lines represent the probability density functions estimated via GMM using Mclust.

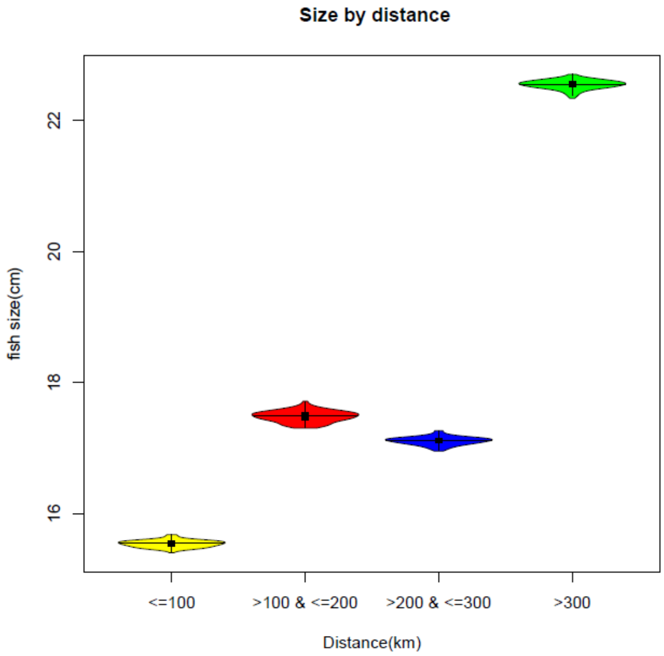

Figure 20 – Average fish size by class distance after a bootstrapping of 100 samples for each level

Table 7 - Results of GLM model (size~management*distance). Percentage of variance explained by management is 78%, by distance 11% and by the iteration of the two 11%

	A	B	Estimator	P
Intercept			17.11321	< 2e-16 ***
Management CCP	17.1132073	0	17.11321	
Management CCP_PN	18.6328497	0	1.519642	2.74e-16 ***
Management CCPs	14.1469591	0	-2.96625	< 2e-16 ***
Management n	12.7621757	0	-4.35103	< 2e-16 ***
Management wCCP	15.9391283	0	-1.17408	< 2e-16 ***
Distance	0	0.0144115	0.014412	< 2e-16 ***
Management CCP	17.1132073	0.0144115		
Management CCP_PN: distance	18.6328497	-0.000100604	-0.00698	4.60e-13 ***
Management CCPs: distance	NA	NA	NA	NA
Management n:distance	12.7621757	3.68372E-05	0.002556	1.16e-05 ***
Management wCCP: distance	15.9391283	-0.000261351	-0.01813	<2e-16 ***

Table 8 - Results from the multinomial logit model (trophic level ~ management + distance, family =binomial).

	(Intercept)		Manag CCP_PN		Manag CCPs		Manag n		Manag weakCCP		Distance	
	Z	P	Z	p	Z	P	Z	p	Z	P	Z	p
High carnivorous	-17.27	0e-20	6.520	6.9e-11	33.943	0e-20	36.207	0e-20	9.718	0e-20	3.359	0.0007
Midle carnivorous	30.844	0e-20	-22.23	0e-20	33.894	0e-20	36.697	0e-20	-32.28	0e-20	-47.47	0e-20

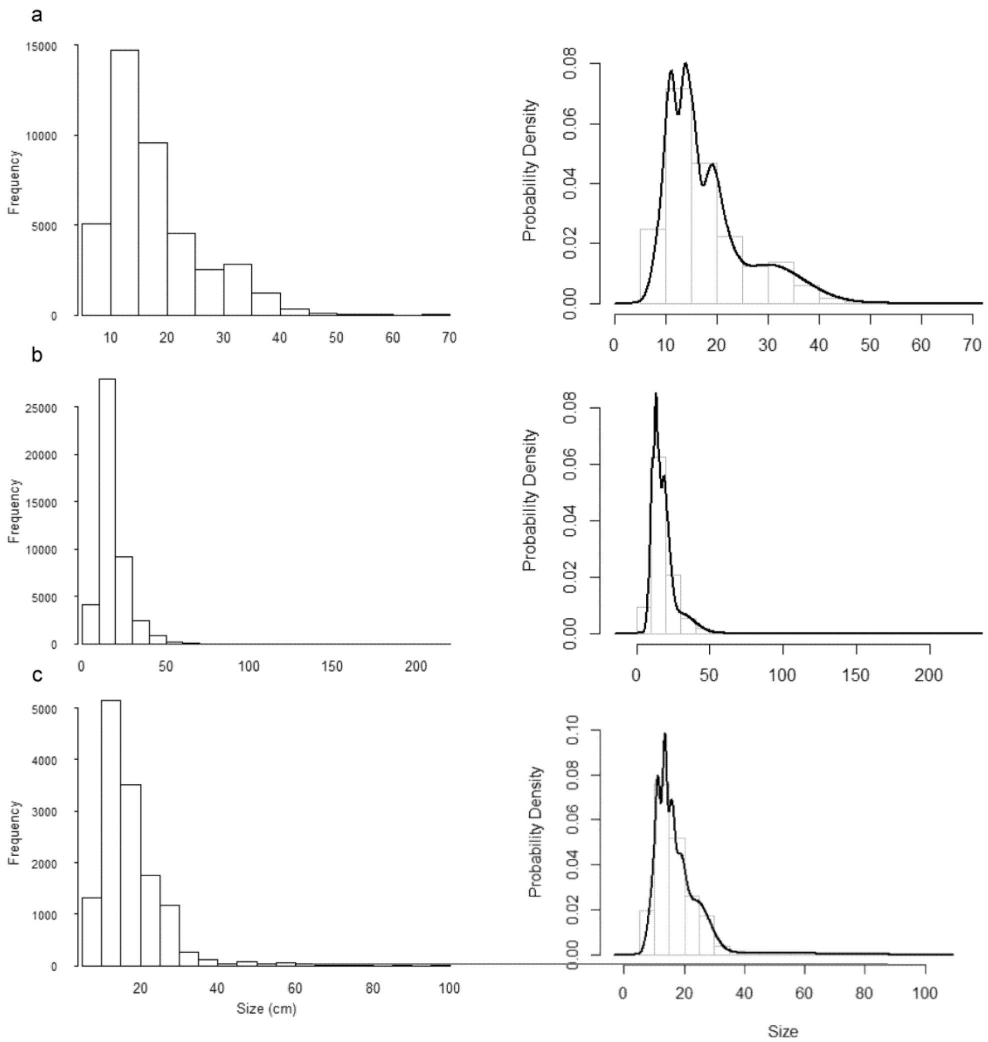

Figure 21 – Individual size distribution histograms for each trophic level: a) herbivorous; b) low carnivorous; c) middle carnivorous. Panel on the right shows solid black lines representing the probability density functions estimated via GMM using Mclust.

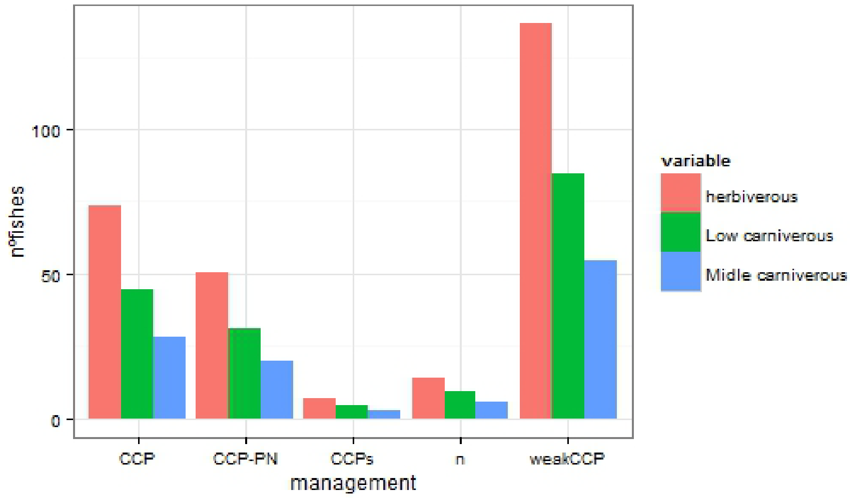

Figure 22 – Number of fish for a certain trophic level by management type, after a bootstrapping of 100 samples for each

4.5 Discussion

Our results showed that the size of fish caught is strongly influenced by the distance to the nearest town and less influenced by different levels of management. In contrast, we did not detect the effects of management level nor the distance to the nearest town on any of the diversity or community structure metrics. We also detected the effect of management level and distance on species abundance distribution. While the other categories were generally better suited to a single lognormal distribution, the SADs from the lowest management level and the lowest and highest classes of distance were better described by multimodal distributions.

In this study we found no evidence of differences in a suite of diversity metrics covering the main axes of diversity among management levels or distance to the nearest town. These results agree with most of the fisheries literature (Bianchi et al., 2000; Piet & Jennings, 2005), and are also in line with a more general assessment of the effects of disturbance on diversity metrics (Supp & Ernest, 2014). A recent study in Kenya, in a context more similar to the tropical coral reefs in Mozambique, shows the homogenization of diversity of the catches in a fished area compared with catches in a protected area (McClanahan, Kaunda-Arara, & Omukoto, 2010). These authors attribute the homogenization of the catches to gear selectivity resulting in fewer species caught in grounds normally fished. This diversity change could impact the ecosystem services provided by coral reefs and tourism, but the resistance and resilience of coral reefs also decreases with decreasing diversity (Worm et al., 2006).

The SAD results did not show any difference from year to year, as expected. This result is similar to other studies that show that long term analyses are needed to detect a change in the species caught (Daan, Gislason, Pope, & Rice, 2005; Magurran & Henderson, 2003). Regarding co-management, our results indicate that the SAD for the lowest level of protection was multimodal, in contrast with the higher management levels. This may indicate that in this case the structure of the community is being affected by the lack of management. Indeed the plotted SAD for “N” appears to be different from the remaining ones, with the first three octaves being empty. This means that the rarest species in the community, represented by 1-7 individuals, were not present in our data. Although this could be attributed to sampling effects, it could also be indicative that the rarest species in the communities being fished under no protection level in this area might be affected. We did not detect any consistent pattern for the increasing management levels. This could be related to the fact that the implementation of co-management in the area is still recent, and not enough time has passed for there to be a strong effect on the SADs.

However, (Rice & Gislason, 1996)) detected a loss of diversity in the high trophic levels and an increase of diversity in the low trophic level when analysing two decades of North Sea fish assemblages caught in trawling. It is possible that this mechanism is buffering any changes in the SADs. On the other hand, regional consumer preferences are for small-sized fish (low trophic level), and the fishing pressure for these sizes would then eliminate the compensation mechanism described above.

Additionally, we found that the SADs were strongly influenced by the distance to the nearest town, with both the lowest and the highest distance SAD classes being multimodal. Higher fishing pressure closer to a town with bigger markets for fish products would diminish the trophic level diversity of the fish caught and this could possibly affect the profile of the SADs. Furthermore, we found a preference for small sizes across the province. Small-sized fish are easier to dry and transport to other markets but also easier to divide between families that are often very numerous (personal observation).

In an apparent contradiction, the preference for smaller sizes did not alter the greater catchability of larger-sized fish: national law enforced by the CCP sets minimum net sizes and hook lines, and favours the catching of bigger sizes. So, when the sizes of the fish caught were analysed, clearer results appeared, either by the mclust or GLM. The fishing centers with higher management level CCPs, CCP-PN and CCP yielded bigger sizes than the fishing centers classified as wCCP or N, the low management levels. We expected a gradient of bigger sizes in the CCPs to smaller sizes in the fishing centers with no CCP, but the data was clearly divided into two groups: the CCPs, CCP-PN and CCP with bigger sizes and the wCCP and N in with smaller sizes. The bigger sizes in the CCP, the middle management level, could indicate that we were too conservative in the classification of the fishing centers and probably more CCP were working better than expected. On the other hand, it could also indicate that the fishing resources are still far from overexploited in this poorly studied region (Elst et al., 2005).

The strongest result of our study shows a strong gradient as far as distance to the nearest town is concerned, with bigger sizes found the farthest away from the main town. The strong influence of urbanization on the size of fish caught is normally measured by the population density of the place where the fish is first sold/disembarked or the distance from disembarkation to the nearest town (Aswani & Sabetian, 2010; Cinner, Graham et al., 2012; Stallings, 2009). Cinner, Graham et al. (2012) found that distance to market was a stronger predictor of fish abundance than population density. However, the same author also found a reduction in the trophic level with closer proximity to the markets in Papua New Guinea (Cinner et al., 2006), an effect that we did not find in our study.

Trophic-level analysis showed bigger sizes and more fish in the herbivorous trophic level for all the fishing centers in line with fisheries literature: the fisheries in Cabo Delgado are fishing “down the food web” (Pauly, Christensen et al., 1998). The lower trophic level are being released from predation because piscivorous are being caught, allowing herbivorous to grow to bigger sizes and in bigger numbers.

Overall, our results point to management level having a weak influence on the size of the fish caught, but distance to market having a strong influence. Markets are the strongest driving force for the size of fish caught. In terms of management, this implies that stronger management measures and stronger CCPs need to be developed so that sustainable fishing spreads along the coast and future generations can continue to enjoy the oceans and their benefits for a long time to come.

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Supporting Information 4.1 – Fishing Centers

Fishing center	District	Type of management	Distance by road to the nearest town
Capetela	Quissanga	CCP	110
Capetera	Quissanga	wCCP	96
Captera	Quissanga	CCP	110
Carapina	Mecufi	CCP	21
Cariacó	Pemba	wCCP	0
Cooperativa	Pemba	n	10
Cumilamba	Ibo	PNQ	108
Cumuamba	Ibo	PNQ	110
Darumba 1	Macomia	CCP	249
Farol	Pemba	wCCP	7
Forjane	Pemba Metuge	wCCP	38
Ingonane	Pemba	wCCP	0
Inos	Pemba	wCCP	0
Javala	Pemba	n	10
Kauri	Quissanga	wCCP	110
Kawamarema	Macomia	wCCP	249
Kinambo	Macomia	PNQ	250
Kirinde	Palma	CCP	442
Kiwandala	Ibo	PNQ	108
Kufungu	Pemba	wCCP	0
Kumuamba	Ibo	PNQ	110
Lobo	Macomia	wCCP	238
Magogo	Macomia	wCCP	249
Mahate	Quissanga	wCCP	93
Malinde	Mocímboa da Praia	CCP	340
Maringanha	Pemba	wCCP	7
Matundo	Quissanga	wCCP	110
Mecuti	Quissanga	wCCP	96
Milamba	Mocímboa da Praia	CCP	340
Milamba1	Ibo	wCCP	249
Minuto	Mecufi	CCP	21
Missahola	Ibo	wCCP	249
Muanacombo	Ibo	wCCP	249
Muenhemerura1	Macomia	PNQ	250
Muijuma	Mecufi	CCP	21
Mweve	Pemba Metuge	wCCP	38
Nabubuzi	Mocímboa da Praia	CCP	340
Namadoro	Quissanga	wCCP	93

Fishing center	District	Type of management	Distance by road to the nearest town
Namaluça	Pemba Metuge	wCCP	38
Namba	Ibo	wCCP	249
Nambo	Macomia	wCCP	233
Ncati	Macomia	wCCP	233
Nfunzi	Macomia	wCCP	233
Nomgue	Palma	wCCP	410
Npewe	Mecufi	CCP	21
Ntenguezi	Pemba	wCCP	7
Olumbi	Palma	CCP	405
Olumboa	Macomia	wCCP	246
Olumboa1	Macomia	wCCP	246
Olumboa2	Macomia	wCCP	246
Pagreja	Ibo	PNQ	110
Pagreja1	Ibo	PNQ	108
Palma Sede	Palma	CCP	418
Palussanca	Ibo	wCCP	249
Pamane	Quissanga	wCCP	93
Pamengabu 1	Macomia	PNQ	250
Pangane lobo	Macomia	wCCP	238
Pangane Sede	Macomia	CCP	238
Pankombolo	Macomia	PNQ	237
Panteuda	Ibo	PNQ	110
Paquissico	Quissanga	wCCP	96
Pastorinho	Quissanga	CCP	110
Pautipula	Quissanga	wCCP	96
Ponte Cais	Ibo	PNQ	110
Quifuque	Palma	n	398
Quionga	Palma	n	440
Quissanga Praia	Quissanga	wCCP	96
Quivuri	Palma	CCPs	405
Rance	Palma	CCPs	405
Reiculo	Ibo	wCCP	249
Ruela	Pemba	CCP	0
Sibolongo	Macomia	PNQ	237
Sicura	Mecufi	CCP	23
Sukutulo	Ibo	PNQ	108
Tandanhangue	Quissanga	CCP	110
Ulondo	Quissanga	CCP	110
Wimbe	Pemba	wCCP	6
Zalala	Mocímboa da Praia	CCP	340

Supporting Information 4.2 – Fish species

Species	Trophic level	Habitat
Ablennes hians	4.5	mix
Acanthocybium solandri	4.4	mix
Acanthopagrus berda	3.5	mix
Acanthurus dussumieri	2.0	coral
Acanthurus tennentii	2.0	coral
Acanthurus triostegus	2.8	coral
Alepes djedaba	3.3	mix
Allothunnus fallai	3.7	mix
Amblygaster sirm	3.3	mix
Aphareus furca	4.1	mix
Aphareus rutilans	4.1	mix
Atule mate	4.5	seagrass
Auxis rochei	4.1	mix
Auxis thazard	4.3	mix
Bodianus perdition	3.5	coral
Caesio caerulaurea	3.4	coral
Caesio caerulaurea	3.4	coral
Caesio lunaris	3.4	coral
Caesio lunaris	3.4	coral
Caesio teres	3.4	coral
Caesio varilineata	3.4	coral
Caesio varilineata	3.4	coral
Caesio xanthonota	NA	coral
Calotomus carolinus	NA	seagrass
Calotomus spinidens	NA	seagrass
Calotomus viridescens	NA	seagrass
Carangoides caeruleopinnatus	NA	mix
Carangoides chrysophrys	NA	mix
Carangoides dinema	4.0	mix
Carangoides ferdau	4.5	mix
Carangoides malabaricus	4.4	mix
Caranx heberi	3.7	mix
Caranx ignobilis	4.2	mix
Caranx papuensis	4.0	mix
Caranx sexfasciatus	4.5	mix
Caranx sp.	4.5	mix
Carcharhinus leucas	4.3	mix
Cephalopholis aurantia	4,4	coral
Cephalopholis leopardus	4,4	coral

Species	Trophic level	Habitat
Cephalopholis miniata	4.4	coral
Cephalopholis urodeta	4,4	coral
Cetoscarus bicolor	2	coral
Chanos chanos	2.0	mix
Cheilinus diagrammus	3,7	coral
Cheilinus fasciatus	3,4	coral
Cheilinus trilobatus	3.5	coral
Cheilinus trilobatus	3.5	coral
Cheilio inermis	4.0	mix
Chirocentrus dorab	4.5	mix
Coryphaena equiselis	4.5	mix
Crenidens crenidens	2.8	mix
Ctenochaetus strigosus	2.8	mix
Cypselurus naresii	4.0	mix
Decapterus kurroides	3.4	mix
Decapterus kurroides	3.4	mix
Decapterus macarellus	3.4	mix
Decapterus macrossoma	3.4	mix
Decapterus russelli	3.7	mix
Decapterus tabl	3.2	mix
Diagramma pictum	3.5	mix
Drepane punctate	3.3	mix
Elagatis bipinnulata	3.6	mix
Epinephelus albomarginatus	4.2	coral
Epinephelus andersoni	4.0	coral
Epinephelus areolatus	3.6	coral
Epinephelus caeruleopunctatus	3.7	coral
Epinephelus chlorostigma	4.0	coral
Epinephelus fasciatus	3.7	coral
Epinephelus faveatus	3.7	coral
Epinephelus fuscoguttatus	4.1	coral
Epinephelus guaza	3.7	coral
Epinephelus hexagonatus	4.1	coral
Epinephelus malabaricus	3.8	coral
Epinephelus malabaricus	3.8	coral
Epinephelus melanostigma	4.0	coral
Epinephelus microdon	3.9	coral
Epinephelus ongus	3.7	coral
Epinephelus posteli	4.0	coral

Species	Trophic level	Habitat
Epinephelus rivulatus	3.6	coral
Epinephelus sp.	3.6	coral
Epinephelus tauvina	4.1	coral
Etelis carbunculus	4.5	coral
Etelis coruscans	4.5	coral
Euthynnus affinis	4.5	mix
Fistularia petimba	4.5	mix
Galeardo cuvier	4.5	mix
Gerres acinaces	3.5	mix
Gerres acinaces	3.5	mix
Gerres filamentosus	3.3	mix
Gerres filamentosus	3.3	mix
Gerres oblongus	3.5	mix
Gerres oyena	3.1	mix
Gerres rappi	3.6	mix
Gnathodentex aurolineatus	3.3	coral
Gymnocrarius griseus	3.2	coral
Hemipristis elongates	4.3	mix
Hemiramphus far	2.9	seagrass
Hemiramphus far	2.9	seagrass
Hemiramphus lutkei	3.3	seagrass
Hemiramphus lutkei	3.3	seagrass
Herklotsichthys quadrimaculatus	3.6	mix
Hilsa kelee	3.3	mix
Hipposcarus harid	2.0	coral
Jhonius amblicephalus	3.3	mix
Kyphosus cinerascens	2.3	mix
Leiognathus berbis	3.3	mix
Leiognathus fasciatus	3.3	mix
Leiognathus leuciscus	3.1	mix
Leiognathus lineolatus	3.5	mix
Leiognathus sp.	3.5	mix
Leptoscarus vaigiensis	2.3	seagrass
Lethinus obsoletus	3.4	seagrass
Lethinus xanthochilus	3.7	mix
Lethrinus conchyliatus	4.0	coral
Lethrinus crocineus	3.7	coral
Lethrinus erythracanthus	3.7	coral
Lethrinus harak	3.6	mix
Lethrinus harak	3.6	mix
Lethrinus lentjan	4.2	mix
Lethrinus lentjan	4.2	mix

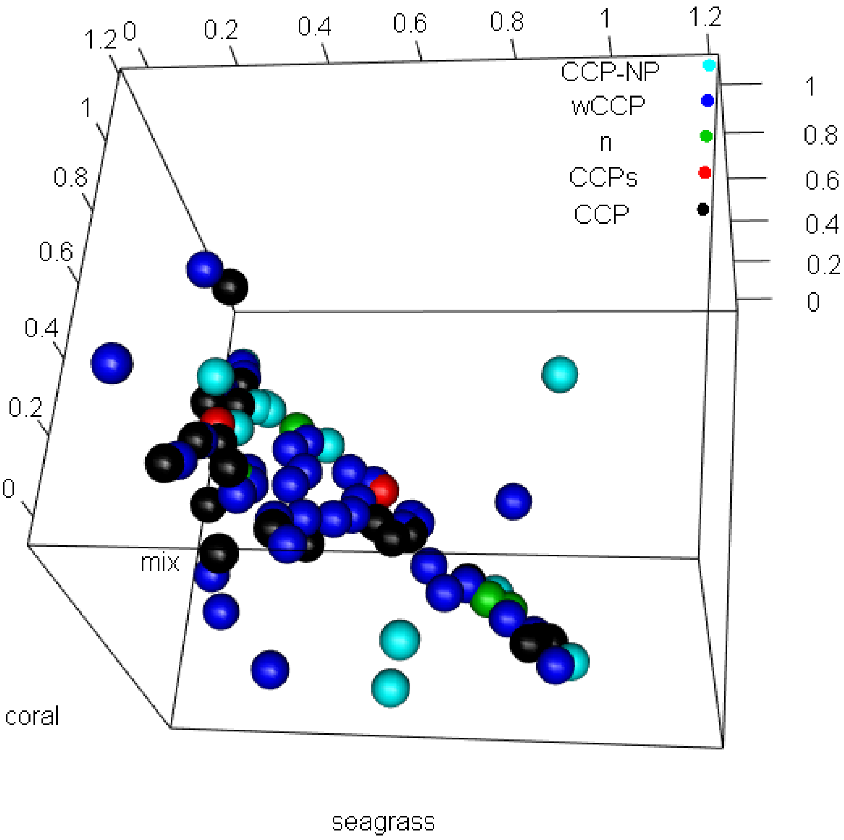
Species	Trophic level	Habitat
Lethrinus mahsena	3.4	mix
Lethrinus mahsena	3.4	mix
Lethrinus microdon	3.8	coral
Lethrinus nebulosus	3.3	mix
Lethrinus nebulosus	3.3	mix
Lethrinus rubrioperculatus	3.6	mix
Lethrinus sp.	3	mix
Lethrinus variegatus	3.8	mix
Lethrinus variegatus	3.8	mix
Lethrinus xanthochilus	3.8	mix
Liza macrolepis	2.6	mix
Liza melinoptera	2.3	mix
Lutjanus argentimaculatus	3.6	mix
Lutjanus bengalensis	3.8	coral
Lutjanus bohar	4.1	coral
Lutjanus fulviflamma	3.8	coral
Lutjanus fulvus	4.1	coral
Lutjanus gibbus	3.6	coral
Lutjanus guilcheri	3.7	coral
Lutjanus kasmira	3.6	coral
Lutjanus lemniscatus	4.0	mix
Lutjanus lutjanus	4.1	coral
Lutjanus lutjanus	4.1	coral
Lutjanus monostigma	4.3	coral
Lutjanus notatus	4.0	coral
Lutjanus russellii	4.3	coral
Lutjanus sanguineus	4.5	coral
Lutjanus sebae	4.3	coral
Lutjanus sp.	4.3	coral
Lutjanus vitta	4.1	coral
Makaira indica	4.5	mix
Makaira mazara	4.5	mix
Megalaspis cordyla	4.4	mix
Monotaxis grandoculis	3.2	coral
Monotaxis grandoculis	3.2	coral
mossambica Anguilla	3.2	coral
Mugil cephalus	2.1	mix
Mulloides vanicolensis	3.6	coral
Myripristis adustus	3.4	coral
Myripristis berndti	3.7	coral
Myripristis melanostictus	3.7	coral
Myripristis murdjan	3.3	coral

Species	Trophic level	Habitat
Naso brachycentron	2.7	coral
Naso hexacanthus	3.3	coral
Naso lituratos	2.3	coral
Nemipterus japonicas	3.8	seagrass
Otolithes ruber	3.6	mix
Pamadasys maculatum	3.6	mix
Papilloculiceps longiceps	4.1	coral
Parupeneus barberinus	3.2	mix
Parupeneus bifasciatus	3.5	mix
Parupeneus cinnabarinus	3.4	mix
Parupeneus cyclostomus	4.2	mix
Parupeneus cyclostomus	4.2	mix
Parupeneus indicus	3.5	mix
Parupeneus macronema	3.5	mix
Parupeneus pleurostigma	3.4	mix
Pellona ditchela	4.0	seagrass
Penaeopsis balssi	4.0	seagrass
Penaeus monodon	4.0	seagrass
Platax orbicularis	3.3	coral
Platycephalus indicus	3.6	seagrass
Plectorhinchus chubby	3.8	mix
Plectorhinchus flavomaculatus	4.0	mix
Plectorhinchus gaterinus	4.0	coral
Plectorhinchus orientalis	3.8	coral
Plectorhinchus playfairi	3.3	coral
Plectorhinchus schotaf	3.8	coral
Plectorhinchus sordidus	4.0	coral
Plectorhinchus sp.	4.0	coral
Plectorinchus gaterinus	4.0	coral
Plectoropomus puntactus	4.5	mix
Plotosus nkunga	3.5	mix
Pomadasys kaakan	3.5	mix
Pomadasys maculatum	4.0	mix
Pomadasys multimaculatum	3.6	mix
Pomatomus saltatrix	4.5	mix
Priacanthus cruentatus	3.8	coral
Pristipomoides sieboldii	3.9	mix
Pterocaesio marri	3.4	coral
Pterocaesio tile	3.3	coral
Pterocaesio tile	3.3	coral
Rastrelliger kanagurta	3.2	mix
Sarcentron caudimaculatum	3.9	coral

Species	Trophic level	Habitat
Sarda orientalis	4.2	mix
Sardinella albella	2.7	mix
Sardinella gibbosa	2.9	mix
Sargocentron rubrum	3.5	coral
Sargocentron sp.	3.5	coral
Saurida gracilis	4.2	coral
Scarus atrilunula	2.0	coral
Scarus enneacanthus	2.0	coral
Scarus festivus	2.0	coral
Scarus frenatus	2.0	coral
Scarus ghobban	2.0	coral
Scarus gibbus	2.0	coral
Scarus globiceps	2.0	coral
Scarus japonesis	2.0	coral
Scarus niger	2.0	coral
Scarus psittacus	2.0	coral
Scarus rubroviolaceus	2.0	coral
Scarus russelii	2.0	coral
Scarus scaber	2.0	coral
Scarus sordidus	2.0	coral
Scarus tricolor	2.0	coral
Scolopsis bimaculatus	3.8	mix
Scolopsis bimaculatus	3.8	mix
Scolopsis ghanam	3.6	coral
Scolopsis ghanam	3.6	coral
Scomber japonicas	3.1	mix
Scomberoides commersonnianus	4.5	mix
Scomberoides lysan	4.5	mix
Scomberoides tol	4.4	mix
Scomberomorus commerson	4.5	mix
Secutor ruconius	3.4	mix
Selar crumenophthalmus	4.1	mix
Selar crumenophthalmus	4.1	mix
Siganus luridus	2.0	mix
Siganus stellatus	2.7	coral
Siganus sutor	2.0	seagrass
Siganus sutor	2.0	seagrass
Sillago sihama	3.4	mix
Sphyraena barracuda	4.5	mix
Sphyraena barracuda	4.5	mix
Sphyraena chrysotaenia	4.5	mix
Sphyraena flavicauda	3.8	mix

Species	Trophic level	Habitat
Sphyraena forsteri	4.3	coral
Sphyraena jello	4.5	mix
Sphyraena putnamie	4.5	mix
Sphyraena qenie	4.5	coral
Spratelloides delicatulus	3.1	coral
Stolephorus commersonii	3.1	mix
Synagrops japonicas	4.3	mix
Synodus binotatus	4.0	coral
Synodus sp.	3	coral
Terapon jarbua	3.9	mix
Terapon puta	3.1	seagrass
Tetrapturus angustirostris	4.5	seagrass
Thallassoma fuscum	3.6	coral
Thryssa baelama	2.9	mix
Thryssa setirostris	3.3	mix
Thunnus alalunga	4.3	mix
Thunnus obesus	4.5	mix
Trachinotus blochii	3.7	mix
Trachurus trachurus	3.6	mix
Trachurus delagoa	3.7	mix
Trachurus delagoa	3.7	mix
Trichiurus lepturus	4.5	mix
Tylosorus acus melanotus	4.3	mix
Tylosurus crocodilus crocodilus	4.5	mix
Upenaeus sulphurous	3.2	mix
Upeneus bensasi	3.6	mix
Upeneus taeniopterus	3.5	mix
Upeneus tragula	3.6	mix
Upeneus vittatus	3.5	mix
Uraspis secunda	4.0	mix
Valamugil seheli	2.3	mix
Variola louti	4.3	coral
Zeus faber	4.5	mix

Supporting Information 4.3 – Fish Center habitat



Fishing center catches distributed according to habitat – Each point is a fishing center, where X is the percentage of reef fish caught in that fishing center, Y the percentage of seagrass fish and Z the percentage of fish that use both habitats and were caught in that fishing center.

Supporting Information 4.4 – SAD results

Table S1 – SADs by years

Year	Fitted Model	Min Loglik	AICc	BIC	Model Selected		Position of the Modes _ **Octaves**						**Best fit Parameters - μ**						N	S	α
					AICc	BIC	1PLN	2PLN		3PLN			1PLN	2PLN		3PLN					
2010	Logser	896.00	1794.02	1797.07	1PLN	1PLN	6	-1	6	0	5	10	32.37	0.44	37.09	0.98	31.27	538.65	#####	161	24.09
	1PLN	868.86	**1741.80**	**1747.88**																	
	2PLN	867.43	1745.24	1760.26																	
	3PLN	864.41	1745.76	1769.47																	
2011	Logser	915.39	1832.81	1835.86	1PLN	1PLN	5	5	9	5	9	10	28.90	26.70	283.40	22.91	283.20	926.96	#####	161	21.90
	1PLN	902.74	**1809.55**	**1815.63**																	
	2PLN	900.64	1811.68	1826.70																	
	3PLN	900.31	1817.57	1841.27																	
2012	Logser	1046.14	2094.31	2097.41	1PLN	1PLN	6	6	10	6	10	13	56.70	53.00	810.40	47.32	814.41	5234.67	#####	168	21.97
	1PLN	1005.37	**2014.81**	**2020.98**																	
	2PLN	1004.32	2019.01	2034.26																	
	3PLN	1001.88	2020.66	2044.75																	

Table S2 – SAD's results for management types

Level of Protection	Fitted Model	Min Loglik	AICc	BIC	Model Selected		Position of the Modes _ **Octaves**						**Best fit Parameters - μ**						N	S	α
					AICc	BIC	1PLN	2PLN		3PLN			1PLN	2PLN		3PLN					
CCPs	Logser	333.82	669.71	671.81	1PLN	1PLN	5	4	7	4	7	10	26.28	13.10	117.61	13.57	117.57	618.97	3893	64	10.88
	1PLN	318.83	**641.85**	**645.97**																	
	2PLN	316.12	643.28	653.04																	
	3PLN	312.53	643.68	658.33																	
CCP-PN	Logser	328.12	658.31	660.23	2PLN	1PLN	6	6	9	5	9	12	44.43	36.74	391.31	16.80	375.80	3575.00	#####	54	7.07
	1PLN	321.96	648.16	**651.90**																	
	2PLN	317.86	**646.98**	655.67																	
	3PLN	317.55	654.29	667.00																	
CCP	Logser	825.76	1653.55	1656.47	2PLN	1PLN	6	5	9	4	6	9	37.24	31.31	504.73	9.52	43.13	501.06	#####	141	19.18
	1PLN	808.37	1620.82	**1626.63**																	
	2PLN	804.97	**1620.38**	1634.68																	
	3PLN	802.67	1622.43	1644.93																	
wCCP	Logser	1060.19	2122.39	2125.60	1PLN	1PLN	5	5	6	0	6	10	29.31	20.18	42.33	0.58	32.80	921.37	#####	186	24.82
	1PLN	1041.83	**2087.72**	**2094.11**																	
	2PLN	1039.43	2089.19	2104.99																	
	3PLN	1037.53	2091.87	2116.86																	
N	Logser	330.12	662.32	664.23	3PLN	1PLN	6	5	7	5	8	11	58.86	23.16	110.93	25.98	139.90	1467.00	6163	54	8.14
	1PLN	300.79	605.82	**609.56**																	
	2PLN	297.05	605.35	614.04																	
	3PLN	292.06	**603.32**	616.04																	

Table S3 – SAD's results for distance to the nearest town

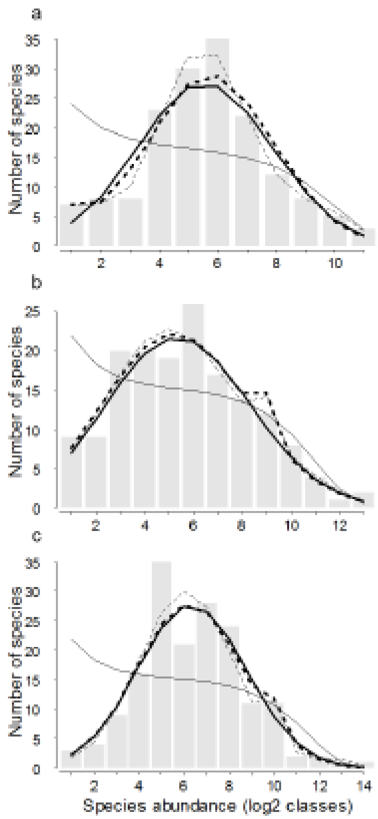
Distance by Road	Fitted Model	Min Loglik	AICc	BIC	Model Selected			Position of the Modes _ **Octaves**						**Best fit Parameters - μ**						N	S	α
					AICc	BIC		1PLN	2PLN		3PLN			1PLN	2PLN		3PLN					
<100	Logser	1065.82	2133.67	2136.87	3PLN	1PLN		6	5	11	0	6	11	34.85	28.39	1596.18	0.52	33.88	1490.47	#####	185	25.38
	1PLN	1038.87	2081.81	**2088.19**																		
	2PLN	1032.51	2075.34	2091.11																		
	3PLN	1027.56	**2071.94**	2096.89																		
100-200	Logser	350.53	703.14	705.14	1PLN	1PLN		6	6	8	4	8	13	39.71	35.34	236.34	10.29	142.15	4850.99	#####	59	7.83
	1PLN	341.53	**687.28**	**691.22**																		
	2PLN	339.70	690.53	699.79																		
	3PLN	336.58	692.04	705.78																		
200-300	Logser	445.19	**892.42**	**894.79**	Logser	Logser		4	4	9	3	5	9	10.94	8.12	350.96	5.07	30.60	346.88	#####	83	11.08
	1PLN	445.88	895.90	900.59																		
	2PLN	443.25	897.28	908.60																		
	3PLN	441.02	899.98	917.39																		
>300	Logser	876.40	1754.82	1757.75	2PLN	1PLN		6	4	7	4	7	8	54.07	13.92	94.27	14.54	91.67	134.73	#####	143	19.74
	1PLN	839.35	1682.78	**1688.62**																		
	2PLN	832.81	**1676.05**	1690.43																		
	3PLN	831.74	1680.55	1703.18																		

Table S4 – SAD results for trophic level

Trophic Level	Fitted Model	Min Loglik	AICc	BIC	Model Selected AICc	Model Selected BIC	Position of the Modes _ **Octaves** 1PLN	2PLN		3PLN			**Best fit Parameters - µ** 1PLN	2PLN		3PLN			N	S	α
Herbivorous	Logser	279.93	561.97	563.60	1PLN	1PLN	7	6	7	5	6	7	69.50	32.53	126.40	16.43	48.50	118.30	#####	42	4.62
	1PLN	272.00	**548.30**	**551.47**																	
	2PLN	268.67	549.01	556.03																	
	3PLN	267.00	554.36	563.89																	
Low carnivorous	Logser	802.02	1606.08	1608.84	2PLN	1PLN	7	7	10	5	7	10	80.38	73.77	710.14	29.99	73.77	710.14	#####	121	15.14
	1PLN	780.63	1565.36	**1570.85**																	
	2PLN	777.05	**1564.62**	1578.08																	
	3PLN	777.05	1571.39	1592.47																	
Middles carnivorous	Logser	506.61	1015.27	1017.77	2PLN	1PLN	5	-1	6	0	6	10	24.35	0.44	45.46	0.83	38.04	640.85	#####	94	13.61
	1PLN	496.19	996.51	**1001.46**																	
	2PLN	491.08	**992.83**	1004.87																	
	3PLN	489.93	997.55	1016.20																	

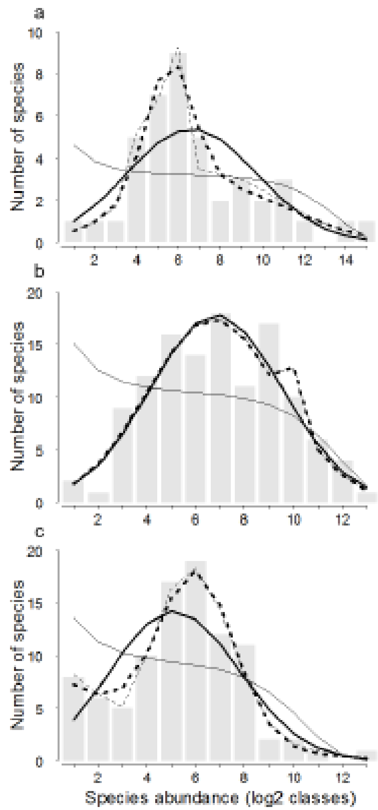
Table S5 – Parametric bootstrap and likelihood ratio test results. Analysis only done for 2 SADs, for which AICc gave strong support to multimodality (dAICc>2) but BIC did not.

		Estimated 1PLN parameters		Model selected		Frequency select 1PLN		False positive frequency		Model selected empirical dataset		Likelihood Ratio test 1PLN vs 2PLN		Likelihood Ratio test 1PLN vs 3PLN	
SAD tested	S	$\hat{\mu}$	$\hat{\sigma}$	AIC_c	BIC	AIC_c	BIC	$dAIC_c \geq 2$	dBIC ≥2	AIC_c	BIC	Critical value	*Empirical* LRT	Critical value	*Empirical* LRT
Manag=n	54	58.86	1.07	1PLN	1PLN	84	99	5	0	3PLN	1PLN	9.711	7.483	14.348	**17.458**
dist≤100	185	34.85	1.83	1PLN	1PLN	55	100	24	0	3PLN	1PLN	11.618	**12.738**	17.466	**22.623**
dist>300	143	54.07	1.57	1PLN	1PLN	65	100	18	0	2PLN	1PLN	11.743	**13.082**	16.686	15.219
troph=4	94	24.35	1.83	1PLN	1PLN	65	97	20	0	2PLN	1PLN	12.192	10.222	18.428	12.519



SADs for each year sampled with the best-fit curves: a) 2010, b) 2011 and c) 2012. Full line for logseries, bold line for 1PLN, bold dotted line for 2PLN and dashed line for 3PLN.

Figure S1



SADs for trophic level with the best-fit curves: a) level 2 – herbivorous, b) level 3 – low carnivorous and c) level 4 – middle carnivorous. Full line for logseries, bold line for 1PLN, bold dotted line for 2PLN and dashed line for 3PLN.

Figure S2

Supporting Information 4.5 – Size results

	N	G	loglik	bic	Means							Mixing probabilities						
2010	19223	7	-63117,87	-126433	10,106	11,221	13,661	15,976	18,864	22,079	27,338	0,095	0,129	0,158	0,153	0,111	0,108	0,245
2011	34075	7	-108566,4	-217341,5	10,097	11,465	13,688	15,471	18,619	20,894	27,846	0,111	0,120	0,164	0,132	0,152	0,141	0,180
2012	45955	6	-154773,9	-309730,4	9,787	11,717	14,512	19,553	28,479	76,296		0,134	0,173	0,164	0,274	0,253	0,002	

	N	G	loglik	bic	Means								Mixing probabilities							
CCPs	3893	8	-12599,25	-25388,65	7,381	11,429	14,988	17,605	20,423	23,175	**25,690**	37,902	0,022	0,119	0,202	0,091	0,152	0,162	**0,211**	0,041
PNQ	14729	5	-49956,89		10,604	**14,526**	18,621	**19,809**	34,105				0,173	**0,217**	0,189	**0,213**	0,208			
CCP	29853	8	-103268,8	-206774,6	10,685	14,141	17,155	19,589	20,234	23,035	**31,348**	32,194	0,178	0,098	0,115	0,091	0,092	0,121	**0,264**	0,041
wCCP	44615	6	-132883,8	-265949,6	9,789	11,371	13,251	14,845	**18,675**	32,582			0,167	0,128	0,110	0,212	**0,336**	0,048		
n	6163	5	-17671,07	-35464,31	10,342	11,585	14,075	**18,779**	137,731				0,107	0,181	0,232	**0,477**	0,004			

	N	G	loglik	bic	Means							Mixing probabilities						
<=100	37159	6	-108019,2	-216217,3	9,990	11,366	13,440	**15,150**	19,956	32,224		0,1247	0,1721	0,16	**0,27**	0,21	0,06	
>100 & <=200	14668	6	-46956,79	-94076,66	8,378	10,254	12,236	**14,277**	**18,582**	36,251		0,0655	0,1736	0,13	**0,24**	**0,23**	0,16	
>200 & <=300	19815	7	-62964,89	-126127,7	7,489	10,054	13,370	16,266	**19,748**	**20,722**	33,579	0,054	0,126	0,197	0,129	**0,220**	**0,222**	0,053
>300	27611	6	-93847,79	-187869,40	11,664	17,014	19,817	22,390	**30,368**	125,013		0,1466	0,1695	0,14	0,19	**0,36**	0	

	N	G	loglik	bic	Means								Mixing probabilities							
Herbivorous	40958	7	-135277,8	-270768	9,909	11,270	13,651	15,315	18,642	20,585	**29,990**		0,147	0,143	0,114	0,134	0,119	0,115	**0,227**	
Low carnivorous	44704	8	-145971,6	-292189,5	9,881	11,260	13,431	15,368	18,361	**20,411**	30,048	113,038	0,103	0,115	0,143	0,105	0,111	**0,258**	0,165	0,001
Middle carnivorous	13591	7	-43812,34	-87815,02	9,778	11,410	13,565	15,698	18,618	**24,120**	46,494		0,116	0,142	0,153	0,145	0,148	**0,260**	0,036	

5. The importance of being older and wealthier for coastal community perceptions

"There is no truth. There is only perception"
Gustave Flaubert

da Silva, I.M.,L., Soares, A.M.V.M., Dornelas, M. (2015) The importance of being older and wealthier for coastal community perceptions

5.1 Abstract

Understanding people's perceptions of fisheries resources, co-management and marine reserves is fundamental for the implementation of a co-management system. This study assesses the community's perception across 7 villages, in the province of Cabo Delgado, in the north of Mozambique. The villages were very heterogeneous in their perceptions but the socioeconomic variables that most influenced these perceptions were wealth and age, and to a lesser degree occupation. Important implications for management are: older people need to be included in the co-management arrangements; Wealthier people are the most supportive. Older people seeing fewer fish than younger people is indicative of a shifting baseline, where younger people can undervalue the importance of management because they cannot "perceive" current losses of fish. Lastly, poverty has serious implications for the implementation of co-management by lowering the motivation levels of the poor, leaving it to the wealthier and deepening their exclusion from decision making.

5.2 Introduction

Efficient implementation of conservation, management and awareness projects relies on knowledge of what people feel, what their perceptions are, about resources and their management (McClanahan et al., 2014). Indeed, stakeholders need to perceive a need for management, and experiencing a period of scarcity often leads communities to realize that they need to manage their resources. Here we identify the most important socioeconomic characteristics associated with support for co-management and reserves, as well as the reasons people point to for the scarcity of resources.

The analysis of a local population's perception of natural resources allows us to understand how populations value their resources (Hicks, Graham, & Cinner, 2013). This valuation varies widely depending on a range of cultural and social characteristics (Hicks et al., 2013; Nazarea, Rhoades, Bontoyan, & Flora, 1998). For projects that aim to promote sustainable use of coastal resources, it is important not only to know the values at stake (Infield & Namara, 2001), but also to shape the strategy of the project according to the ways in which local communities perceive natural resources (Epps & Benbow, 2007). Fishermen's willingness to manage resources depends on their perception of the state of the resource (Leleu et al., 2012), but also on the degree of dependence from the resource (Lise, 2000). Other socioeconomic characteristics have an important influence on the perception of natural resources (Cinner & Pollnac, 2004). Knowledge of people's perceptions about resources is needed in order to effectively implement management practices that fulfil people's needs.

The main focus of fisheries management should be people, not fish (Pomeroy, 1995). The causes behind fisheries over-exploitation are social, institutional and/or political (Béné et al., 2009; Bruggemann et al., 2012; Pomeroy, 1995). For this reason, increasingly more studies address the two-way relationship between fisheries and human welfare. Small-scale fisheries provide work and cash income to the very poor and act as a "safety valve" or a '"labour buffer" (Béné et al., 2010). This happens because fisheries are a common-pool-resource that everyone can access when nothing else is available. However, when more people exploit a resource, they inevitably increase exploitation levels, and often end up depleting it. This situation in which individuals exploit an open-source resource independently and in their own self-interest, behaving contrary to the best interests of the group until the resource is completely depleted, is called "the tragedy of the commons" according to (Hardin, 1968). This concept was later re-evaluated by (Ostrom, 1990, 2009, 2014; Ostrom et al., 1999; Ostrom, Walker, & Gardner, 1992) and (Dietz et al., 2003; Liu et al., 2007; Schlager & Ostrom, 1992), showing that self-governance is possible and has more chances of succeeding in particular institutional designs such as small villages with strong communities (MacNeil & Cinner, 2013).

In developing countries where resources are over-exploited or nearly over-exploited due to wars, poverty or lack of infrastructure, improved management of resources is urgently needed. Unless people experience increased scarcity or even suffer from it, they will not be ready to discuss management measures that restrict their freedom to exploit resources. If they do not feel the need for management, they will not support it. Understanding people's perceptions about resources is important in order to take accepted management measures and to increase compliance with them.

In the developing world, co-management is becoming the mainstream approach to small-scale fisheries governance. An alternative to conventional management, co-management empowers people and is a reaction to the perceived failure of top-down conventional management, recognizing that fishermen are better placed to develop their own rules than policy makers in capitals far away from the fishing villages (MacNeil & Cinner, 2013). Co-management has been not only theoretically discussed but also extensively put in place with a variety of results. Some co-management experiences has resulted in improved ecosystems (Gelcich, Kaiser, Castilla, & Edwards-Jones, 2008; Russ & Alcala, 1998; Silva, Hill, Shimadzu, Soares, & Dornelas, 2015) and livelihoods (Gurney et al., 2014), but in others it has been unsuccessful (Béné et al., 2009; Gurney et al., 2014). Good co-management projects help and encourage users to follow the rules, implement progressive sanctions, and define boundaries and membership (Ostrom, 1990). The success and acceptance of co-management depends also on socioeconomic variables such as age, education, wealth, ethnicity (MacNeil & Cinner, 2013). Finally, the degree of involvement in community events and in the decision-making process also influences the success of co-management institutions (MacNeil & Cinner, 2013). Success of co-management will depend on its acceptance by the community, which will be greatly increased if the implementers know their communities and what they think: their perceptions.

When it comes to conservation of the ocean, marine reserves are the strongest management measure that can be implemented, but also that which implies the highest cost to the community. Part of the costs have to do with longer travelling distances to fishing grounds (Daw, 2008; Mascia & Claus, 2009), loss of familiar fishing areas and increased fishermen density in the remaining area (Carter, 2003). The distribution of costs within the community depends on fishermen's characteristics, such as age, number of occupations and diversity of occupation (Coulthard, 2011; Smith, Lynham, Sanchirico, & Wilson, 2010). In addition, the benefits of reserves are not equally distributed. Wealthier people can take advantage of marine reserves in order to better fit their needs and to position themselves in order to profit from the alternatives they bring. On the other hand, poor people normally have fewer opportunities to profit from marine reserves (Béné et al., 2009; Christie, 2004). In the long run, fishermen can perceive direct benefits from reserves: Enhanced larval production (Harrison et al., 2012); Spillover (Silva et al., 2015); Benefits resulting from the exclusion of outsiders and better enforcement around the reserve (Mascia, Claus, & Naidoo, 2010); Longer term effects such as the increase in tourism with more jobs and markets for fish (Badalamenti et al., 2000). Studying a community's perceptions of reserves will help find more ways to implement them.

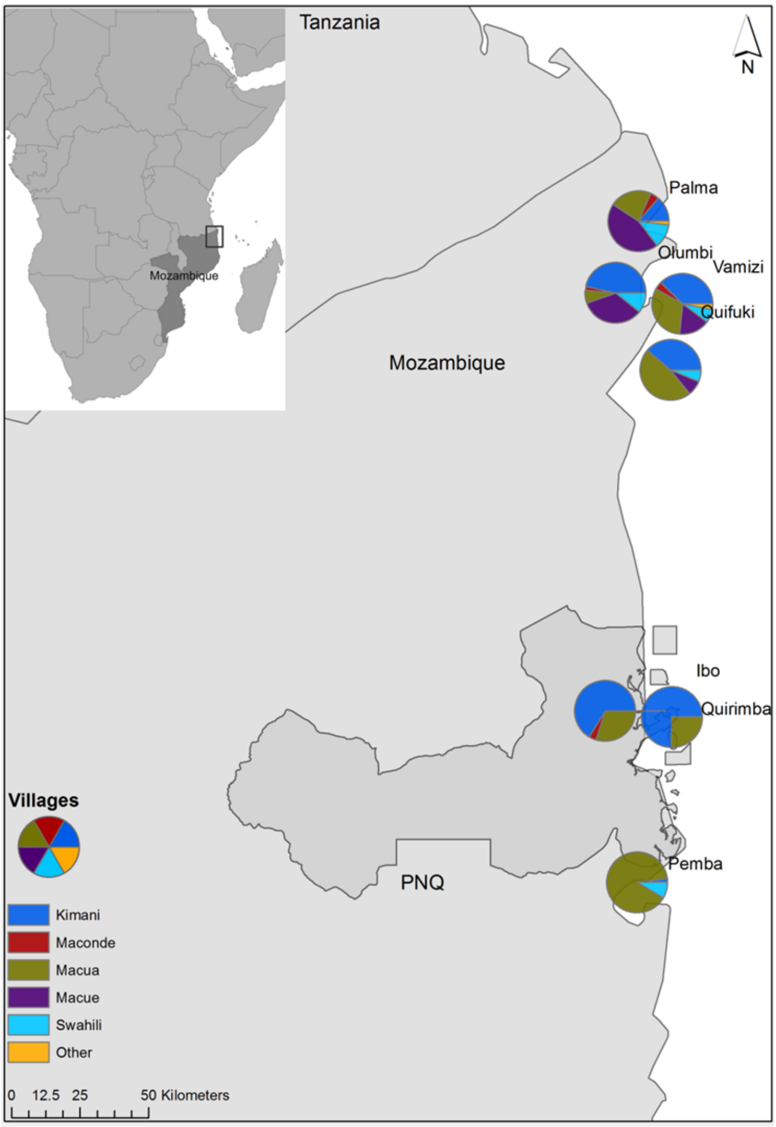


Figure 23 - Map of studied locations

This paper attempts to answer 3 research questions, all related to the population's perception of natural resources and co-management: (1) How do people perceive marine resources today compared to 5 years ago? Do they know the reasons behind this trend? And do they have solutions on how to replenish marine resources? (2) Which are the social and economic factors that influence the population's perception of co-management? (3) Which are the social and economic factors that influence people's perception of marine reserves?

5.3 Methods

5.3.1 Study location

Table 9 – Characterization of the studied villages

Name of the village	Communities	Inhabitants	Estimated no. of Households	No. of questionnaires	CCP	Reserve	Support	Highest Government presence
Vamizi island	Quivuri Rance Aldeia	1500	365	98	Yes	Yes	WWF and lodge	Village chief
Kifuki island		900	321	49	No	No	None	Village chief
Olumbe	Nongue Dominga	8000	1300	101	Yes	No	IDPPE	"Chefe do posto"
Palma	Quelimane Milamba Muaa nsemo	7000	1166	196	Yes	No	IDPPE, ADNAP	Administrator
Ibo island	Rituto Cimento Cumuamba Cunangala	5838	1061	80	Yes	Yes	IDPPE, ADNAP, WWF, PNQ, AMA	Administrator
Quirimba island	Igreja Cabine Cumilamba Cuminage sukutulo	3240	675	91	Yes	Yes	IDPPE, ADNAP, WWF, PNQ, AMA	"Chede do Posto"
Paquitequete (Pemba)		13184	1690	47	Yes	No	IDPPE, ADNAP	Governor of the Province

The study location for this work was set along the coast of the province of Cabo Delgado. This province is bordered to the north by the Rovuma river, which separates Mozambique from Tanzania, and to the south by the Lúrio river. The main coastal feature is the Quirimbas archipelago, a chain of 32 islands surrounded by coral reefs and divided from the continent by seagrass and mangroves (Figure 23). Historically, only those islands which had a supply of freshwater, like Ibo and Quirimbas, were inhabited. Other islands, like Quifuki and Vamizi, do not have freshwater, but the abundance of fish makes it worthwhile to pay to bring water from the mainland. Hence, these islands have been inhabited in more recent years. Swahili Muslim traders first established settlements, both on the coast and on the islands, to develop trade. The

Portuguese took control of the coast and the islands later, but the Muslim and Swahili-like dialects have remained. In the past 40 years, people from the surrounding areas, as well as from the next province and as far away as Tanzania, have been attracted to the coast and the islands. At first, these people sought protection from the civil war, but more recently they have moved in search of better fishing. Therefore, these days, the coast of Cabo Delgado province is a multicultural mix of several dialects spoken by at least 3 different ethnic groups: the Macua, Kimani and Macué (Figure 23). The villages chosen for this study encompass not only a great variety of ethnic groups but also different co-management settings.

Co-management arrived in Mozambique in 2003 under the fisheries law (Républica de Moçambique, 2003). The management unit in the villages is the "Conselho Comunitário de Pesca" - CCP, or fishing council. In Cabo Delgado province, the CCPs started to be implemented in 2006. The CCPs are responsible for managing the fisheries, in their own area, as representatives of the government. The councils enforce Mozambican fisheries laws but they can also implement additional rules, such as establishing sanctuaries (no-take zones) and specifying restrictions on gear or fishermen numbers, and can also impose fines on offenders. The National Park of Quirimbas (PNQ) was proclaimed in 2005 and the first CCPs were implemented there in 2006.

Table 10 - List of household possessions and their abundance in the interviewed households

	% in the households
Generator	0.11
TV	0.21
Electricity	0.13
VCR	0.03
Fridge	0.04
Fan	0.16
Radio	0.75
Piped water	0.05
Mobile phone	0.78
No light	0.01
Kerosene light	0.30
Candle Light	0.11
Torch light	0.68
Lightbulb	0.26
Bicycle	0.20
Motorbike	0.23
Vehicle	0.02
Goats	0.08
Chickens	0.46
Sheep	0.02
Cooking with wood	0.84
Cooking with charcoal	0.84
Cooking with kerosene	0.00
Cooking with gas/electric	0.01
Thached roof	0.74
Metal roof	0.17
Tile roof	0.01
Dirt floor	0.77
Bamboo floor	0.17
Plank floor	0.02
Concrete floor	0.24
Finished floor	0.01
Cashew tree	0.06
Coconut tree	0.22
Cassava field	0.35
Maize field	0.12

5.3.2 Methodology

Six hundred and sixty-two households in the community were surveyed to elicit information on socioeconomic well-being and perceptions about fisheries, co-management and reserves. A household was defined as people living together and sharing meals. The number of households surveyed per village ranged from 47 to 196 (Table 9). We tried to sample 10% of all households in a village, but most of the time the number of households was assigned by the public administration: either the "chefe do posto" or "chefe do bairro". When not given, we calculated the mean number of persons in a household from the first 20 questionnaires in the village and divided it by the number of people in the village according to government statistics, to get an estimate of the number of households in a village. The sampling of households within villages was based on a systematic sample design, where one in every 10th household was chosen. The head of the household was interviewed, or, if the head of the household was not available, another adult from the household was interviewed. Respondents were asked about their age, education, fortnightly expenditures, migration status, household possessions (Table 10 and Table 11). The questionnaires used were adapted from the ones used in several other socioeconomic studies done in fisheries villages by Cinner in several of his papers (Cinner, 2005; Cinner, Daw, & McClanahan, 2009; Cinner, McClanahan, Abunge, & Wamukota, 2009; Cinner & Pollnac, 2004).

Table 11 Explanatory variables

Explanatory variables	Description
Village	Seven villages
Age	In four classes
Migration	Village is not migrant; A Migrant Region is a migrant from the same region; Other Region is a migrant from another province; Other country is a migrant from another country
Years of formal education	From 0 to 12
Fortnightly expenditures	Cash expenditures over the past two weeks. 'dkno' refers to people who chose not to answer; 100-700 refers to an expenditure between 100-700 meticais and so on 701-1994, 1995-2500, More than 2500. The metical is the national currency of Mozambique (US$1 = ±30meticais)
Material style of life (wealth and structural wealth)	Presence/absence of TV, electricity, radio, thatched or metal roof, dirt or cement floor etc. (explain in the text)
Occupation	Type of occupation: FISH refers to fishing, GLEAN to gleaning, SELMA to selling marine products, INFML to informal activities, AGRIC to agriculture, TOURS to tourism, EMSAL to occupation with a salary, and OTHER to other occupations
Occupational multiplicity	Records the total number of person-jobs the household was engaged in
Occupational diversity	The number of different occupation types the household was engaged in

In developing countries, household possessions or the material style of life can be an indicator of relative wealth or social status within a community (Pollnac & Crawford, 2000). The material style of life measures wealth on the basis of household possessions or structure. For each household in the survey (n = 662), we calculated a score by running a factor analysis with a varimax rotation on the presence or absence of the items in the household (Table 10). A scree test was used to determine the total number of factors to be included. Factors with negligible additional variance explained were dropped from the analysis.

We also asked respondents to describe all activities that brought food or money into the household. Occupational diversity was defined as the number of different types of occupation (e.g., fishing, agriculture, and informal economy sectors). Occupational multiplicity was defined as the sum of the number of occupations held by all household members (Pollnac & Crawford, 2000).

Survey questionnaires also examined how respondents perceived fisheries, co-management and reserves. Information regarding perceptions of fisheries resources was elicited by asking open-ended questions regarding fisheries. Respondents were asked three open-ended questions about fisheries: (1) What is the state of the fishery compared to five years ago? (2) What activities affect the amount and variety of fish (3) What can increase the number of fish in the sea?

Table 12 – Response (perceptions) variable

Response variables	**Description**
State of the fisheries compared to 5 years ago	**Dkno =** don't know; **More** = more fish; **Same =** all the same; **Less** = less fish
Knowledge about what can affect the number of fish in the sea	Responses to the open-ended question "What reduced the number of fish in the sea" (**10 levels)**
Knowledge about what can increase the number of fish in the sea	Responses to the open-ended question "What do you suggest might increase the number of fish in the sea" **(5 levels)**
Involvement in the community	Number of community events the household was involved in
Involvement in decision-making	**N** = not involved; **P** = passively involved; **A** = actively involved
Involvement in the CCP	**N** = not involved; **P** = passively involved; **A** = actively involved
Perception of the CCP	**Dkno** = don't know; **All** = full trust in the CCP; **Most** = mostly trusted; **Half** = mean trust; **Less** = almost no trust; **None** = no trust in the CCP
Perceptions of the fish near a Reserve	**Dkno =** don't know; **More** = more fish; **Same =** all the same; **Less** = less fish

Co-management perception was assessed by using two approaches: questions about the CCP (Conselho Comunitário de Pesca), the body that implements co-management, and questions about community involvement. The reason for this duplication is that the CCP is a relatively new body (legislated for in 2003 and the province's first CCP was only set up in 2006) and with different degrees of implementation. Some fishermen may have had little contact with the CCP, or have a poor understanding of what the CCP is for, and could be ashamed of admitting it. Integrating the answers for the community, we can see if the households interact differently with the CCP than with the community, especially those households connected to the fisheries. Regarding perceptions of the CCP and involvement in the community, respondents were asked to list the times they participate in community events, how they participate in the CCP and in the community and their opinion about their CCP (Table 12).

Finally questions were asked about marine reserves (Table 12): (1a) How is fishing in this particular village (with a reserve) compared to the next village (in villages without a reserve)? (1b) How is the fishing in the next village compared to this village (in villages without a reserve, but with a nearby village with a reserve)?.

5.3.3 Analysis

We fitted a multinomial logit model to predict 8 response variables (Table 12) on the basis of 9 socioeconomic variables (Table 11) with the function multinom of nnet Package of R (Venables & Ripley, 2002). We used a stepwise model selection procedure which added and removed each of the 9 explanatory variables in turn to select a model with the optimal fit to the data on the basis of Akaike information criterion (AIC). The variable village was included as a fixed factor in all the models.

5.4 Results

The principal component analysis of household possessions resulted in two factors explaining 38% of the variance. Items with high positive loadings on factor 1 included electricity, a fan, a lightbulb and a motorcycle, while a thatched roof and a dirt floor had a high negative load. A high score on this factor actually equates with high wealth, thus we called this the "wealth" factor. Items with high positive loadings on factor 2 include piped water and a metal roof. We called this the "structural wealth" factor (Table 13).

Table 13 - Factor analysis loadings used in the calculation of scores for the wealth and structural index

	Factor 1 Wealth	Factor 2 Structural
Generator	0.25	-0.01
Electricity	**0.66**	0.47
TV	**0.54**	0.38
Fridge	0.19	0.50
Fan	**0.72**	0.22
Radio	0.30	-0.17
Piped water	0.16	**0.61**
Mobile phone	0.49	-0.04
Kerosene lamp	-0.37	-0.08
Candlelight	**0.64**	-0.04
Torchlight	0.01	**-0.56**
Lightbulb	**0.75**	0.38
Bicycle	-0.19	-0.04
Motorbike	**0.68**	0.14
Goats	-0.19	0.40
Chickens	-0.02	0.11
Cooking with wood	-0.22	**-0.56**
Cooking with charcoal	**0.54**	0.20
Thatched roof	-0.35	-0.61
Metal foof	0.04	**0.70**
Dirt floor	-0.38	-0.24
Bamboo floor	0.30	-0.36
Concrete floor	**0.69**	0.15
Coconut Tree	0.04	0.34
Cassava	-0.35	0.11
Maize	0.13	-0.26

In the process of determining whether explanatory variables were related to perception of fisheries, co-management and reserves, the stepwise process removed different variables for each of the response (perception) variables (Table 14). Multiple occupations and fortnightly expenditure were dropped from all the models. The "Village" variable was always picked but was not considered in the explanation of the models, since there was insufficient replication (only 7 villages were included).

5.4.1 Community perceptions of the fisheries resources

Of the three perception variables on fisheries - the state of the fisheries compared to 5 years ago, knowledge about what can affect the number of fish, and knowledge about what can increase the number of fish in the sea - the stepwise model selection did not pick any explanatory variable for the last question. For the first question, the perception of the state of the fisheries compared to 5 years ago, the age, wealth, occupation and occupational diversity variables were chosen (Figure 24). Figure 24a shows that the answer "less" fish increases in prevalence with age. The "more" fish answer increases up to the mid-40s and then decreases. "Same" and "dkno" (don't know) are constant for every age group. If we look at Figure 24b), the most important feature is that the answer "more" fish increases with wealth. The answer "dkno" is constant, and both "less" and "same" decrease with wealth. Regarding occupation (Figure 24c), fishing, gleaning, and selling marine products, all related with the sea, have the highest numbers of "less" responses. However, "dkno" is higher for occupations with salaries, informal activities and other activities. "More" is the highest answer in tourism and agriculture. If we look at occupational diversity, i.e the number of different occupations in a household (Figure 24d), "less" increased with occupational diversity. There was always a higher number of "more" responses than "less" responses at all different levels of occupational diversity.

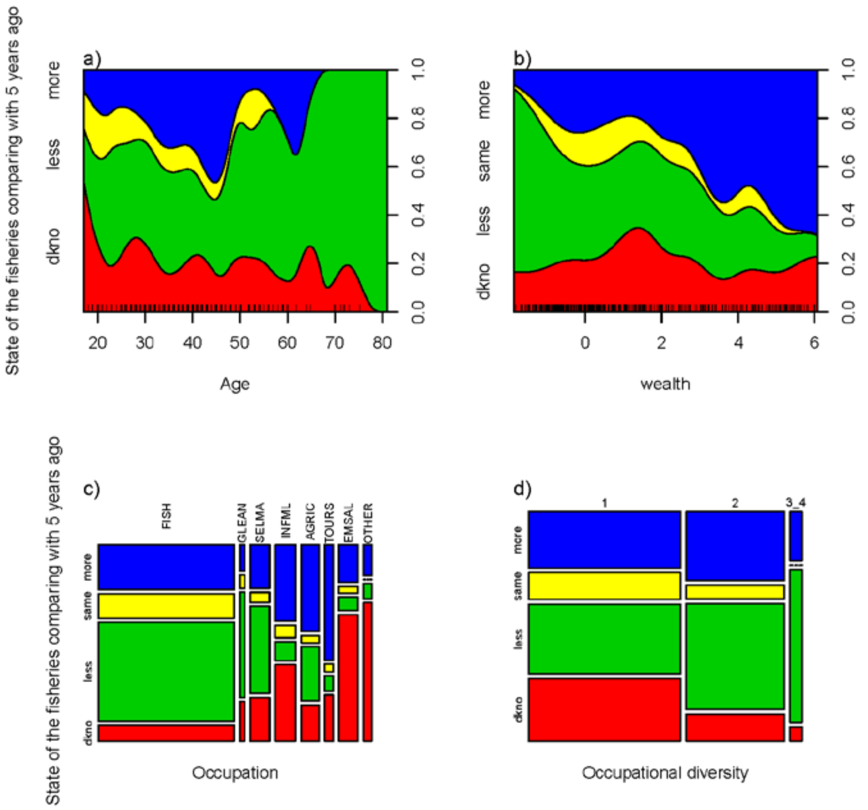


Figure 24 – Perceptions of actual fisheries compared to 5 years ago. a) and b) have a rug plot of age and wealth, respectively in the bottom. Each mark represents an answer: **Dkno** – don't know, **more** – more fish, **same** – same as before, **less** – less fish. Occupation: **fish** – fishing, **glean** – gleaning, **selma** – selling marine products, **infml** – Informal activities, **agric** – agriculture, **tours** – tourism, **emsal** – occupation with salary, **other** – other occupations

For the second response variable regarding fisheries perceptions - knowledge about what can affect the number of fish in the sea - "dkno" has the highest number of answers in the households with one occupation. The most occupational-diverse households also have a greater diversity of answers. "Too many fishermen" is the principal reason for fish trends, followed by movements of "oil company" boats, "reserve" and "NP" (National Park) bring more fish. In more diverse households, the responses "supernatural" and "wrong gear" were higher than in single-occupation hosueholds (Figure 25).

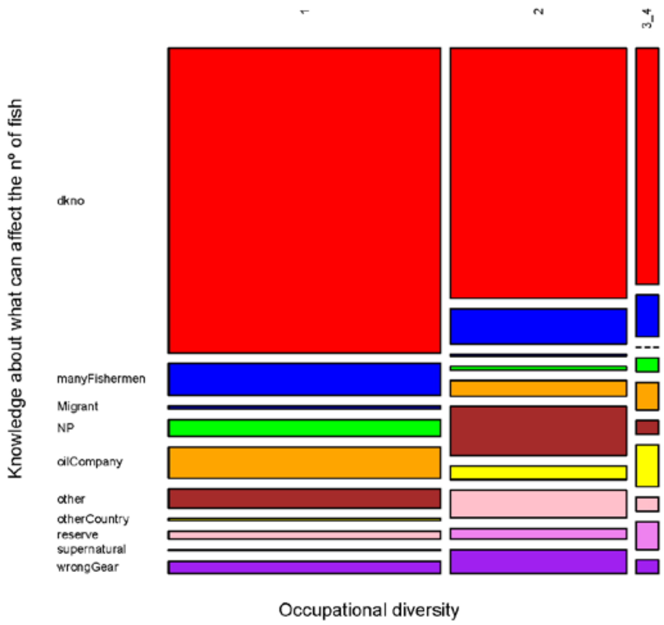


Figure 25 - Knowledge about what can affect fish abundance. Answer possibilities: **dkno** – do not know**, many fishermen**, **migrant** – migrant fishermen, **NP** – national park, **oil company** – traffic of oil company boats, **no jobs** - no occupation alternatives, **reserves** – marine reserves, **wrong gear**, **supernatural** – God/Allah determines, **other** – was given just once

Table 14 - Results of the multinomial logit model. *"Village" will not be represented since the sample was too small (7)

	State of the fisheries compared to 5 years ago	Knowledge about what can affect the no. of fish in the sea	Knowledge about what can increase the # of fish in the sea	Involvement in the community	Involvement in decision-making	Involvement in the CCP	Perception of the CCP	Perceptions of the fish near a Reserve
AICbefore	1281,967	1684,852	1019,802	2412,63	1031,72	848,761	1721,78	1062,743
AICafter	1225,733	1454,269	962,709	2276,565	976,065	807,2697	1604,763	1009,179
AICdifference	56,234	230,583	57,093	136,065	55,655	41,4913	117,017	53,564
Explanatory varibles not dropped	Occupation Occup. Diversity Wealth Age Village*	Occup. diversity Village*	Village*	Occup. diversity Wealth Structural W. Age Village*	Migration Structural W. Village*	Occup. diversity Structural W. Age Village*	Occupation Occup. diversity Village*	Occup. diversity Wealth Structural W. Village*

Table 15- Co-management response variables Included in the model

Co-Management	Involvement in the community (Figure 26)	Involvement in decision-making (Figure 27)	Involvement in the CCP (Figure 28)	Perception of the CCP (Figure 29)
Explanatory variables not dropped		Occup. diversity	Occup. diversity	Occup. Diversity
	Migration			
	Wealth	Wealth		Occupation
		Structural wealth	Structural wealth	
	Age	Age	Age	

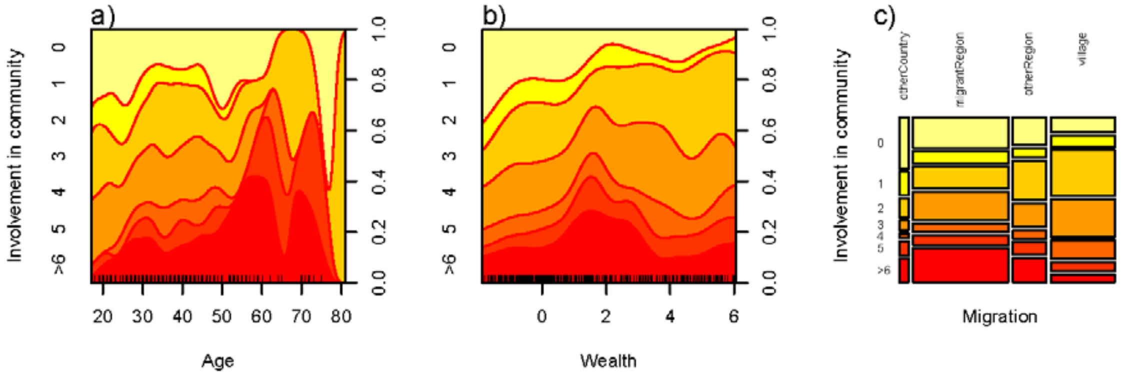


Figure 26 – Involvement in community events. Number of events a household has participated in

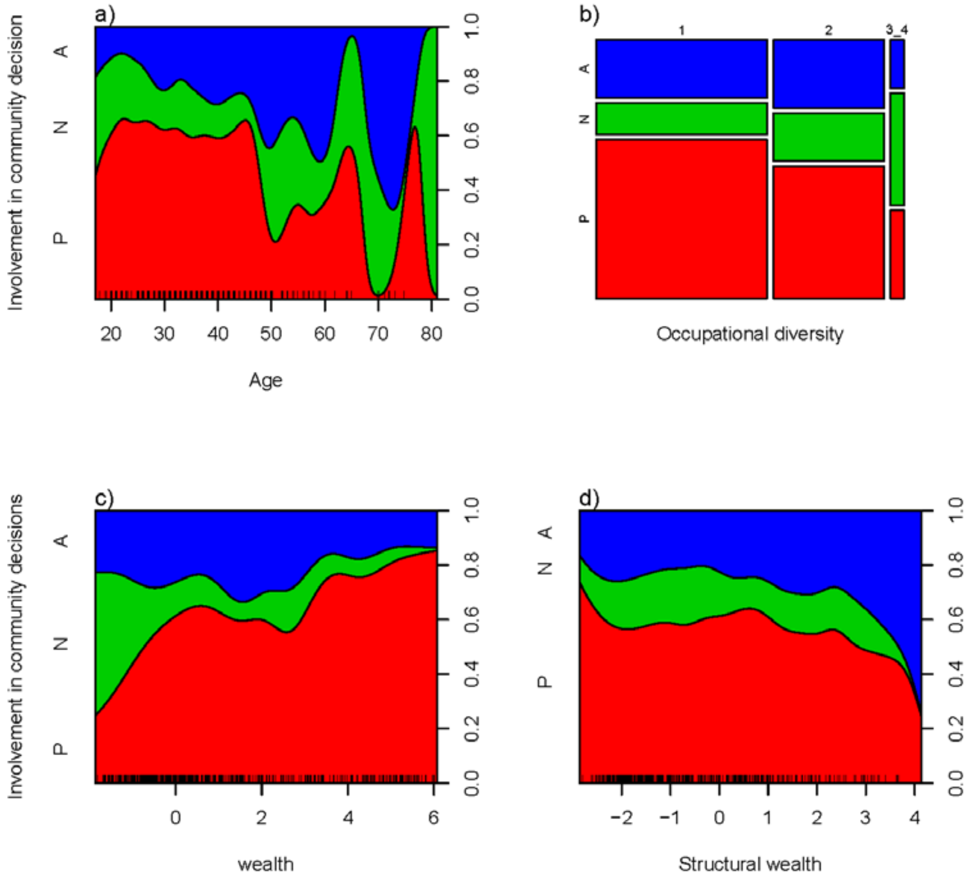


Figure 27 – Involvement in decision-making: **N** = not involved, **P** = passively involved, **A** = actively involved

5.4.2 Involvement and participation in community and co-management

The explanatory variables (Table 15) of age and occupational diversity are the ones that explain the models of co-management mostly followed by wealth and structural wealth. As people get older, involvement in community events increases (Figure 26a) and they are more active (A) in the community and in the CCP (Figure 27a and FIGURE 28a). In contrast, younger people go less to community events and are also more passive (P) in the community and the CCP (Figure 26a, Figure 27a and FFigure 28a). Age was not picked as an explanatory variable for perceptions of the CCP (Figure 29).

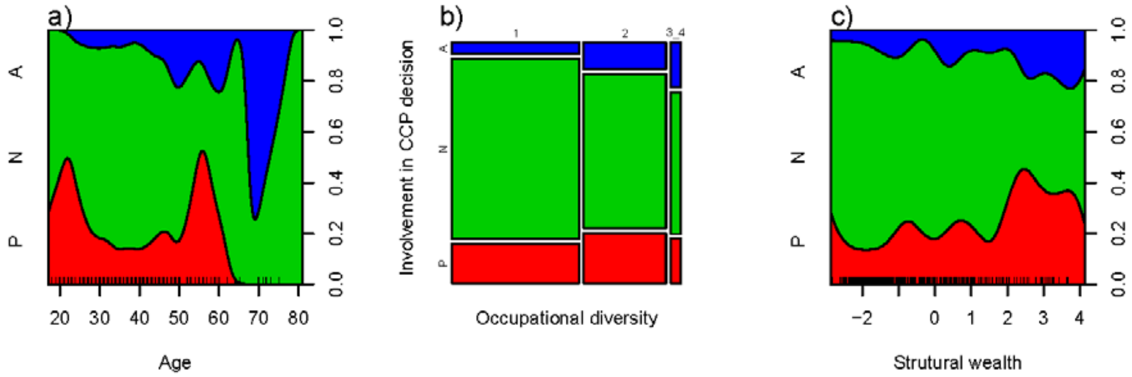


Figure 28 – Involvement in the CCP: **N** = not involved, **P** = passively involved, A = actively involved

As occupational diversity increases, passive (P) behavior in community decision-making decreases and no participation (N) in community decision-making increases (Figure 27b). Occupational diversity has a completely different behavior in relation to participation in the CCP (Figure 28b). An increase in occupational diversity corresponds to an increase in passive behavior (P) and active behavior (A), while no participation (N) decreases with an increase in occupational diversity. The most prominent feature of the CCP perception variable related to occupational diversity is that most of the households do not have an answer about their level of confidence in the members of the CCP (dkno) (Figure 29). As occupational diversity goes up, the number of “all”, “most” and “half” responses by households increases. “No trust”, “none” and “few” were residual answers at all levels of occupational diversity (Figure 29a).

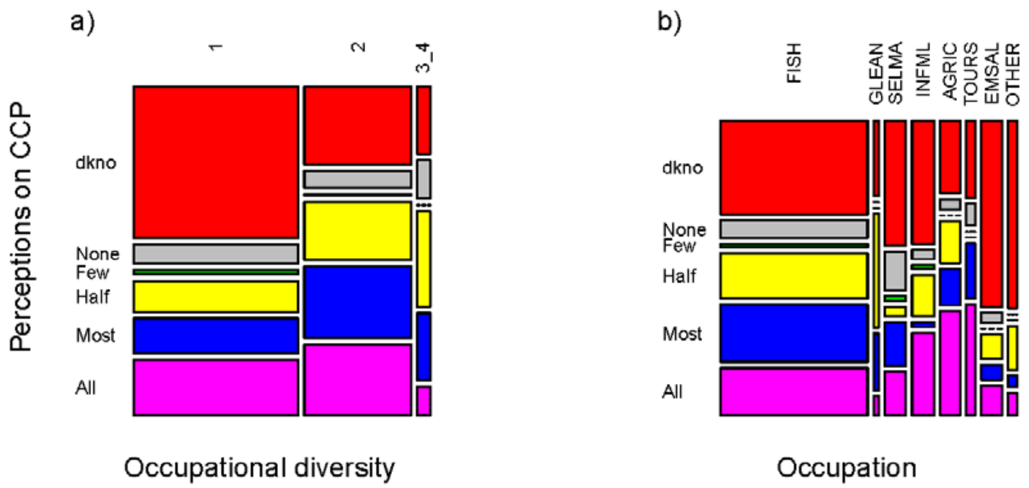


Figure 29 – Perception of the CCP. **Dkno** – don’t know, **all** – full trust in the CCP, **most** – mostly trusted, **half** – half trusted, **less** – almost no trust, **none** – no trust in the CCP

Whenever wealth increases, involvement in community events increases (Figure 26b), but the those “active” in community decisions remains steady (Figure 27c). However, if we look at increases in structural wealth, the number of people “active” in community decision-making increases (Figure 27d) and those with an “active” attitude towards the CCP also increases (Figure 28c). No participation (N) decreases or is constant across increasing levels of wealth and structural wealth (Figure 24b, Figure 27c and Figure 28c).

Migration only explains participation in community events. Migrants from the region tend to participate more than other migrants and villagers. Village people often participate 2-3 times in community events (Figure 26c).

Occupation only explains perceptions of the CCP. Fishing received fewer “dkno” answers. Agriculture and tourism have the highest scores for “all” and “most” (Figure 29b).

5.4.3 Community perceptions of spillovers

The majority of households did not have an opinion about the fish around the reserves (dkno), followed by the perception that there was more fish (more) near the reserve, while “less” and “same” were residual answers (Figure 30). After “dkno”, migrants from outside the region and villagers say that there were more fish around the reserves (Figure 30b). Wealthier people said that the reserve brought “more” fish (Figure 30c), but as structural wealth in households increased, fewer answers of “more” were reported (Figure 30d). The opposite happened with “dkno” answers, which decreased with the increase in wealth (Figure 30c) and structural wealth (Figure 30d). Answers did not seem to change with occupational diversity (Figure 30a).

5.5 Discussion

Age and the two indexes of wealth and occupation were the variables most often picked up by the model selection process for all the research questions. Wealth and occupation results agreed with several other studies on perceptions about the oceans and environment in general (Cinner, 2010; Cinner, McClanahan, & Wamukota, 2010; Cinner & Pollnac, 2004; MacNeil & Cinner, 2013; McClanahan et al., 2014; Setiawan, Cinner, Sutton, & Mukminin, 2012). Age is normally a social variable that is not picked up as having an influence on perceptions or decisions by rural households but was one of the variables most often selected in our study. Age was chosen despite the fact that life expectancy in Mozambique is one of the lowest in the world, at 50.3 years according to (UNDESA, 2013), decreasing the range of ages and hence making it less likely that age would be selected. Our data suggest this is an area of recent and rapid change, and given that older people think things are worse and younger people that all is good, which is indicative of shifting baselines, we will explore this concept later on in this paper.

Surprisingly, fortnightly expenditure was not picked up by any model. Expenditure is an extensively used indicator of wealth and it typically explains important aspects of population behavior. For example, Daw et all (2011) found that fishermen with low expenditure were less willing to leave a decreasing fishery (presumably because of lack of perceived alternatives). Additionally, Cinner (2010) uncovered that fishermen with low expenditure were the ones using more destructive fishing gear. Our contrasting result is possibly due to the high number of households that chose not to answer this question (20%). This situation could be a consequence of a cultural bias: there is reluctance among Mozambicans to speak about money because it is considered impolite and even taboo if talked about with someone outside the family. Another explanation for fortnightly expenditure being excluded by the models is that there is little variation in expenditure among the people interviewed, who were all extremely poor. Wealth indices may be a more reliable measure of wealth in Mozambique.

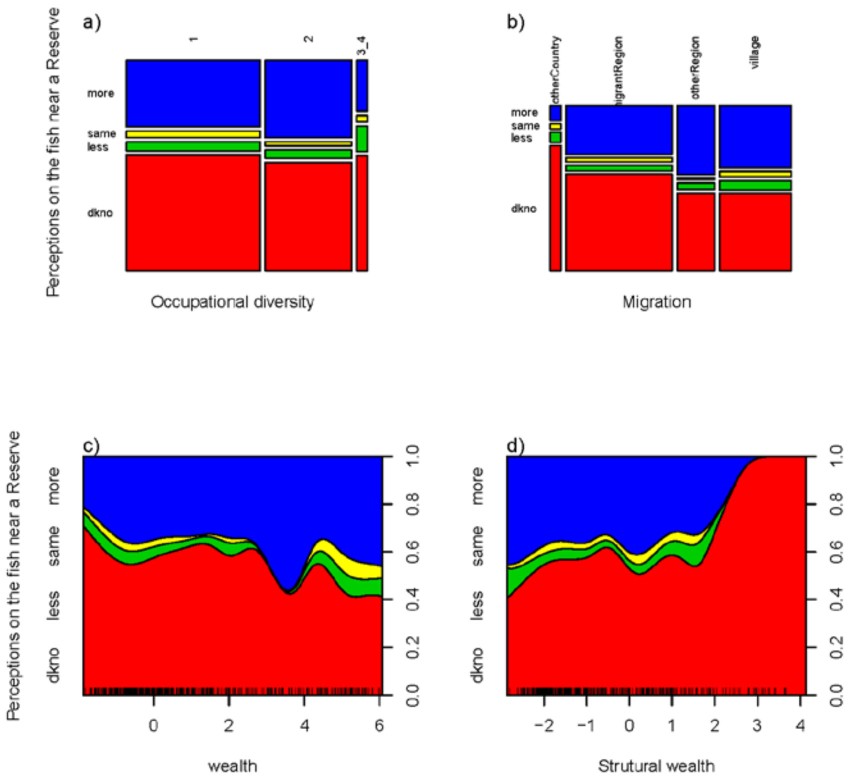


Figure 30 – Perception of fish abundance near a reserve. **Dkno** – don't know, **more** – more fish, **same** – as usual, **less** – less fish

5.5.1 Community perceptions of resources

We found in our study that older people saw fewer fish and younger more fish than 5 years ago. Young people measured fish quantities against a lower level of fish so they see more fish. Older fishermen have a baseline which relates to an earlier time, when there were more fish in the oceans, and they now see less fish. The baselines in between the two generations have changed. This is a dangerous case of shifting baselines referenced by Daniel Pauly in "Anecdotes and the shifting baselines syndrome of fisheries" (Pauly, 1995). Younger people are less likely to consider the need for conservation measures because they do not consider there to be such a big problem.

If poverty is extreme, and the lack of living conditions unrelated to fishing make people insecure, they will also be less interested in conservation and co-management (Allison et al., 2012). These authors advocate that before (or at the same time as) the implementation of conservation or co-management, basic human rights need to be fulfilled (e.g. the right to food, right to decent work, children's rights, etc). Certainly our results show that wealth influences perceptions of resources, and we will later see that it also influences perceptions of co-management and reserves. Poverty makes people more worried about surviving than thinking about the future of fishing resources and their management.

Occupational diversity was also selected as having an influence on the community's perception of the amount of fish in the sea. Less fish in the ocean was the highest answer among the people with fewer occupations. This result is consistent with the literature. In a similar study about the perceptions of fishermen near a reserve compared with fishermen far away from a reserve, the ones near the reserve had fewer occupations but were more knowledgeable about the sea (Cinner et al., 2010). Those in fishing-related occupations tended to think that there were less fish, which we can see as a result of their proximity to reality. Those in non-fishing-related occupations tended to think there were more fish, possibly because they were far removed from the reality of fishing and were not aware of the increasing difficulty of getting fish on to the table. Concerning opinions about the cause of the state of the fisheries, the most common answer was “don’t know”. This result was also found in other studies on fishing communities (Cinner, McClanahan et al., 2009,Cinner & Pollnac, 2004). In household groups with one occupation, “too many fishermen” was the principal reason for the state of the resource, but also the “movement” of oil companies. Too many fishermen is pointed out as a problem in other studies done in the region about marine protected areas (Rosendo et al., 2011) or in a study about migrant fishermen (Wiomsa, 2011). Oil companies arrived in the region to do bathymetric surveys after some seismic survey work the year before the survey took place. The boats were in the bay daily for six month to collect data. This movement was quite unusual in a place where nothing new happens and probably motivated these answers. In the groups with more occupations, besides the already stated answers, “wrong gear” that destroys resources, reserves and “supernatural” causes (e.g “God provides and is responsible for all the fish”) were also mentioned.

5.5.2 Involvement in the community and community participation

Involvement in the community and decision-making are important elements of successful co-management institutions (Agrawal, 2001; Ostrom, 1990, 2009). This study contributes to understanding the socioeconomic variables that influence involvement in communities and decision-making.

The three variables selected as predictors of involvement in the community were age, occupational diversity and migration. Migrants from the region were more involved in the community followed by people in the village. This finding is not consistent with what is found in the literature, where typically migrants are not involved in the community (Crona & Bodin, 2006). However, this result is probably consistent with the history of Mozambique, where the first migrations to the coast were driven by war, and the prevalence of solidarity for those fleeing conflict. Besides the fact that migrants are from different ethnic groups with a different language, integration was probably provided by a common Islamic faith: prayers are held in the same mosques where most of the discussions about village issues take place. But they also married local girls making them more accepted. Community involvement and community participation depend on age and occupational diversity. Unsurprisingly, older people go to more meetings and are more active; they have more time and also are more respected thus facilitating their intervention at meetings. The African cultural tradition of respecting older people, added to the “extraordinary” feat of living a long life in a country with such low life expectancy, make older people especially important in coastal villages.

Community participation in decision-making also depends on wealth and structural wealth. The wealthier participate less in decision-making, but if they have more permanent goods (structural wealth) they tend to get more actively involved. The two indices of wealth have opposite effects. This makes sense since most of the villages surveyed have a large population of migrants who are normally wealthier. They use resources more intensively and are less invested in their long-term sustainable use. In contrast, wealthier people who are resident (structural wealth) are more aware of resources and their conservation. McClanahan et all (2014) pointed out that people with permanent wealth tend to be more favourable to co-management.

5.5.3 Participation and perception of co-management

Participation in co-management depends and varies in the same way as community participation. The only difference is that non-participation in co-management is higher and we can attribute it to the fact that there is a percentage of households (18%) that have no connection to fishing for whom co-management still remains a mystery.

The level of trust in co-management depends on one's occupation and also on occupational diversity. People that are directly involved with fisheries are aware of and have good perception (trust) of the CCP (co-management) institutions. Some studies report a relation between the support for the MPA and the type of fishing gear used by fishermen (Svensson, Rodwell, & Attrill, 2010). Additionally, people with a more diversified portfolio of occupations trust more in co-management and this is consistent with the literature (McClanahan et al., 2014).

5.5.4 Perceptions of spillover from reserves

"Don't know" was the most common answer for questions about the quantity of fish around the village, and is consistent with the perspective that coastal communities have a low awareness of natural resources (Cinner, McClanahan et al., 2009; Cinner & Pollnac, 2004). The model relating to perceptions of reserves selected occupational diversity and migration, wealth and structural wealth. Occupational diversity also had an influence on the difference in knowledge about the sea between fishermen and non-fishermen and between fishermen near a reserve and far from a reserve (Cinner et al., 2010). Migratory status was also important in another study about the population's awareness of resources (Cinner & Pollnac, 2004) and in the community's perception about co-management, where non-migrants were the biggest supporters of co-management (Setiawan et al., 2012). Wealth and structural wealth behaved in opposite directions, as before. Wealthier people "see" more fish around reserves but people with more structural goods (e.g. a permanent house) "see" fewer fish around reserves. McClanahan (2014) also highlights the importance of having a permanent house in the support of management restrictions. (Chaigneau, 2008) found that, in general, fishermen perceive the benefits of the reserves, especially the ones living near reserves that were well managed. (Leleu et al., 2012) found that fishermen perceived spillover even when scientists did not detect it. On the contrary, (Versleijen & Hoorweg, 2006) found that fishermen living near reserves aided a negative perception of reserves, but those living faraway were not so negative, especially under the circumstances that the implementation of a new reserve would not impact their livelihoods.

5.6 Conclusions

The perception of resources, co-management and reserves are very heterogeneous depending on different backgrounds and socioeconomic variables. Understanding differences between stakeholders and how they are related to key socioeconomic drivers such poverty/wealth, household characteristics and migration can help uncover potential solutions to: provide legitimacy for the co-management process, identify strategies that have more extensive support, and locate groups more willing to support the co-management process. Diversification of occupations in coastal populations should also be a priority because it increases resilience to climate change (Cinner, Fuentes, & Randriamahazo, 2009) and because these households are prone to community co-management support. In the case of northern Mozambique, wealthier and older people are supportive of the co-management arrangement.

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6. The CCPs (Conselhos Comunitários de Pesca): exchange of experiences and future prospects

"Government by the people for the people"
Plato

Recommended citation: Silva, I.M, Rosendo, S. 2015 CCP (Conselhos Comunitários de Pesca): exchange of experiences and future prospects.– Workshop Report, Pemba, 1-2 June 2015.

6.1 Abstract

Mozambican law establishes co-management as the preferential model for fishery resources management and specifically defines a framework for its implementation, formed by several agencies at national, provincial, district and local level. Locally, the Conselhos Comunitários de Pesca (CCPs) are the base structure for participative artisanal fisheries management.

The goal of this workshop was to present and discuss, with the CCPs of Cabo Delgado, the scientific results of the permanent Vamizi community sanctuary, to share with the CCPs an exchange of experiences on temporary marine reserves in Madagascar promoted by the AMA (Associação Meio Ambiente) – OSOL (Our Sea, Our Life) program, to enhance successful experiences among the CCPs, and to identify the capacity-building needs and difficulties of the CCPs. It is expected that the workshop results may contribute to the planning of due interventions to reinforce the CCPs. We hope the results of the workshop can contribute to shape capacity-building interventions that can reinforce the capacity of the CCPs.

The CCPs have recognized the importance of marine community sanctuaries and understand their role in fishing resources renovation. In general, the CCPs support the idea of creating sanctuaries, mainly temporary, seasonal or rotational ones. There are several examples of experiences with sanctuaries created by CCP members that did not succeed due to their lack of resources and/or capacity to manage and supervise. Although there is great interest from the CCPs in creating sanctuaries, it is necessary to provide them with the relevant resources and to strengthen their organizational capacity in order to implement them.

The participants consider that the CCPs have been making progress in several areas, such as in raising community awareness about using resources well; supervising and controlling the use of inappropriate gear; creating conservation areas and resource management; restoring habitats (planting mangroves); and improving labour conditions, including the building of headquartesrs. Elements prone to help the success of the CCPs were presented, namely NGO support and international development projects. Nevertheless, a clear need to further analyze the operation of the CCPs was diagnosed. It is necessary to evaluate what went well and what went badly and why. This is a vital source of learning for the CCPs in order to plan further activities leading to reinforced capacity.

The main operating difficulties, mentioned by the participants, were the lack of a means of transport to supervise effectively; the lack of a uniform and similar equipment; the lack of clearly defined functions and powers especially in relation to leaders and other government agencies; weak coordination with local authorities; failure to have their authority recognized by the fishermen and local authorities; lack of capacity building in several activities; and insufficient technical support.

The main difficulties, though, were the lack of a means of transport and the lack of a uniform. Solutions suggested by the participants included seeking external support through projects and donors, and mobilizing funds mainly from fines and taxes. This last proposal raised controversy.

The CCPs’ authority in this area requires some clarifying. Presently, each CCP follows different policies on this issue, due to their own different interpretations of the law.

The capacity-building needs referred to during the workshop were the following:

- Fishery co-management tools, including planning and implementation of measures conducive to resource conservation;
- Capacity building, not only of the CCPs but also of government agencies, in their actual duties and responsibilities concerning resource management;
- Financial management of the income of the CCPs in order to improve efficiency and transparency;
- Legislation on fishing, the environment and natural resources;
- The exchange of experiences among the CCPs and relating of successful management initiatives;
- Profit-generating activities to be run by the CCPs to improve their financial sustainability, such as apiculture in the mangroves;

The main recommendations stated at the workshop were:

- To promote studies to better understand the facts behind the successes and failures of the CCPs in order to promote future learning;
- To build the capacity of the CCPs in terms of their responsibilities, powers and in the legislation on fisheries, the environment and related issues;
- To build the capacity of the SDAE and other technicians and local government members regarding the CCPs and their objectives, functions, responsibilities and powers;
- To build the capacity of the CCPs wirh regard to resource management tools. To create conditions for implementing and managing community-protected areas, either permanent, temporary or rotational, according to the local conditions;
- To incentivize cooperation among the CCPs, PNQ, lodges and other private institutions in areas such as enforcement, working tools and financial sustainability;
- To incentivize cooperation between the CCPs and NGOs that work on environmental and community development issues. NGOs may effectively act in a liaison role between the CCPs, and private and government institutions;
- Stronger support of the CCPs by the fisheries sector is recommended mainly in terms of capacity building and technical support;
- The presence of the IDPPE/SDAE “extensionista”, which is a very important element in the support provided to the CCPs, must be strengthened by enhancing capacity building;
- It is imperative to find solutions for the financial sustainability of the CCPs. A workshop, solely dedicated to this problem should be organized, followed by a series of capacity-building actions specifically dedicated to fund-raising and financial management;
- Evidence leads us to infer that bigger CCPs work better. The possibility of creating bigger CCPs (in similarity to Madagascar) encompassing all the villages in the area should be discussed;
- To allow the CCPs to continue their awareness-raising actions. Whenever possible, to provide the CCPs with the proper tools and data to help accomplish this task;

- To continue surveillance, including solving the problem of a lack of means of transport, and to look for viable and sustainable solutions.

6.2 Introduction

Community management of natural resources is becoming increasingly important in several parts of the world (Wamukota et al., 2012). This is not a new concept: throughout the world there are several experiences of communities managing their own resources with different levels of success (Evans et al., 2011). In Africa, central management has been the rule during the colonial and post-colonial periods. The first voices supporting a bigger local community involvement in natural resources management were only heard in the eighties. In the nineties, some governments started a process of devolvinhg power back to the communities for the management of several different kinds of common-use natural resources such as fisheries and forests (Chuenpagdee & Jentoft, 2007; Cinner, Daw et al., 2012).

In Mozambique, although central management was the rule, its authority did not arrive to most of the small villages, difficult to access and to where the fishing administration could not reach due to lack of resources. The laws and the management measures were largely unknown to the fishermen, who seldom had any contact with central fishing authorities. Following several positive experiences in other countries, the first natural resources co-management (central authorities and local communities) experiences arrived to Mozambique in the eighties (Amade, 1999; Blythe et al., 2013; Kristianssen & Poiosse, 1996 ; Lopes & Gervasio, 1999).

In 2002, the Ministry of Fisheries adopted an artisanal fisheries co-management plan. In 2003, the new Law of Fisheries (REPMAR) declared co-management as the preferential management model for artisanal fisheries. Since then, the Instituto de Desenvolvimento de Pesca de Pequena Escala (IDPPE) has been promoting the creation of Concelhos Comunitários de Pesca (CCP) (Menezes et al., 2009).

It was in this context that the main guideline to this workshop was born, to create the opportunity for the CCPs in Cabo Delgado to meet and exchange experiences. The main objectives were:

- To present the scientific results of the study on the effects of the community sanctuary in Vamizi and its partnership with the local lodge;
- To present results from the temporary octopus reserves in Madagascar, namely the visit to the Quirinde, Quiwia and Velondriaka communities where such reserves exist;
- To share the positive experiences of the participating CCPs;
- To share the main difficulties of the participating CCPs;
- To share the capacity-building needs of the participating CCPs.

By defining these objectives we expect to help agencies that work with the CCPs, such as the IDPPE, ADNAP and SDAEs, and NGOs and other private partners, to define their lines of work. In this way, we expect to create a list of the main activities and successes of the CCPs, but also of their view of the main difficulties, frustrations and priorities. By doing this we hope to clarify and facilitate the work of those that closely interact with the CCPs.

6.3 Methodology

The workshop was organized around presentations on a particular topic followed by a plenary session, small group activities and then another plenary session to present and discuss the results of the group work. For the workshop program and guidelines of the two group activities, please refer to Supporting Information 1.

6.4 Results

6.4.1 Sanctuaries as a fisheries management tool

a) Research results

During the presentation, the results of 8 years of permanent community sanctuary in Vamizi Island were shown in a rather visual manner. In short, the results for the coral coverage ("live rocks") indicate that its diversity and percentage was maintained within the sanctuary but lost outside it. As far as fish is concerned, results show that they increased in the sanctuary and that parrot fish also increased outside the sanctuary.

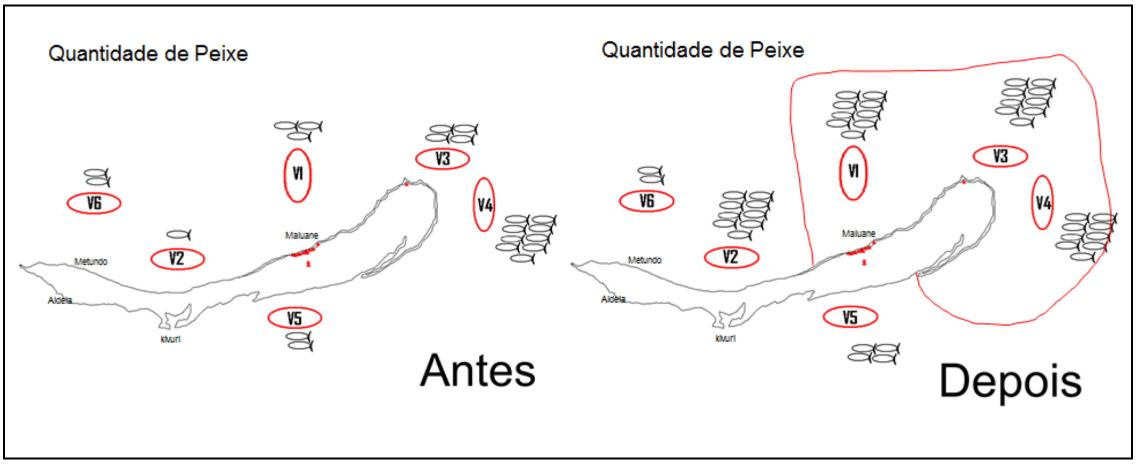

Figure 31 – Study results on the amount of fish inside and outside the sanctuary, before and after its creation.

Two videos were presented showing some of the scientific activities undertaken in conjunction with the CCPs, namely the tagging of fish in the sanctuary and the tagging of sharks.

The CCPs in the Parque Nacional das Quirimbas (PNQ) were quite pleased with this approach of close cooperation between the scientists and the communities, and they asked for further collaboration in this field.

b) Perceptions of the sanctuaries

All the CCPs were acquainted with the basic concept of a sanctuary: to close a specific area to fishing temporarily or permanently in order to allow for the conservation and reproduction of fish and other resources. Generally speaking, the "reserve effect" of sanctuaries is understood. All the CCPs agreed to create similar areas in their communities. One of the participants mentioned that *"sanctuaries as well as other conservation and management resources are welcomed"*. Some of the CCPs have even tried to create areas closed off to fishing, but they were not able to do so over the long term. The main problem mentioned was always the lack of the means to enforce the appointed areas. In their own words, *"even if we identify an area we do not have the means to control it."*

Experiences with three closed areas were presented by the Bandar, Quirimba and Darumba CCPs. In every case presented, the lack of continuous support, whether by an NGO, government or a private entity, was mentioned as one of the main reasons affecting their capacity to guarantee the continuity of these areas. Cases 1, 2 e 3 in the following boxes summarize these experiences.

CASE 1 – PEMBA BAY

In 2008, the Bandar CCP promoted an experience of community conservation in which an area near the coast was closed during 6 months. After 6 months, the results of the measure were observed. Namely, some resources that were no longer visible in the area, such as prawns, reappeared. These positive results led to the decision to close another area. A coral zone was identified and chosen in order to promote its protection. However, it has not gone ahead due to the lack of capacity of the CCP to monitor it. Although the protected area was in the vicinity of Londo Lodge, the lodge and the CCP did not have a strong relationship and thus there was no help from the lodge in enforcing the reserve. In the meanwhile, Londo Lodge closed, but there are other lodges in the area interested in this sort of collaboration.

Reflecting on the experience in Vamizi, participants considered that the support, in terms of the means of surveying and the systematic backing of the IDPPE's experts provided by the lodge, was one of the main factors which ensured the proper functioning of the Vamizi sanctuary.

The issue of continuous technical support and follow up, as a major condition for the implementation of efficient conservation measures, received considerable attention and was extensively debated. This perception was very evident in several interventions. For instance one participant said that, *"Vamizi has support, but the CCPs here are forgotten – we do not receive visits."* Another commented, when referring to Ibo, that, *"In Vamizi, the connection between the lodge and the CCP is very important. In Ibo there are several lodges but no connection whatsoever. The connection has been made with the PNQ, but the PNQ has more tasks than it can handle. In Ibo the CCP needs further support from private organizations."*

CASE 2 - QUIRIMBA

In 2007, the Quirimba CCP closed the "Quirinde" canal for one year. When it was reopened, seven tonnes of fish were caught. They closed it again for one more year, with the same very positive results. The third time it was closed, the results were not as good for 2 main reasons, according to the CCP. The first was due to environmental issues, namely the sedimentation of the canal which affected the fish habitat. The second reason had to do with the end of the AMA (Associação Meio Ambiente) project, which directly supported the CCP. Without it, the CCP members could not guarantee the surveillance of the closed area even though the project had provided them with a boat. The CCP considered that a single boat was not enough and that it also needed an engine to do the surveillance, even when the wind makes operations very difficult.

The collaboration in enforcement actions was also commented on by the PNQ. According to its representative, the CCPs always point to the lack of transport as the main constraint on enforcement. On the other hand, the PNQ has been doing everything in its power to integrate the CCPs into its enforcement plans and actions. Some CCPs take part in these actions, others do not. Given this, it is understood that it is also the responsibility of the CCPs to try and establish a partnership with the PNQ and to make efforts to create a joint enforcement team.

CASE 3 - DARUMBA

The CCP worked in coordination with the Parque Nacional das Quirimbas (PNQ) in order to identify an area to be closed. In this area, defined by the community, it was decided not to fish during the neap tides in order to let the resources "rest". Because they did not have the means to conduct inspections, the CCP denounced violations to the PNQ, which performed them instead. At the time, there was a strong connection with the CCP and this arrangement was efficient. Lately, however, according to the CCP, this arrangement has suffered due to lack of coordination between the Parque and the CCP. The CCP claims that it has failed to enforce that area, due to the absence of support from the Park and the means to pursue offenders.

The collaboration with the technicians of the *Serviços Distritais de Actividades Económicas* (SDAE) was also addressed. In some cases, related to the use of harmful gear, it did not work. Examples were given of situations in which the SDAE officers are aware of the mosquito nets but they did not penalize or even admonish users. One of the participants said that, *"the SDAE officers see the mosquito nets, do nothing about it and even receive curry from the fishermen."*

The weak collaboration and coordination among some of the CCPs was another of the reasons given for the difficulties in implementing management measures, sanctuaries as well as others. This problem was mainly identified with regard to the CCPs' policy towards the fishermen from outside the communities, especially Tanzanians. Despite the fact that foreigners are not allowed to have artisanal fishing licenses in Mozambique, local fishermen get the licenses on their behalf and fish with their gear. Some CCPs accept these situations and they do not fully control harmful gear. As a consequence, fishermen very soon arrive to fish in nearby CCP fishing areas and do not comply with the rules established by this new CCP.

The following description of an intervention clearly illustrates the difficulties of coordinating management measures, fishing rules and access to the resources: *"There is illegal fishing by Tanzanian fishermen coming a nearby village. We organized a meeting with the CCP and the chief of the village in order to solve the situation. However this man benefits the Tanzanians."* Another CCP commented in relation to a neighbouring CCP that: "*The CCP does not control these men, they all live in a community … Since the Tanzanians have arrived, we do not have any fish. They have all the necessary documents. The fish they catch - "*malhação*" (small but much appreciated) - attract and feed the bigger fish from further away. Without "*malhação*", the bigger fish will also disappear."*

6.4.2 Achievements of the CCPs

In this session, the participants formed two groups, each one tasked with identifying and discussing the main achievements of each CCP. The end purpose was to share experiences among the CCPs. Following we list the main achievements referred to by the groups, organized by theme.

a) Awareness

To promote the awareness of the communities in general, and of fishermen in particular, has been one of the main activities of the CCPs. Namely:

- Community awareness about open defecation;
- Awareness by fishermen of the use of harmful fishing gear;
- Awareness by fishermen of the need to protect the sea turtle;
- Community awareness of the importance of mangroves;
- Awareness by fishermen of the need to to pay for fishing licenses;
- Community sensitization of the sanctuary area;
- The need to convince children to devote themselves to school and not to fishing.

b) Supervision and control of harmful fishing gear

Participation in fisheries supervision and compliance with the Fisheries Act and other regulations is one of the main functions of the CCPs, recommended by law. Notwithstanding their lack of means, all of the CCPs have engaged in supervisory actions which they consider one of their main duties, which are:

- Supervisory activities;
- Fishing gear licencing;
- Application of fines for the use of harmful fishing gear;
- Mosquito net seizures;
- Prevention of the use of flashlights when fishing at night;
- Supervision in order to reduce coral/rock destruction;
- Defintion and implementation of the rules to prevent the catching of juvenile sea cucumbers.

c) Creation of special areas for the use and protection of marine resources

As already mentioned, several CCPs have taken action to create community conservation areas. They have also been mapping the use of marine resources in order to define utilization areas. The steps referred to by the participants CCPs included:

- Creating a specific area in the mangrove for cutting firewood and timber in order to confine the exploitation of the mangrove to restricted areas;
- Creating a rotational reserve where fishing is only allowed during the spring tides;
- Identifying the marine sanctuary area;
- Confining open- air defecation to specific areas in order to contain the problem;

d) Habitat restoration

Marine erosion has negatively affected some communities. Mangrove destruction has been identified as the main cause. In Quirimba, the CCP has planted mangroves as a way to control erosion.

e) Working instruments

According to the participants, a headquarters, uniforms, a log book and a stamp are some of the basic working instruments needed to comply with the CCP tasks. Some CCPs considered that obtaining these tools was one of their chief achievements. However, many CCPs have not yet managed to do so (see below).

f) Other achievements

Building a school and a community porch with their own funds were two accomplishments referred to by the Mucojo CCP.

6.4.3 Main difficulties and possible solutions

a) Difficulties

Difficulties affecting the good functioning of CCPs were discussed in two different work groups. Table 16 shows the difficulties identified by each group and its importance. Several difficulties referred to were common to the 2 groups. Some difficulties are specific to one or a few CCPs, others are shared by all of them. General difficulties are the lack of surveillance means, uniforms, financial incentives and capacity building. Difficulties specific to a particular CCP include the weak coordination between the village authority and the CCP, insufficient technical support and the lack of headquarters.

Table 16- Main difficulties faced by the CCP and their importance

Difficulty	Prioritization	
	Grupo A	Grupo B
Lack of surveillance transport (boat, engine, bicycle)	1	1
Lack of uniform (pants, shirt, boots)	2	2
Weak government awareness of the role of the CCP	4	
Weak coordination between local leaders and the CCP	3	7
Lack of working equipment (lifejackets, stamp, log book)	5	
Lack of incentives	7	4
Lack of capacity building	6	3
Insufficient technical support		6
Lack of headquarters		5

b) Possible solutions

Both groups identified the lack of means of transport for surveillance activities and the lack of uniforms as the main difficulties. There was only time to discuss the first of these, namely the lack of means of transport for surveillance.

The solutions identified referred to 3 main possibilities:

- Acquisition through external support
- Acquisition out of their own income
- Cooperation with other institutions in surveillance activities

Acquistion of the means of transport through external support

One of the solutions identified was to raise funds from donors and private institutions in order to buy a boat, engine and/or other necessary means of transport. The role of several NGOs, such as the AMA and others, was considered very important to help the CCPs identify and contact potential donors.

Acquisition of the means of transport out of their own income

This could be done by saving the money from taxes and fines to be collected by the CCP. It was also suggested that the CCP should look for alternative sources of income. However none of these possible sources were identified.

Cooperation with other institutions in the surveillance activities

This collaboration would involve creating partnerships with institutions such as the PNQ and private entities, including tourist lodges interested in conservation and sustainable management of marine resources.

6.4.3 Capacity- building needs

Table 17 presents the main capacity- building needs identified by the CCPs and their prioritization. Followed by a short description of each.

Table 17 - Main capacity building needs identified by the CCPs

Suggestions	Prioritization	
	Group A	Group B
Fisheries co-management tools, including mangrove and marine resource conservation.		1
Capacity-building in both government and CCPs on each other's role and responsibilities in managing marine resources.	2	2
Fund-raising for the CCP namely via mangrove apiculture		5
Greater knowledge of fishery laws		3
Experiences exchanges with other CCPs		4
Financial management	1	

a) ***Capacity- building on the role, responsibilities and powers of the CCPs regarding marine resources management***

The lack of clarity about the role, responsibilities and powers of the CCP was one of the main problems identified. Although CCP training includes these matters, their knowledge needs to be reinforced and repeated more frequently. With each new CCP, the leaders change and the institutional memory is lost. The CCPs argued that not even the government has a clear understanding of what the role and responsibilities of the CCPs are and as such they suggested that this capacity- building session should be attended jointly by the leaders of the CCPs and government technicians. Particularly with regard to the CCPs' powers to create and implement fishing rules, including fines and taxes, and the creation of conservation and management areas.

b) Legislation on fishing, the environment and natural resources

This is partly related to the previous point. The training the CCP leaders are presently receiving is apparently insufficient to equip them with enough information on the legislation relevant to their responsibilities.

c) Fisheries co-management tools, including planning and implementation of resource conservation measures

During the workshop, it became evident that the CCPs had a willingness to actively manage their resources, not only through supervising but also by using several other management tools such as sanctuaries and community reserves. These tools are already established in the new Conservation Law (2014). The strong need to build the capacity of the CCPs in marine resources management tools, which will prepare them to choose the best options for their local conditions, was discussed. This general capacity- building should be followed by a more detailed one specifically concerning sanctuaries, community reserves, restrictions on the use of certain fishing gear, the limitation of fishermen numbers, and the minimum size of fishes caught, etc. Also mentioned as important was the need for capacity- building in resource monitoring, in order to allow the CCPs to understand the effects of implementing these management tools.

d) Improving the financial management of the income of the CCPs for greater transparency and efficacy

In general, the CCPs have little planning and financial management capacity and these needs to be reinforced with capacity building in basic planning methodologies in order to identify financial needs and possible fund raising opportunities, as well as basic accounting methods.

e) Income- generating activities to be implemented by the CCPs in order to improve their financial sustainability

This item is related to the previous point. Each CCP is trying to raise income notwithstanding the fact that the legal basis for this is anything but clear. Strong action needs to be taken in order to help build the capacity of the CCPs to find new forms of financing . It is vital to be creative because the present sources of income are insufficient or unsustainable. For instance, it is not realistic to expect that the CCPs can survive by collecting fines. Ideally, the number of violations should drastically reduce with time. It is also expected that part of the sums raised by the licensing of fishing gear should revert to the CCPs. The increase in the number of members paying an annual fee will only be feasible if the CCPs have a very strong image, making fishermen perceive this as an advantage. It is essential to explore different options, including business opportunities to be implemented by the CCPs. Cases 4 and 5, below, are examples of alternative forms of generating income, put in place by CCPs participating in the workshop.

CASE 4 - FINANCING THROUGH A ROTATIONAL RESERVE

In the village of one of the CCPs, there was a “river” where the fish came in and could not get out, due to the tide. The CCP decided to close the area and only authorize fishing when the trapped fish were big enough, for which the CCP received a percentage of the sale.

CASE 5 - COLLECTING TAXES FOR THE USE OF THE BEACH

In this CCP village, there is a beach where it is very easy to load and unload boats. The CCP charges a fee for each boat that lands and departs from the beach. This money is used to build community facilities such as a school or a community porch.

f) Exchanging experiences and successful management initiatives among CCPs

During the workshop, the CCPs expressed the importance of exchanging experiences and visiting successful management projects as a learning experience and capacity-building exercise. This could involve workshops bringing together CCPs from different parts of the country, together with training in a specific subject, namely management tools, legislation, financial management, etc. Visiting successful management projects in Mozambique as well as abroad may inspire new ideas which CCPs can replicate in their own communities with the necessary adaptations. However, it is important that these visits are followed up by specific procedures which promote the exchange of information between the participants and their own (or other) communities.

6.5. Discussion

In general, the CCPs understand the concept, importance, efficiency and relevance of the sanctuaries as a fisheries management tool. CCPs other than Vamizi have experienced creating several kinds of community areas, mainly temporarily closed areas (6 months to a year) and areas where fishing is forbidden during neap tides. In general, these CCPs have not managed to provide continuity and efficient implementation in these areas. The main causes mentioned are the lack of a means of transport for surveillance and of scientific and technical support for planning, implementing and monitoring the management measures

The example of Vamizi was considered unique and unrepresentative of the general conditions and constraints faced by the CCPs in the rest of the province, where there are no lodges to guarantee technical and scientific support and follow-up to the CCP. Nevertheless, understanding and discussing the example of Vamizi has opened new perspectives to the CCPs operating in areas where the private sector is present, such as Ibo, Bandar/Jimpia and Quiwia (oil companies). For the CCPs, the big challenge is to establish partnerships with these players. For this, the role of NGOs such as the AMA was considered very important in establishing a bridge between the CCPs and the private sector. Therefore, the sanctuaries issue cannot be addressed in isolation from a wider discussion, which is that concerning the sustainable financing and strengthening of the capacity of the CCPs.

The CCPs have made progress in several areas, including raising community awareness about the proper use of resources and the enforcement of the prohibition of harmful fishing gear. They are a mixed bag. Some CCPs have managed to succeed in engaging their communities in solving some problems such as open-air defecation and the fight against the use of destructive fishing methods and gear. Others have achieved very little in minimizing these problems. Due to the short discussion period available during the workshop, it was not possible to fully understand the reasons behind these differences in solving similar problems. However, support for the projects and local recognition of the legitimacy and authority of the CCPs are factors likely to influence the degree of success of these co-management institutions.

Some of these achievements need further analysis. Such as, for example, the fight against the use of harmful fishing gear. When supervising its use, the actions of the CCPs are often limited to the fishing centers and fishing areas close to the villages. The lack of transportation prevents supervision in more remote centers and fishing areas. This means that the activities of the CCPs tend to focus on certain fishing gear, groups of fishermen and fishing areas. One example is the mosquito nets used by women, seizure and burning of which are one of the common measures taken. While reducing the use of mosquito nets requires attention, their role in food security and household welfare is misunderstood and its eradication without the development of alternatives may have serious impacts on vulnerable social groups, in this case women and children who depend on them.

Fines, regarded as a success by some CCPs, have generated debate and some controversy. The collection of fines for the use of harmful gear, open defecation, and destruction of habitats, and of fees for the use of the beach for loading and unloading, and for the overnight stays of migrant fishermen are important sources of revenue for some CCPs. This is especially important in a context where the CCPs point to the lack of funding as a major limitation on their actions. During the discussions, it was noted that there is a considerable lack of clarity regarding the legal basis for the collection of fines and fees. Positions vary among the CCPs and do not follow the tables attached to the fisheries legislation.

The areas in which the CCPs were not functioning well were identified by participants as the following: a lack of resources for enforcement; a lack of clarity about the role, responsibilities and powers of the CCP; weak coordination with local authorities; a lack of recognition of the authority of the CCPs by the general population and local authorities in particular; a lack of monetary incentives for members of the CCPs to carry out inspection activities and other activities that occupy their time; a lack of training in various areas; and insufficient technical monitoring by the fisheries management and others.

The identified priority problems were: a lack of transport for surveillance and uniforms. The lack of transport clearly limits the ability of the CCPs to act on the ground, particularly in remote areas. According to the participants, uniforms as well as the need for an office are essential to demonstrate the authority of the CCP. In the solution of priority problems, both related to the lack of economic means for the acquisition and maintenance of transport for surveillance and uniforms, two options were considered: to obtain external support (through projects and donors) and internal funds (from fees and income-generating activities). The feasibility of both options depends on greater support and training of the CCPs to capture, generate and manage funds.

The priority capacity- building needs identified by the participants focused on improving the clarity and understanding of the CCPs and government agencies on their respective roles and responsibilities in the co-management of resources; and improving financial management and identifying sustainable funding sources. Other skills identified included: fisheries co-management tools, including planning and implementation of resource conservation measures; legislation on fisheries, the environment and natural resources ; the exchange of experiences between CCPs and the success of management initiatives; and income-generating activities that may be developed by the CCPs to improve their financial sustainability, such as beekeeping in the mangroves.

Mozambican law is very advanced in terms of the recognition of co-management and the rights of communities to organize themselves to participate in the management of resources. However, the responsibilities and powers of the CCPs are not clearly defined. For instance, the “Estatuto Tipo” (CCP law) of the CCPs states that their fundamental objective is to contribute to "the preservation of the coastal marine ecosystem" through licensing, monitoring of resources, compliance with management measures and conflict resolution. It also foresees the possibility of CCPs conducting inspection and licensing actions "within the limits of the powers that may be delegated". These limits are not clearly defined.

In terms of management and financial sustainability, it became clear that the CCPs depend largely on fines and various fees they charge. The legality and sustainability of some of these forms of raising revenue need to be better examined. It is necessary to enable CCPs to identify other sustainable sources of funding, including other players.

6.6. Recommendations

The main recommendations resulting from this workshop are:

- The promotion of studies, to better understand the facts that influence the successes and failures of the CCPs, in order to promote learning;
- The training of the CCPs about their responsibilities and powers and on the legislation in the area of fisheries, environment and the like;
- The training of the SDAE and other technical and local government officials about the CCPs and their objectives, functions, responsibilities and powers;
- Financial sustainability;
- The encouragement of collaboration between the CCPs and NGOs working in the areas of the environment and community development. NGOs can be good intermediaries between the CCPs and private and government institutions;
- Greater support of the CCPs by the fisheries sector, especially in the areas of training and technical support;
- Greater presence of the IDPPE / STAE ” extensionista” by training these important members in supporting the CCPs;
- The need to find solutions for the financial sustainability of the CCPs. It is advisable to dedicate an entire workshop to finding solutions to this problem, after which specific capacity- building actions in fundraising and financial management should be provided;
- Evidence seems to suggest that larger CCPs work best. Discuss the possibility of promoting larger CCPs covering all the villages in the jurisdiction of a CCP (as in Madagascar);
- CCPs should be allowed to continue their awareness-raising activities. If possible, they should be provided with materials and information to assist in this work;

Continued surveillance is necessary, including the resolution of the problem of lack of transportation looking for viable and sustainable

We hope that after this workshop, the development of management programs with the CCPs will became much easier. By clarifying the CCPs principal needs and difficulties with them, new co-management actions can be made more efficient and quicker.

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Supporting Information 6.1 - Guide for group activities

Activity 1: Successful Experiences (in small groups)

The purpose of this activity is to give the CCPs an opportunity to exchange experiences on issues that have been settled in their areas, as they so decide, and what contributed to their successful resolution. The discussion will be done in groups.

First step

Each CCP has a problem that could be reduced.
The facilitator writes the following on the flip chart:

The problem (or goal);

The measures taken to reduce this problem (which they did);

Contributing factors to the success of the measures;

(the factors may be many, such as support from local authorities, government, respect for the CCP, availability of resources, transportation, etc.)

Second step

After describing each problem and the measures taken, the group reflected on the experiences presented.
Questions for reflection:

-Did these problems also affect other areas controlled by the CCPs?

-Did what happened in these areas solve the problems?

-If so, were the measures used the same or different?

-If not, why has it still not been possible to resolve the problem?

Third step

The group presents a summary of the discussions in plenary.

Activity 2: Key issues affecting the efficient operation of CCPs and training needs

The purpose of this activity is to (1) identify and prioritize the main problems that hinder the smooth functioning of CCPs; (2) propose solutions; (3) identify skills / training to strengthen the CCPs.

The discussion is done in groups. At the end of the group work, a group representative presents his work in plenary. This is followed by questions and answers and a discussion**.**

First step

Each participant identifies the problems that are of greatest difficulty with regard to the proper functioning of their CCP. The problems in question are not those which affect fishery activities, but the problems affecting the CCP.
List the problems identified on the flip chart.

Second step

Prioritize the problems (e.g. 1, 2, 3, 4, 5…)

Third step

Select the two most important problems (consensus).

Fourth Step

Propose solutions to these two problems.

Fifth step

Identify skills / training that would help strengthen the CCP.
Prioritize capacity building activities (e.g. 1, 2, 3, 4)

Sixth step

Summarize the discussions and give a presentation in plenary

7. General discussion and conclusions

"Nature's music is never over; her silences are pauses, not conclusions."

Mary Webb

7.1 Fish identification – an endless research process

“Diving in a different universe. Fish of the coral reefs of Pemba Bay” did not intend to be exhaustive, but a starting point, a list of the most important fish in Cabo Delgado for divers . It is an awareness book for Mozambican students, but also for divers and the general public who think fish are only for eating. “You go diving just to see the fish? You don’t shoot them?” is one of the phrases most heard by divers in Mozambique. For this reason, showing people that they have an endless underwater world that is not only a source of food but is also beautiful, a rich tourism resource that also provides services like shore protection, medicines and more, is of extreme importance. There is nothing better than a scientific book that at the same time tries to be a window of awareness on to the underwater world. The book does not include photographs of fish that the author was unable to identify, especially in the wrasses and parrotfish families. The parrotfish is especially important from a fisheries point of view because it is one of the Mozambicans’ favorite groups of species because of its exquisite taste. Nonetheless, the parrotfish is also key species in maintaining coral reefs since it keeps the algae from overgrowing the corals (Bonaldo, Hoey, & Bellwood, 2014). It is a sequential hermaphrodite and overfishing drags the changing of sex and color back to earlier sizes (Hawkins & Roberts, 2004). This makes the identification of parrotfish families very difficult when working in different areas with different exploitation rates. Adding to this problem is the fact that the colors of the same species (females, juveniles and males) change between regions (Streelman, Alfaro, Westneat, Bellwood, & Karl, 2002). Most research has been done in the south of Mozambique where the number and diversity of parrotfish species is small. For this reason, proper identification and description of the parrotfish is needed for the adequate management of fisheries containing these herbivores. Wrasses are probably not as important commercially and ecologically but their diversity of feeding habitats and their behavior make them an interesting subject and special challenge to photograph. Last but not least, it was amazingly sad that in almost 10 years of diving in the tropical coral reefs of Cabo Delgado, I only saw the blacktip reef (*Carcharhinus limbatus*) and whitetip reef (*Triaenodon* obesus) in Vamizi island after 8 years of protection and the grey reef shark (*Carcharhinus amblyrhynchos*) along a remote open sea wall. Colonial-era descriptions mention that “Quirimbas islands were infested with sharks”, and they are supposed to be found in pristine coral reefs. It is evident that they have been over- fished and the study of the last remaining populations of sharks in Cabo Delgado must be a priority.

One of the biggest problems in fisheries monitoring is fish identification. Most of the fisheries *extensionistas* (IDPPE employees responsible for the fish monitoring for the IIP and who implement co-management together with the CCPs) take a one- week course on fish monitoring and then go out into the field to do monitoring in places where fish identification is crucial. They are given (W. Fisher et al., 1990) and are supposed to be sufficient to identify the fish correctly. Re-examining fish ID was supposed to happen at least once a year, but constraints on budgets means that it happens only very rarely. The development of fish identification material that helps *extensionistas* better identify fish and that is cheap, easy to use and self-explanatory is very important. The use of new technology like phones and apps is already a reality in other countries, such as Madagascar (Oliver et al., 2015). This author is already using an app and shark photos sent by *extensionistas* for a project on the assessment of sharks in Cabo Delgado. Meanwhile, the photos taken for the book (chapter 2) can be a good start for a project for a fish identification app for fisheries monitoring in Cabo Delgado.

7.2 Spillover of marine reserves in Mozambique

After the first reserves were set up on Inhaca Island in 1965 and Bazaruto (PNB) in 1971 during the colonial era, conservation was far from being a priority in Mozambique due to the instability of a long civil war. But recently (2000s), international NGOs, especially the WWF, have been pushing for new reserves. The first was the Quirimbas Archipelago National park (PNQ) in 2002 and soon after the Primeiras and Segundas Archipelago reserve in 2012. In the south of the country, the Reserve Especial de Maputo came about due to international transboundary collaboration with South Africa. Besides conservation, the development of tourism was also given as an incentive for the creation of these reserves, facilitated by the ministry of tourism who is also responsible for the creation of protected areas. At that time, communities needed to be consulted and to agree to a conservation area before a marine reserve could be announced. In the fishing villages, one of the reasons given to fishermen to convince them to "buy into" the Marine reserve idea was that closing an area would protect fish, allowing them to reproduce and grow inside and then move outside where they could be fished, what is known as "spillover".Inside these big national parks or marine reserves were created marine reserves (no-take zones), better known in Mozambique as *santuários*. Meanwhile, co-management was being implemented by several IFAD finance projects. Some of these fisheries development projects coincide in area with the National parks: the PPAGI (Fisheries Project for Gaza and Inhambane) with the PNB and the PPANNCD (Northern Nampula and Cabo Delgado Artisanal Fisheries Project) with the PNQ. On the one hand were the national parks that were restricting fishing in certain areas, and on the other was the fisheries department promoting better gear, infrastructure and co- management (IFAD, 2010). In these areas, permanent sanctuaries in the national park co-habit with the rotational sanctuaries (no-take areas open to fishing periodically) of the CCPs. In neither of these two types of reserves had any scientific studies been done on spillover.

This thesis has brought important findings, set out in chapter 3, that are worthy of debate. First, that so- called spillover takes years to be seen and that it is limited to the borders of the reserve. In a poor region like Cabo Delgado, where people think of survival in weekly terms, asking fishermen to wait years to see the results of no-take areas is very difficult unless compensation is given. Projects that improve the livelihood of the local populations while they wait for the long-term effect of the reserves to bear fruit are needed. Building schools, health centers and roads to increase the quality of life can help local populations cope with the hardships of reduced fishing. Surprisingly, we saw in the workshop that community sanctuaries are welcomed but the CCPs need logistical support to enforce them (chapter 6). Fishermen understand that there are more fish around sanctuaries. Migrants from other regions have seen other areas (mainly Nampula province) where over-fishing is prevalent and agree that there is more fish around reserves (chapter 5). There is an apparent contradiction here: they probably didn't witness any spillover because of the time it requires to take place but nevertheless they say there is more fish around reserves. Other researchers also found that fishermen around a reserve in the Mediterranean report spillover but the scientist was unable to prove that spillover actually existed (Leleu et al., 2012). Besides all the hardships of enforcing a sanctuary, communities support them. Nonetheless, they should get support for enforcement and to deal with difficulties.

Sometimes, rotational sanctuaries, especially those dedicated to species that grow quickly, like octopus, have been shown to be very useful, such as in Madagascar (Oliver et al., 2015). CCP members in the workshop (chapter 6) were very interested in this type of sanctuary. The OSOL (Our Sea Our Life, a ZSL project with an EU grant) project is trying to reproduce this model in fishing centers in Palma and Mocimboa da Praia. The WWF and the AMA have also been very successful with rotational oyster bed sanctuaries inside national parks, resulting in increasing sizes and quantities of oyster collection. They have also coupled projects with improving commercialization and food processing capabilities.

The design and locations of these no-take areas need careful thought if spillover is to be expected (chapter 3). A homogenous habitat is needed on the border so that no natural barriers are created to spillover. To our knowledge, these details were not explored in the implementation of the Mozambique no-take areas. The size of the perimeter should be prioritised: smaller reserves have a bigger perimeter in comparison to their area so they should be chosen if spillover is to be expected (Halpern, Lester, & Kellner, 2010;McClanahan & Mangi, 2000). Finally, one of the last things to bear in mind when spillover is expected is that not all fish families spill over in the same way. As we have seen in this thesis, herbivorous fish are the first to be spotted but longer studies reveal that they peak first followed by carnivorous species (McClanahan et al., 2007). In Mozambique, the preferred species are parrotfish followed by groupers and snappers. These should be kept in mind if fishing around the reserve is used to feed tourists, since they prefer bigger fish such as kingfish and tuna, or for local consumption, in which case parrotfish is preferred.

7.3 Fisheries research in the Mozambique co-management context

Besides the aforementioned reference to the deficiency in fish identification, more studies need to be done on the efficiency of co-management to stop overexploitation and provide sustainable development. A preliminary study on the influence of co-management on the diversity and size of fish caught was included in chapter 4 but it lacks the effects of effort and CPUE (catch per unit of effort). Nevertheless, important conclusions for the development of co-management in the province can be taken. First, the CCPs with all their problems of implementation and lack of support from fishing and local authorities (chapter 6) have done an impressive job, which is mentioned in our study (chapter 4). It is left to the imagination as to what they could do with proper support. Second, the effects of co-management on fish size and diversity were evident but the influence of the markets was even stronger. These findings are very important for the CCPs, which are struggling to be implemented because of a lack of infrastructure (both physical and human resources), the low education of fishermen and the high big numbers of migrants (Wiomsa, 2011). These results mean that the rapid development seen in the province over the last 2 years, resulting from the discovery of gas, is moving faster than the development of co-management, which is a slow process as emphasized in chapter 1. Co-management is far from being fully implemented (chapter 6), but development, with closer markets, is advancing quickly. We run the risk that the province's CCPs cannot handle market forces. Illegal gear, such a dynamite fishing and poison, which are wide spread in Tanzania, might spread to Mozambique or there might be a reapearance of techniques that the CCPs are managing to control. Scuba diving for sea cucumbers might spread to lobster, and mosquito nets could peak again in areas that were already under control.

7.4 Co-management in Mozambique: what has been done and future prospects

Co-management and the CCPs are still unknown among the wider population, and local administrations still have to fight for their implementation, as is shown in both chapters 5 and 6. Nonetheless, the effects of co-management are already evident in some community reserves, fruit of the collaboration between communities and private interests, and spillover is starting to occur. But the CCPs, either supported or not, are also showing bigger fish sizes in catches than fishing centers where no CCPs exist or where CCPs are inactive. The objectives of co-management as stated in chapter 1 are being followed but not completely achieved: responsible fishing and the promotion of capacity- building still need a lot of attention.

Most of the benefits of co-management are slow to appear. Firstly, it is not completely participatory and/or democratic with wealthier fishermen or sellers controlling some CCPs (Menezes et al., 2011), as referred to in chapter 6. Secondly, district fisheries plans do not exist so they cannot be implemented. Thirdly, if local authorities (SDAE) do not know what their role in co-management is, and how to support it, how can CCPs be legitimised at local level? Lastly, the CCPs fulfill their goal of being economic because governments do not have the means to invest more in the co-management strategy but their efficiency is jeopardized by the lack of investment.

We hope that this thesis will be helpful to those working with the CCPs and co-management since it was the aim of this work. But we specially hope that the recommendations that come out of the CCP workshop can find their way into being implemented. Regardless of the strength of the support provided, the effect of the work of the CCPs is detectable by science and in the perceptions of fishermen .

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Annex 1
Diving in a different universe. Fish of the coral reefs of Pemba bay
(fac-simile of the book)

Um mergulho num outro mundo

Peixes dos recifes de coral da Baía de Pemba

Diving in a Different Universe. Fish of the Coral Reefs of Pemba Bay

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Biologicando

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Amadeu Soares
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Inserido na nossa coleção «Biologicando», «Peixes dos Recifes de Corais da Baía de Pemba» é um dos legados do projeto «Conhecer para Conservar a biodiversidade Marinha de Pemba (Cabo Delgado, Moçambique) – Ordenação Sócio-Ambiental para a Sustentabilidade», simplificado para PPEMBA. Este foi o projeto ganhador, em 2010, do concurso «Galardão Gulbenkian/Oceanário de Lisboa: Governação Sustentável dos Oceanos – Responsabilidade Solidária. Capacitar para Conservar», patrocinado pela Fundação Calouste Gulbenkian e pelo Oceanário de Lisboa. Coordenado por nós, o PPEMBA não teria sido possível sem a valiosa e indispensável participação da Universidade Lúrio, Moçambique, de que a Universidade de Aveiro se orgulha de ser parceira desde a sua primeira hora. Através da sua Faculdade de Ciências Naturais, sita em Pemba, a Universidade Lúrio teve um papel ativo no trabalho de pesquisa, no envolvimento das comunidades locais e na coordenação das parcerias com as restantes instituições moçambicanas parceiras do PPEMBA: o Centro de Pesquisa do Ambiente Marinho e Costeiro (CEPAM), o Instituto Nacional de Investigação Pesqueira (IIP), o Instituto Nacional de Desenvolvimento da Pesca de Pequena Escala (IDPPE) e a Associação do Meio Ambiente de Cabo Delgado (AMA).

A autora principal desta obra, Isabel Silva, é docente na Universidade Lúrio, Moçambique, e doutoranda no Departamento de Biologia da Universidade de Aveiro, Portugal. A publicação desta obra é o corolário da sua dedicação ao projeto PPEMBA, do qual foi a primeira coordenadora da UniLúrio, e ao estudo da baía de Pemba, das Quirimbas, das ilhas de Vamizi e Rongo, patrimónios naturais moçambicanos, autênticas pérolas e laboratórios naturais de uma riquíssima biodiversidade, que urgia conhecer para valorizar e conservar, como fica amplamente demonstrado nesta obra.

Within the book series «Biologicando», «Fishes from the Coral Reefs of Pemba Bay» is one of the legacies of the project «Know to Preserve the Marine Biodiversity of Pemba (Cabo Delgado, Mozambique) – Socio-Environmental Planning for the Sustainability», hereafter refer as PPEMBA. This was the winning project, in 2010, of the competition «Galardão Gulbenkian/Oceanário de Lisboa: Governação Sustentável dos Oceanos – Responsabilidade Solidária. Capacitar para Conservar», sponsored and financed by the Calouste Gulbenkian Foundation and the Lisbon Oceanarium, Portugal. Coordinated by ourselves, PPEMBA would not be possible without the valuable and indispensable participation of the Universidade Lurio, Mozambique, that the Universidade de Aveiro is proud to be a partner since its first hour. Through its Faculty of Natural Sciences, located in Pemba, the Universidade Lúrio took an active role in the research, the involvement of local communities and the coordination of the partnerships with other PPEMBA Mozambican partner institutions: Research Center of the Marine Environment and Coastal (CEPAM), the National Institute for Fisheries Research (IIP), the National Institute for the Development of Small Scale Fisheries (IDPPE) and the Association of Environment Cabo Delgado (AMA).

The main author of this book, Isabel Silva, is lecturer at the Universidade Lúrio, Mozambique, and a PhD student at the Department of Biology from the Universidade de Aveiro, Portugal. The publication of this book is the corollary of her dedication to the PPEMBA project, where she was the first coordinator from the UniLúrio team, and to her studies and research efforts focused on the Pemba bay, the Quirimbas and the islands of Vamizi and Rongo, Mozambican natural heritages, authentic pearls and natural laboratories with an immense biodiversity, that one must know, value and preserve, as it will be demonstrated in this book.

Professor Oscar Monteiro

Eu entro nesta história um pouco desprevenido. Advogado de um projecto sobre uma ilha longínqua com um nome sedutor, Vamizi ou Amizi que quer dizer viajante ou amigo, encantou-me a sua história de entreposto nos intercâmbios da costa do Índico ainda por desvendar. Mas estava curioso de conhecer o novo tipo de turismo que se propunha, turismo de baixa intensidade, conservação da natureza e trabalho com as comunidades.

Em geral como juristas, nós olhamos para os assuntos pelos seus aspectos formais, comparamos papéis com papéis ou seja propostas com leis e regulamentos e dizemos «do ponto de vista jurídico está perfeito». E não pode deixar de ser assim, não podemos visitar cada empreendimento, ou cada local antes de emitir um parecer. Mas na redação de nova legislação sinto que tenho que visitar locais ou situações, assistir a simulações, ouvir pessoas em vez de ir apenas a papéis ou seja outra legislação e começar a redigir a partir daí. Bem, isso é uma conversa mais longa. Onde entra Vamizi.

Porque foi esta ânsia de conhecer o projecto Vamizi, na altura apenas uma ilha, uma praia e uma

I come into this story a bit off guard. Lawyer of a project on a remote island with a seductive name, Vamizi or Amizi which means traveler or friend; I was enchanted by its story, yet to unravel, of warehouse in the crossroads of the Indian coast. But I was curious to know the new type of tourism that was being proposed, low-intensity tourism, nature conservation and working with communities.

In general, as lawyers, we look at the issues for their formal aspects, comparing papers with papers, that is: proposals with laws and regulations and we say «the legal point of view is perfect». And it can't be otherwise, we can not visit each project, or each site before issuing an opinion. But when drafting new legislation I feel I have to visit places or situations, watch simulations, listen to people instead of just looking into papers ie another legislation and start writing from there. Well, that's an even longer conversation. Where Vamizi plays a role.

Because truly it was this eagerness to meet Vamizi project, then just an island, a beach and an idea that makes me to switch from papers to another way to work as a lawyer. But the matter became even more serious. Visit Vamizi was my undoing.

ideia que me leva a mudar dos papéis para uma outra forma de trabalhar como jurista. Mas a coisa foi mais grave. Visitar Vamizi foi a minha perdição.

De maravilhamento em maravilhamento vou encontrando o azul do céu e o verde mar, diria o azul e o verde originais, as areias brancas, mas logo a seguir, já em 2005, as tartarugas e os seus ninhos localizados, assistir silencioso à postura nocturna dos 80 ovos por ninhada de que se sabe apenas 0.09% vão sobreviver, mas que por um estranho mistério hão de voltar ao mesmo lugar, ano após ano.

Na altura Serena, Lorenzo e um casal israelita mergulhavam e localizam os corais e mostravam-mos cada noite em slides que prolongavam o êxtase diário do sol. Eu aventurei-me a fazer snorkel, olhando os corais à distância, mantendo-me a prudente proximidade do ar que respiramos, nada de aventuras. Pude compreender o papel que os corais jogam na cadeia alimentar, micro-organismos que quase se autogeram e que são fundamentais para a existência dos peixes e tudo o que segue.

Os estudos da equipa científica do Great Reef Barrier da Austrália trouxeram uma explicação para a sobrevivência e variedade dos corais de Vamizi, a Southern Tropical Current que vem do sul e bifurca para o interior mesmo em frente do paredão que vai até sessenta metros. O que manteve frias as águas e tem feito resistir aqueles corais aos efeitos do aquecimento. E ainda recentemente, na semana passada, compreendi melhor, a eclosão dos corais, que se conhece ainda mal, uma explosão escarlate de vida que espalha vida.

Mas resistia determinadamente aos convites insistentes para mergulhar, já sou velho, até que ao ver uma pessoa da minha idade, David, justamente o pai de Serena, a mergulhadora que se preparava para mergulhar. Como assim? Já mergulhaste? Nunca. Então vou também.

Vem-me a memória a citação inicial de D.H. Lawrence, no livro de poemas de Rui Knopfli, sobre um outro mundo que existe e de que não nos damos conta, «o reino submarino» lhe chamou ele. E descubro, maravilhado, que em qualquer idade podemos descobrir novos mundos.

Richard Branson explicou-me na ilha o seu projecto de levar visitantes ao espaço para ver a terra de longe. But this is an extraordinary endeavour? disse-lhe. It can be done, Oscar. Certo! Mas se a terra é bela vista do alto, – posso imaginar a sensação –, nós temos aqui à nossa beira, essa terra vista do alto, a terra submergida, a Atlântida dos sonhos gregos, o nosso paraíso pessoal. Não há medo, nem tempo, nem idade para mergulhar, eu só fui até nove metros, mas que sensação, a de ver passar por cima de nós um cardume de xaréus, e por baixo desfilarem corais em montanhas e vales, em árvores e arbustos, flores múltiplas e incontáveis.

Acho que a palavra inefável foi descoberta justamente para descrever o belo que não se pode descrever.

E ao ir para o centro de mergulho com o livro da Isabel na mão, lê-lo antes e depois de cada mergulho, compreender o que esconde por detrás de cada coisa que vejo e reencontrar, por via da ciência, uma outra forma da mesma racionalidade para onde o Direito me havia outrora levado.

Mas meditar sobretudo sobre quanto e tão belo foi preciso para fazer a vida e fazer cada de um de nós.

Of wonder in amazement I discover the blue of the sky and green of the sea, I would say the original blue and the green, the white sands; soon after, already in 2005, also the turtles and their nests. I watched silently in the night to the laying of eggs, 80 per nest knowing that only 0,09% will survive, and even though, by some strange mystery, they will return to the same place year after year.

At the time it was Serena, Lorenzo and an Israeli couple. They dived and located corals and every night we were showed slides that lengthened the daily ecstasy of the sun. I ventured me to snorkel, looking to corals at distance, keeping a careful proximity of breathing air, no risks taken. I understood the role that corals play in the food chain, micro-organisms that almost self generate and that are fundamental to the existence of fish and all that follows.

Studies from the scientific team of Australia's Great Barrier Reef explain the survival and variety of coral at Vamizi, the Southern Tropical Current that comes from south and bifurcates into the interior just in front of the wall that goes up to sixty meters. This kept the cold water temperature and allowed those corals to resist the effects of warming. As recently as last week, I understood better, the outbreak of coral, which is still poorly known, a crimson explosion of life that spreads life.

Even though I always strongly resisted the pressing invitations for scuba diving. I'm old and until I saw someone of my own age, David, Serena´s father, preparing himself for diving. How come? Have you ever dived? Never. In that case I'm going too.

It comes to my mind the initial quote from DH Lawrence, in the book of poems by Rui Knopfli on another world that exists and that we do not realize, «the underwater kingdom» he called it. And I'm amazed to learn that at any age we can discover new worlds.

Richard Branson explained me in the island his project to send visitors to space in order to see the earth from a distance. But this is an extraordinary endeavour? I told him. It can be done, Oscar. Right! But if the land is beautiful view from the top – I can imagine the feeling – here we have it, really close to us, this earth seen from above, the submerged land, the Atlantis from the Greek myths, our personal paradise. There is neither fear, nor time or age to dive. I just went down to nine meters, but what a feeling, to see passing above us a shoal of kingfish, and having underneath us a parade of corals in mountains and valleys, trees and shrubs, multiple and countless flowers.

I believe the word ineffable was discovered precisely to describe the beauty that you cannot describe.

To go to the dive center with Isabel's book in hand, read it before and after each dive to understand what hides behind everything. I see and rediscover, through science, another form of the same rationality to which the law had taken me once.

But above all to meditate on how much beauty was needed to make live and make each one of us.

Professor Jorge Ferrão
Reitor da Universidade do Lúrio

Volvidos sete anos depois da criação da Universidade Lúrio, no norte de Moçambique, estabelecida como corolário do processo de massificação e expansão do Ensino superior público em Moçambique, a Faculdade de Ciências Naturais publica, em livro, os resultados dos seus primeiros projetos de pesquisa, agora sistematizados e em forma de livro. Investigar tem sido um dos pilares básicos das instituições de ensino superior e, consequentemente, a Universidade Lúrio não se alheia a esta responsabilidade, como pretende assegurar que os resultados da pesquisa sirvam a comunidade local e ao país de forma geral.

Por conseguinte, no limiar de mais um ano académico, a Unilurio deverá publicar, inter alia, um conjunto significativo de resultados de pesquisas iniciadas em anos anteriores. São pesquisas a escala do percurso da instituição e do capital humano existente. Jovens pesquisadores ávidos em contribuir para o engrandecimento da academia nacional.

Analogamente, serão pesquisas e projetos respaldadas no suporte técnico e científico de outras universidades e, igualmente, de notáveis pesquisadores e professores de diferentes países e escolas de pensa-

Seven years passed since the Lurio University was born in the north of Mozambique. Established as a corollary of the massification and expansion of Public Higher Education in Mozambique, the Faculty of Natural Sciences publishes in book, the results of its first research projects, systematized and now in book form. Investigation has been one of the basic pillars of higher education institutions and, consequently, the Lurio University is not oblivious to this responsibility, as a way to ensure that the research results serve the local community and the country in general.

Therefore, on the threshold of another academic year, Unilurio shall publish, inter alia, a significant body of research findings initiated in previous years. Research are the scale of the route of the institution and the existing human capital. Young researchers eager to contribute to the enhancement of the national academy.

Similarly, research and projects will be supported in technical and scientific support from other universities and also of notable researchers and teachers from different countries and schools *mento. Aproximadamente vinte projetos de pesquisas já sistematizadas deverão ser apresentadas em formato digital ou como livro.*

Apresentar os resultados de anos de pesquisa revela-se como um dos mais importantes desafios desde o período do estabelecimento desta instituição de ensino superior. Nós retratamos e pesquisamos a nós próprios. Queremos, com estes novos e sedentos olhos, entender o nosso bioma, os ecossistemas, a vida de milhares de homens e mulheres, desta vasta região geográfica de Moçambique, associando sua vivência as suas culturas, a sua disposição para melhorar e seus padrões de vida e, acima de tudo, para se afirmarem como um povo de tradição, coragem, orgulho e fraternidade.

Se o desafio de pesquisar os ecossistemas terrestres se afigura, per si, como um exercício demasiado complicado e oneroso, os ecossistemas marinhos, seriam, ainda, duplamente mais complexos. Na realidade, Moçambique dispõe de uma linha de costa de 2,800 km de comprimento, sem mencionar os numerosos rios, lagos, barragens e outros corpos de água.

O mar, essa terra preferida da pesquisadora Isabel Silva, faz parte da identidade e cultura moçambicanas. O todo poderoso mar aglutina, numa só gota, as diferentes culturas do mundo que aqui cruzaram e transformaram-se na marca da nossa identidade. Eventualmente, Moçambique jamais teria existido sem mar e, nem o mar existiria sem Moçambique. Pemba, essa descomunal baía que incubou este projeto de pesquisa, não existe apenas como baía, mas como o centro da vida de milhares de seres, de espécies e como um infinito centro de biodiversidade.

A Universidade Lúrio e a sua Faculdade de Ciências Naturais elegeram a baía de Pemba e as ilhas de Vamizi e Rongui, como focos de investigação. Na costa norte de Moçambique, nenhuma outra área, aparenta, ter tido sua biodiversidade e suas gentes assim tão estudada. Porém, não basta o conhecimento. Continuaremos devolvendo à comunidade local, uma parte de suas experiências, saber local e o amor com que nos acolhem, este meio que permitirá que se estabeleçam mecanismos de gestão e conservação de uma natureza que sempre lhes pertenceu.

Catalogar, descobrir novas espécies e formas de uso dos recursos naturais continuará sendo o mote que move cada membro da Unilurio. Assim, nos redescobriremos e traremos à luz da superfície todo um tesouro que continua escondido e desconhecido para nós e para o mundo. Cada uma destas obras engrandecerá a insípida academia moçambicana e, muito em particular a região norte do porto, hoje confrontada com a descoberta de imensos recursos energéticos que, deverão conviver com todas as restantes formas de vida.

of thought. About twenty research projects already systematized should be submitted in digital format or as a book.

Present the results of years of research reveals itself as one of the most important challenges since the period of the establishment of this institution of higher learning. We researched and portrayed ourselves. We want, with these new and thirsty eyes, understand our biome, ecosystems, the lives of thousands of men and women, this vast geographical region of Mozambique, linking their experiences, their cultures, their willingness to improve their living standards and, above all, to affirm themselves as a people of tradition, courage, pride and brotherhood.

If the challenge of researching terrestrial ecosystems appears, per se, as a too complicated and costly exercise, marine ecosystems, would be twice more complex. Indeed, Mozambique has a coastline 2,800 km long, not to mention the numerous rivers, lakes, dams and other water bodies.

The sea, this preferred land of researcher Isabel Silva, is part of Mozambican identity and culture. The almighty sea coalesces in a single drop, the different cultures of the world that crossed here and have become the hallmark of our identity. Eventually, Mozambique would never have existed without the sea and the sea would not exist without Mozambique. Pemba, this enormous bay that incubated this research project, is there not just like a bay, but as the center of life of thousands of beings, species, and as an infinite center of biodiversity.

The Lurio University and its Faculty of Natural Sciences elected the bay and the islands of Pemba and Vamizi Rongui as foci of research. On the northern coast of Mozambique, no other area, appears to have had its biodiversity and its people so well studied. However, knowledge is not enough. We will continue returning to the local community, a part of their experiences, local knowledge and the love with which they have welcomed us, this will allow establishing mechanisms for management and conservation of a nature that has always belonged to them.

Cataloging, discovering new species and forms of use of natural resources will continue to be the motto that drives every member of Unilurio. Thus, we will rediscover ourselves and bring into light a whole treasure remained hidden and unknown to us and to the world. Each of these works will magnify the insipid Mozambican academy and, in particular the northern port today faced with the discovery of huge energy resources that should live together with all other life forms.

Introdução | Introduction

Um mergulho num outro mundo: Os recifes de corais | Diving in a different Universe: The coral reefs

Preparo a minha mascara de mergulho com o tubo, ponho as barbatanas e salto na água. De repente, milhares de cores, formas, texturas, e movimentos enchem-me os sentidos. Nem sei para onde olhar!! Estou num dos recifes de corais das Quirimbas. Apesar das mais de 1000 horas de mergulho com garrafa e de outras tantas só com a mascara e o tubo, este cenário não cessa de me surpreender. Um fervilhar de atividade continua, plena de biodiversidade. Senão vejamos: os recifes de corais são lar de uma enorme variedade de peixes tropicais tais como peixe-papagaio, peixe-anjo, peixe-borboleta, peixe-caixa, peixe-coelho, peixe-balão e muitos mais. São também a «casa» de uma grande variedade de outros organismos: coloridas esponjas, caranguejos, múltiplos camarões e lagostas; moluscos, com conchas de todos os tamanhos, formas e cores; equinodermes (estrelas de mar, ouriços e pepinos do mar, é só escolher o mais bonito!). Não esquecendo as «estrelas»: golfinhos e tartarugas marinhas!!!

Os recifes de corais são um dos ecossistemas com maior biodiversidade no mundo. Consti-

I prepare my diving gear, the scuba mask, the swim fins and I jump into the water. Suddenly, thousands of colors, textures and movements overwhelm my senses. It's hard to choose where to look! I'm in one of the Quirimbas coral reefs. More than a thousand hours of scuba diving and as many of snorkeling and even though this scene always surprises me. A treasure of biodiversity continuously bursting with activity. Coral reefs are home for a huge variety of tropical fishes: parrotfish, angelfish, butterflyfish, boxfishes, rabbitfishes, pufferfishes and so many more. They also foster many, many other species: sponges, crabs, multiple shrimps, lobsters and shellfish with myriads of shapes and colors, echinoderms (sea stars, sea urchins and sea cucumbers. Choose your favorite!). And don't forget the "stars": dolphins and sea turtles.

Coral reefs are one of the ecosystems with the highest biodiversity in the world. They occupy only 0,2 % of the ocean area and even though they provide the habitat for one third of all the marine species.

tuem unicamente 0,2% da área dos oceanos, no entanto providenciam habitat para um terço de todas as espécies marinhas.

A sua importância não se resume a ter muitos e diversos animais; são também responsáveis pelo sustento de uma pescaria muito importante: um quarto da produção mundial de peixe, nos países em vias de desenvolvimento, é feita nos corais. Só no leste asiático mais de um bilião de pessoas tem como fonte principal de proteínas os peixes de coral.

Contudo não é só a pesca a única utilidade do recife de coral. O Tsunami de 2005, veio confirmar que as zonas da costa com mais e melhor conservado coral têm a melhor proteção contra tempestades. Também ajudam a prevenir inundações, e a tão preocupante erosão costeira. Para além destes benefícios indiretos, os corais são um ponto de atração turística. Milhares de pessoas no mundo inteiro deslocam-se para vir mergulhar e pescar nos recifes de corais levando ao desenvolvimento do turismo. Em áreas remotas como as Ilhas Maldivas, a maior fonte de rendimento do país é o turismo. O turismo e atividades relacionadas representavam em 2002, 70% da atividade económica do país. As Maldivas tornaram-se conhecidas somente pelos seus recifes de coral.

Mas o que são afinal os corais?

Os pescadores com quem trabalho nas Quirimbas chamam-lhe as pedras vivas, e os mais antigos respeitam-nos e não os partem porque são as casas dos peixes. Não estão longe da verdade: são pedras, porque tem um esqueleto calcário; e são vivas porque esse esqueleto nasce da associação entre um animal e uma alga (planta). A alga tira do sol e da água, os nutrientes que vão alimentar o animal para produzir o esqueleto.

Its importance is not only about having many and diverse animals, they are also the support of a very important fishery: a quarter of the world's fish production in developing countries is made in corals. Only in East Asia, there are more than a billion people whose main protein source is the fish from coral reefs.

However coral reefs show other very important features. The 2005 tsunami confirmed that the coastal zones with more corals are best protected against the elements and the better preserved coral reefs, are the better protection they provide. They also help prevent flooding and the dreadful coastal erosion. Further to these indirect benefits coral are a point to tourist attraction. Thousands of people all over the world travel long miles to dive and fish in coral reefs, causing an important tourism increase. In remote areas such as the Maldives, the largest source of income for the country is tourism. Tourism and related activities accounted, in 2002, 70% of economic activity in the country. The Maldives became known only by its coral reefs.

But what are, after all, the corals?

Fishermen who work in the Quirimbas call it the living stones and the old people respect them and preserve them because they are the homes of the fish. They are not far from truth: they are stones, because they have a limestone skeleton, and they are alive because that skeleton is born of the association between an animal an algae (plant). The alga takes, from the sun and the water, the nutrients that will feed the animal in order to produce the skeleton. This association produces miles and miles of habitat for other species.

Uma associação que produz quilómetros e quilómetros de habitats para outras espécies.

Mas infelizmente estes habitats prodigiosos estão em perigo… As técnicas de pesca destrutivas como redes de arrasto e a pesca com dinamite, partem estas frágeis estruturas. Também sofrem os efeitos nefastos da sobre pesca; da poluição gerada pelas populações que vivem na costa, e talvez o mais preocupante de todos, o perigo das mudanças climáticas. Periodicamente alguns recifes sofrem subidas de temperatura de água que fazem com que a frágil associação entre animal e alga se desfaça: os corais perdem as algas e a sua cor, dando-se o fenómeno chamado branqueamento ou «bleaching».

Vamos por isso aproveitar com cuidado e sustentavelmente os nossos corais: são um mundo de cores mas também de oportunidades.

E não se esqueça de mergulhar nos recifes de coral! Moçambique dispõe de alguns dos mais bonitos do mundo no arquipélago das Quirimbas, no Bazaruto, no desconhecido arquipélago das Primeiras e Segundas, ou noutros recifes ainda por descobrir, o importante é aproveitar esta riqueza incalculável: mergulhe noutro mundo!

But unfortunately these prodigious habitats are in danger… Destructive fishing techniques such as trawls and fishing with dynamite, ruin these fragile structures. They also suffer the adverse effects of over fishing, pollution generated by the people who live on the coast, and probably the most troubling of all, the danger of climate changes. Periodically, some reefs suffer water temperature rises that destroy the fragile relationship between algae and animals: corals lose the algae and its color. This is the phenomenon known as bleaching.

So very carefully and sustainably enjoy our corals: they are a world of colors but also of opportunities.

And do not forget to dive in the coral reefs! Mozambique has some of the nicest ones in the world in the Quirimbas Archipelago, Bazaruto Archipelago and in the unknown Archipelago of Primeiras e Segundas, and many others yet to discover. Wherever they are the important is to enjoy this invaluable wealth: dive into another world!




1. Tubarões | Sharks

Uma nova atração turística | A new tourism attraction

Como é? Atração turística?!? Há pessoas que querem ver tubarões?

A maior parte das pessoas estará agora a pensar: quem são os doidos que querem mergulhar com os tubarões, os comedores de pessoas? E porquê?

Para mim que comecei a trabalhar com tubarões em aquários, e continuei durante 10 anos, nunca tive receio destes animais tranquilos e pachorrentos. Comparados com outros peixes, são muito fáceis de tratar. Normalmente só comem 1 vez por semana e muitas vezes ficam meses sem comer. Não incomodam e são fáceis de manter. Quando comecei a mergulhar com eles, fora dos aquários, via-os ao longe e a fugir dos mergulhadores. Sempre me perguntei onde começou este medo dos tubarões?

A principal razão por trás deste medo é o tubarão branco e o filme de terror feito por Spielberg chamado «Jaws». O protagonista, o tubarão branco, é o único tubarão especializado em comer mamíferos marinhos, geralmente focas. O comportamento humano à superfície da água é

What? A tourist attraction?! Are there people who want to see sharks?

Most people will now be thinking: who are the freaks who want to dive with sharks, the men eaters? And why?

Even when I started to work with them in aquariums, 10 years ago, I could never be afraid of them because they are really quiet and easy going. Compared to many other fishes, they are easy to take care. They usually only eat once a week, sometimes they don't even eat for months. They do not bother and are very easy to maintain. When I first start diving with them in the open sea, I always saw them in the distance and fleeing from divers and so I wondered, how did this widespread fear started?

I believe that the main reason behind this fear it's one of the species – the great white shark – and the horror movie, by Steven Spielberg, called «Jaws». The protagonist, a white shark, is the only shark specializing in eating marine mammals, usually seals. Human behavior at water surface is quite similar to that of a semelhante ao de uma foca, sobretudo quando se trata de um surfista numa zona de boas ondas, também frequentada pelas focas. É esta confusão que faz vítimas. Os tubarões de recife raramente atacam humanos. Para eles somos indigestos, principalmente debaixo de água e a fazer ruidosas bolhas com uma garrafa nas costas.

No filme de Spielberg o tubarão branco, retratado pelo realizador, é um animal de dimensões surrealistas com um comportamento completamente fora do normal nos oceanos. Um exagero que tem dado uma imagem errada dos tubarões.

Infelizmente grande parte das espécies de tubarão encontram-se ameaçadas de extinção, devido à pescaria desenfreada para a produção de sopa de tubarão no oriente. Nesta pescaria só interessam as barbatanas, o resto do animal é normalmente deitado fora, o que constitui um enorme desperdício. Do tubarão pode-se aproveitar tudo: a carne é muito saborosa; a sua pele, muito resistente, é usada para a produção de sapatos e malas; do fígado extrai-se um precioso óleo – o esqualeno – muito usado na indústria cosmética e farmacêutica; as córneas dos seus olhos têm sido utilizadas em transplantes para humanos com bastante sucesso. Mas a maior dádiva do tubarão para a humanidade pode ser a cura do cancro. O tubarão é o único animal que desenvolve taxas baixíssimas de tumores cancerígenos, mesmo quando injetado com as substâncias mais nocivas. No entanto, não é tomando cápsulas de cartilagem de tubarão (à venda na medicina tradicional chinesa) que se vai encontrar a cura, mas sim mantendo as espécies de tubarão vivas para compreender os processos biológicos que impedem o desenvolvimento das células cancerígenas. Mantendo

seal, especially when it comes to a surfer on a good waves area also frequented by seals. Seen from bellow, they cast a very similar shade and it's this confusion that makes the victims. The reef sharks rarely attack humans. For they are indigestible, especially underwater and making noisy bubbles with a bottle in the back. In Spielberg's movie the white shark portrayed by the director, is an animal of surrealistic dimensions with a totally abnormal behavior. This exaggeration has given a wrong image of sharks.

Unfortunately much of the shark species are threatened with extinction, due to rampant fishing for the production of shark fin soup in the East. For this purpose, only the fins are used and the rest of the animal is usually discarded, which is a huge waste. Everything in the sharks is useful: the meat is very tasty; the skin, incredibly resistant, is used for the production of shoes and bags; precious oil – squalene – is extracted from the liver and widely used in the cosmetic and pharmaceutical industry; the corneas of its eyes have been used in transplants for humans with considerable success. But the greatest gift to mankind from the shark could become a cancer cure. The shark is the only animal that develops unusually low rates of cancerous tumors, even when injected with the most harmful substances. However, it is not taking shark cartilage capsules (available in Chinese traditional medicine) that a cancer cure will be found, but preserving the sharks and studying them in order to understand the biological processes that prevent the development of cancer cells. Keeping this irrational hatred of sharks will allow fishing fleets to lead these extraordinary animals to extinction.

este ódio irracional pelos tubarões podemos estar a permitir que as frotas pesqueiras levem à extinção estes animais extraordinários.

Vamos, por isso, mudar de atitude com os tubarões: nem são terríveis, nem são numerosos. Dificilmente os encontrará nadando na praia.

Neste momento os seus números são tão reduzidos que se tornaram numa atração turística e uma fonte de receitas. Moçambique tem a sorte de albergar alguns dos melhores locais para ver tubarões:

- «Pinnacles» na Ponta de Ouro, principalmente Tubarão Zambezi ou Bull shark;
- «Neptune's», entre as ilhas de Vamizi e Metundo nas Querimbas, Tubarão Marracho ou Grey Reef Shark, possivelmente uma agregação para reprodução;
- Ao largo da praia do Tofo, Inhambane, tubarão-baleia, com os seus enormes 14m (não se assustem só comem plancton, animais muito pequenos);
- Em Zavora, Inhambane, tubarão Tigre, Zanbezi e, muito de vez em quando, algum tubarão branco aparece.

A quem não ficou completamente convencido que os tubarões são praticamente inofensivos, posso garantir que todos estes locais para ver tubarões são bem longe das maravilhosas praias que Moçambique têm para lhe oferecer!

Vá descansado à praia e goze o sol e mar moçambicano!!!!

Therefore it is necessary a change of attitude towards sharks: they are neither terrible, nor numerous. You will hardly find them when swimming in the beach.

Presently their numbers are so low that they have become a tourist attraction and a source of revenue. Mozambique is fortunate to host some of the best places to see sharks:

– «Pinnacles» in Ponta de Ouro, especially Bull Shark or Zambezi shark;

– «Neptune's», between the islands of Vamizi and Metundo in Querimbas, Tubarão Marracho or Grey Reef Shark possibly an aggregation for reproduction;

– Along the beach of Tofo, Inhambane, whale shark, with its huge 14m (do not be scared: they only eat plankton, tiny animals);

– In Zavora, Inhambane, Tiger Shark, Zanbezi and, once in a while, a white shark appears.

To whom still has doubts about the near harmlessness of sharks, I can assure that these places for shark watching, are really far away from the best beaches Mozambique has to offer you.

You may enjoy the Mozambican sea and sun without worries!

1.1. *Carcharhynus amblyrhynchos*

Nome Científico | Cientific Name • *Carcharhinus amblyrhynchos* (Bleeker, 1856)
Nome Inglês | English Name • Blacktail reef shark
Nome Português | Portuguese Name • Tubarão cinzento de recife
Nome Francês | French Name • Requin gris de récif

Ecologia: Lagoas e recifes com profundidade de 274 m. Frequentemente encontrado ao longo das encostas exteriores de recifes e canais. Particularmente comum em atois. Poucos individuais, muitas vezes em cardume. Alimenta-se principalmente de peixes, ocasionalmente de crustáceos e cefalópodes. Geralmente curiosos, mas podem ser agressivos, mostrando primeiro a posição de ameaça e só depois e raras vezes atacam (Lieske, 1994).

Distribuição: Indo-Pacífico: Madagáscar e na área de Maurícia-Seychelles, possivelmente Índia, também Mar Vermelho até África do Sul se *Carcharhinus wheeleri* esta sinonimizada com essa espécie. No Pacífico, estende-se desde do sul da China até ao norte da Austrália e o Arquipélago Tuamoto (Fishbase, 2000).

Ecology: Lagoons and reefs with depth of 274 m. Often found along the outer slopes of coral reefs and channels. Particularly common in atolls. Few individual specimens, mostly in schools. It feeds mainly on fish, crustaceans and occasionally cephalopods. Usually curious, but can be aggressive, showing first the position of threat and only then and rarely attack (Lieske, 1994).

Distribution: Indo-Pacific: Madagascar and the Mauritius-Seychelles area, possibly India; also Red Sea to South Africa if Carcharhinus wheeleri is synonymized with this species. In the Pacific, it ranges from southern China to northern Australia and the Tuamoto Archipelago.

1.2. *Carcharhinus albimarginatus*

Nome Científico | Cientific Name • *Carcharhinus albimarginatus* (Roppell, 1837)
Nome Inglês | English Name • Silvertip shark
Nome Português | Portuguese Name • Tubarão de pontas brancas de recife
Nome Francês | French Name • Requin pointes blanches de récife

Ecologia: Paredes e recifes a profundidades de 10 a 400 m, frequentemente abaixo de 30 m. Alimentam-se principalmente de peixes, incluindo raias e pequenos tubarões. Podem ser persistentes e potencialmente perigosos (Lieske, 1994)

Distribuição: Indo-Pacífico: Mar Vermelho e África Oriental, incluindo Madagáscar, Seychelles, grupo Aldabra, Maurícias e o Arquipélago de Chagos a leste de Tuamotu. Desde o sul do Japão até à Austrália (Fishbase, 2000).

Ecology: Dropoffs and reefs at depths of 10 to 400 m, often below 30 m. Feed mainly on fish, including rays and small sharks. Can be persistent and potentially dangerous (Lieske, 1994)

Distribution: Indo-Pacific: Red Sea and East Africa, including Madagascar, Seychelles, Aldabra Group, Mauritius and the Chagos Archipelago east to Tuamotu Is., north to Japan and south to Australia (Fishbase, 2000).

2. Raias | Rays

Os tubarões do fundo, espalmados, com caudas perigosas e alguma «eletricidade» | Bottom dwelling flat-bodied sharks, with dangerous tails and a bit of «electricity»

As raias, *salamalas* em Kimani, língua da costa de Cabo Delgado, têm a mesma origem, e são família próxima, dos tubarões, *papas*, na mesma língua. Estão adaptadas para viver no fundo. O seu corpo é achatado e as barbatanas pectorais estão desenvolvidas para favorecer a natação, perdendo a cauda a função propulsora. Algumas espécies, Mantas e Ratões (infelizmente não representadas neste livro) «voam» a meia água com as suas barbatanas peitorais alargadas. O resto das raias vive junto ao fundo. As raias elétricas de forma arredondada são capazes de dar choques elétricos quando tocadas. Quanto maiores, mais forte o choque. Outras raias, a maior parte, têm espinhos venenosos na cauda. Quando alguém as pisa sem querer, elas levantam a cauda e espetam o veneno. As suas toxinas raramente são fatais e são destruídas pelo calor, pelo que este ajuda no tratamento das picadas. As feridas devem ser mergulhadas em água quente (a maior temperatura que se puder aguentar) até passar a dor. No entanto a sensação de dor pode demorar vários meses a desaparecer. O caso fatal mais famoso foi filmado para a serie «Crocodile hunter» onde o apresentador, Setphen Irwin, que estava a manusear as raias para a filmagem recebeu um espeto fatal diretamente no coração matando-o em pouco minutos.

Rays or salamalas in Kimani – the dialect spoken in Cabo Delgado coast – have the same origin, and are closely related to sharks, papas, in the same language. They are adapted to live in the sea floor. The body is flattened, the enlarged pectoral fins are designed to promote swimming and the tail lost its propulsion function. Some species, Mantas and stingrays (unfortunately not represented in this book) «fly « half water with their enlarged pectoral fins. All the others live close to the sea floor. Electric rays, round-shaped, are able to give electric shocks when touched. The bigger they are, the stronger the shock. Other rays, the majority of them, have poisonous spines on the tail. When someone inadvertently steps on them, they raise the tail and prick the poison. Their toxins are rarely life threatening and are destroyed by heat, which helps when treating the wounds. Wounds should be immersed in hot water (the highest temperature that can be endured) to stop the pain. However the pain sensation may take several months to disappear. The most famous fatal case was filmed for the series «Crocodile Hunter» where the presenter, Stephen Irwin, who was handling the rays for filming, was fatally sting directly in the heart and he died in a few minutes.

2.1. *Taeniura lymma*

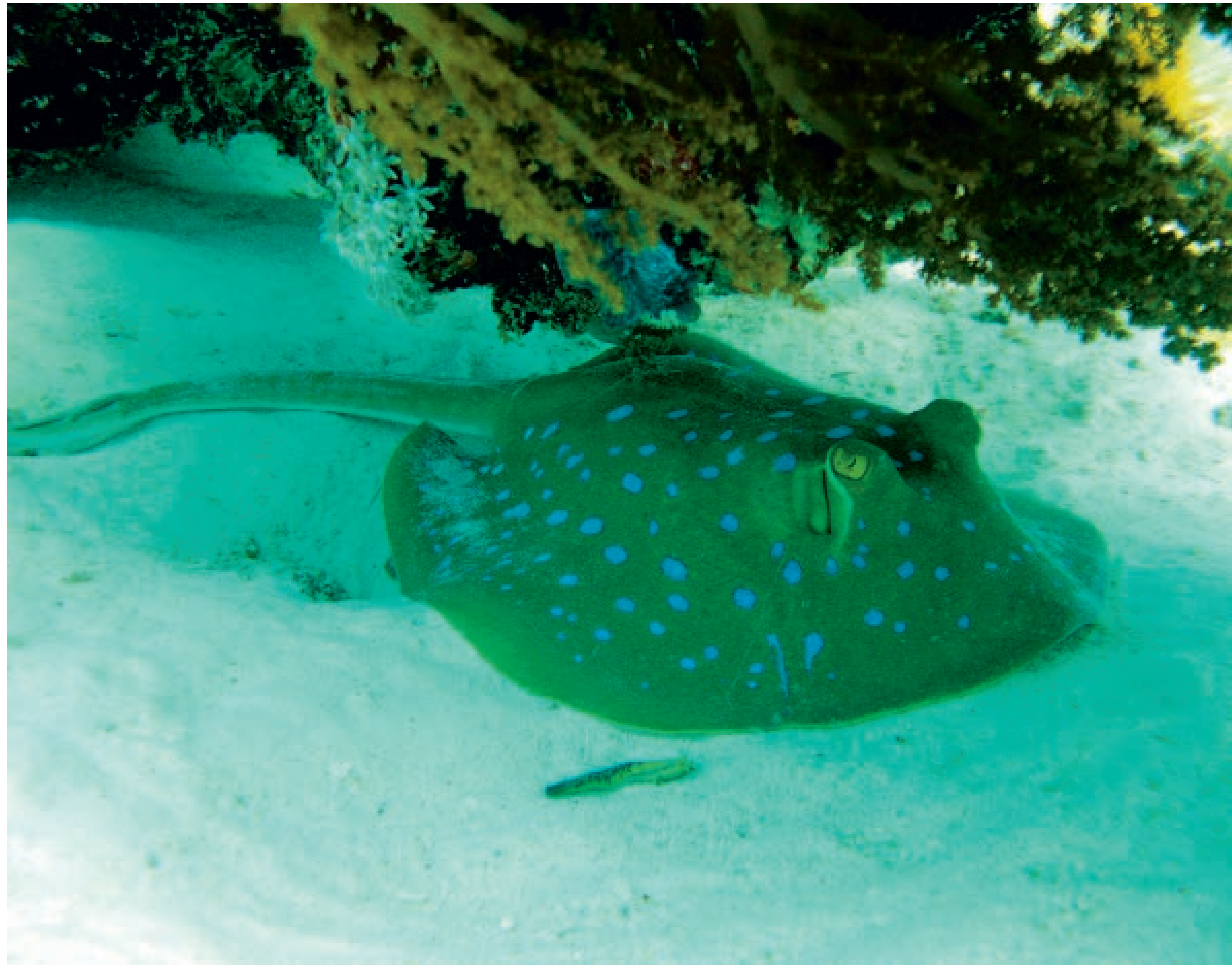
Nome Científico | Cientific Name • *Taeniura lymma* (Forsskål, 1775)
Nome Inglês | English Name • Ribbontail stingray
Nome Português | Portuguese Name • Raia de pintas azuis
Nome Francês | French Name • Pastenague à taches bleues

Ecologia: Áreas arenosas dos recifes de coral, muitas vezes em cavernas ou debaixo de saliências (Lieske, 1994).

Distribuição: Indo-Pacífico Ocidental: Mar Vermelho e África Oriental até às Ilhas Salomão. Desde o sul do Japão até ao norte da Austrália (Fishbase, 2000).

Ecology: Sandy areas of coral reefs, often in caves or under ledges (Lieske, 1994).

Distribution: Indo-West Pacific: Red Sea and East Africa to the Solomon Islands, north to southern Japan, south to northern Australia (Fishbase, 2000).



2.2. *Dasyatis Brevicaudata*

Nome Científico | Cientific Name • *Dasyatis brevicaudata* (Hutton, 1875)
Nome Inglês | English Name • Short-tail stingray
Nome Português | Portuguese Name • Raia
Nome Francês | French Name • Pastenague

Ecologia: Ocorre em recifes exteriores algumas vezes em profundidades baixas em recifes interiores. Encontradas em área entre áreas rochosas. Algumas vezes em agregações. Come peixes, bivalves, lula e crustáceos.

Distribuição: Indo-Pacífico Ocidental: sul de Moçambique e África do Sul até Nova Zelândia, e costas temperadas e subtropicais da Austrália. Registos da espécie na Tailândia podem ser do Dasyatis matsubarai, intimamente relacionados com esta espécie (Fishbase, 2000).

Ecology: Occurs offshore, on the outer shelf and uppermost slope; sometimes close inshore in very shallow depths. Found on sandy bottoms, in bays, harbors, and near rocky reefs. Often in aggregations Feeds on fishes, bivalves, squid, and crustaceans.

Distribution: Indo-West Pacific: southern Mozambique and South Africa, New Zealand, and temperate and subtropical coasts of Australia. Accounts of this species from Thailand may be of the closely related Dasyatis matsubarai (Fishbase, 2000).

2.3. *Himantura fai*

Nome Científico | Cientific Name • *Himantura fai* (Jordan & Seale, 1906)
Nome Inglês | English Name • Pink whipray
Nome Português | Portuguese Name • Raia
Nome Francês | French Name • Raie fouet

Ecologia: Ocorre em agregações em fundos moles na plataforma continental perto de recifes de coral.

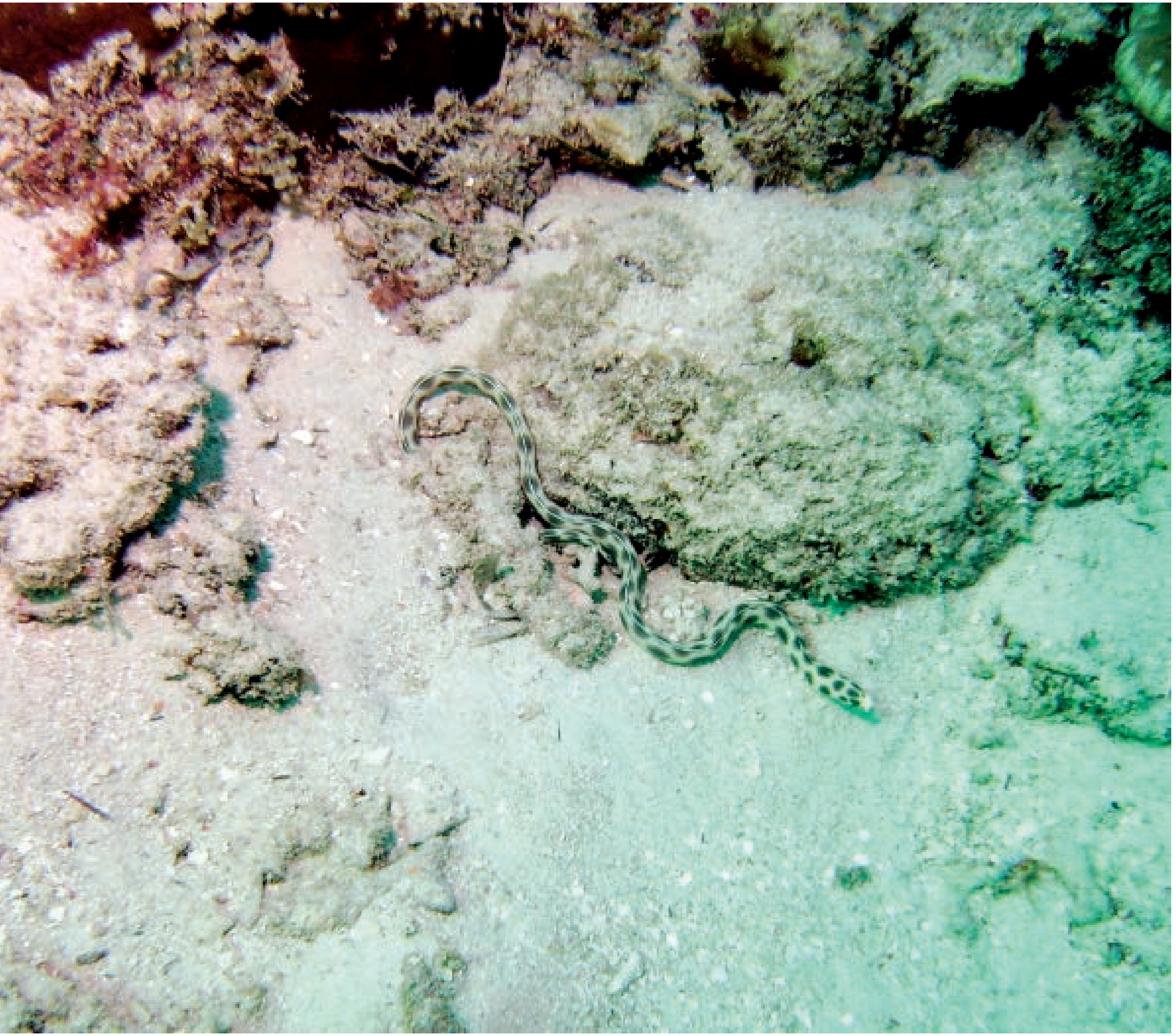
Distribuição: Indo-Pacífico: possivelmente muito difundido na África do Sul para Micronésia. Possível sinónimo de *Himantura gerrardi*. Frequentemente confundido com *Himantura jenkinsii* (Fishbase, 2000).

Ecology: Occurs in aggregations over soft bottoms of the inner continental shelf, often near coral reefs.

Distribution: Indo-Pacific: possibly widespread from South Africa to Micronesia. Possible synonym of *Himantura gerrardi*. Frequently confused with *Himantura jenkinsii*.

3. O veneno das Moreias | Moray's poison

As bactérias mortíferas | deadly bacteria



As Moreias estão desprovidas de barbatanas peitorais e pélvicas. Além disso têm as barbatanas dorsais, caudais e anais unidas numa só, ao longo da sua forma esguia. Muitas vezes são chamadas de cobras, pelos que não conhecem o mar, por causa da semelhança da forma do corpo. As Mkungas, em nome local, são apanhadas ocasionalmente pela pesca artesanal e normalmente em pesca submarina. Vivem em buracos e tocas, nas rochas ou entre os corais, de onde só saem à noite para caçar. De dia raramente se pode ver mais que a cabeça fora da toca. As moreias têm a reputação de ser agressivas pois tendem a defender as suas tocas quando nos aproximamos. As mordeduras têm tendência a infetar com frequência e demorarem a cicatrizar. Muitas vezes os locais dizem que têm veneno, no entanto são só bactérias, frequentemente resistentes aos antibióticos mais comuns e daí a fama de «venenosas».

The Morays are devoid of pectoral and pelvic fins. Besides they have the dorsal, caudal and anal fins united in one single fin that runs along its slender form. Those who do not know the sea, often call them snakes, on the account of the similarity of the body shape. The Mkungas, local name, are occasionally caught by artisanal and more often in underwater fishing. They live in holes and burrows on corals or rocks, from which they only come out at night to hunt. During the day one can rarely see more than its head out of the hole. Moray eels have a reputation for being aggressive because they tend to defend their burrows when something approaches. Their bites tend to infect and have long delayed healing periods. Quite often local people say they have venom. This is due to the presence of bacteria, frequently resistant to common antibiotics, and hence the reputation as «poisonous».

3.1. *Gymnothorax favagineus*

Nome Científico | Cientific Name • *Gymnothorax favagineus* (Bloch & Schneider, 1801)
Nome Inglês | English Name • Laced moray
Nome Português | Portuguese Name • Moreia leopardo
Nome Francês | French Name • Muréne léopard

Ecologia: Recifes rasos e encostas exteriores de recifes continentais ao longo de 35 m (Lieske, 1994)

Distribuição: Indo-Pacífico: Mar Vermelho até África Oriental e Papua-Nova Guiné. Desde o sul do Japão até à Austrália (Fishbase, 2000).

Ecology: Shallow reefs and outer slopes of coral reefs along continental 35 m (Lieske, 1994)

Distribution: Indo-Pacific: Red Sea and East Africa to Papua New Guinea, north to southern Japan, south to Australia (Fishbase, 2000).

3.2. *Gymnothorax javanicus*

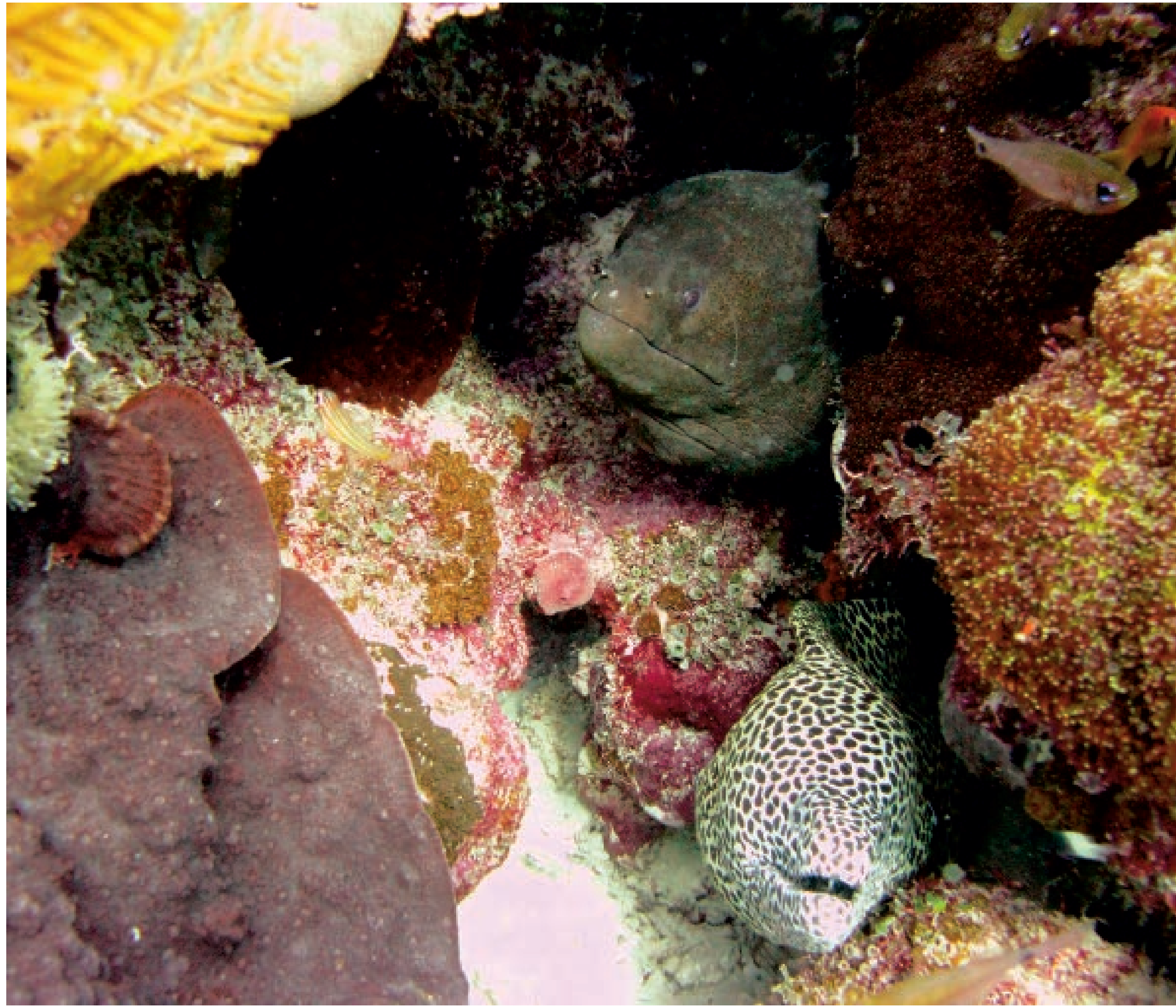
Nome Científico | Cientific Name • *Gymnothorax javanicus* (Bleeker, 1859)
Nome Inglês | English Name • Giant moray
Nome Português | Portuguese Name • Moreia gigante
Nome Francês | French Name • Muréne javanaise

Ecologia: Lagoas rasas e recifes com mais de 46 m, a mais comum das grandes moreias ao longo do Indo-Pacifico. Alimenta-se principalmente de peixes, ocasionalmente de crustáceos. Frequentemente ciquatóxica. Capaz de causar lesões graves, mas normalmente dócil e até domada por guias de mergulho em certas áreas (Lieske, 1994).

Distribuição: Indo-Pacífico: Mar Vermelho e África Oriental até às ilhas Marquesas e Oeno Atoll (Pitcairn Group). Desde as ilhas Ryukyu e o Havaí até à Nova Caledónia e Ilhas Austrais (Fishbase, 2000).

Ecology: Shallow lagoons and reefs with more than 46 m. The most common large moray along the Indo-Pacific. It feeds mainly on fish, occasionally crustaceans. Often ciguatoxic. Capable of causing serious injury, but normally docile, in certain areas even being tamed by dive guides (Lieske, 1994).

Distribution: Indo-Pacific: Red Sea and East Africa to the Marquesas and Oeno Atoll, north to the Ryukyu and Hawaiian islands, south to New Caledonia and the Austral Islands (Fishbase, 2000).



Nesta imagem encontram-se as duas espécies, *Gymnothorax favagineus* (em baixo), *Gymnothorax javanicus* (em cima)

3.3. *Heteroconger hassi*

Nome Científico | Cientific Name • *Heteroconger hassi* (Klausewitz & Eibl-Eibesfeldt, 1959)
Nome Inglês | English Name • Spotted garden-eel
Nome Português | Portuguese Name • Enguia de jardim
Nome Francês | French Name • Hétérocongre tacheté

Ecologia: Em colónias nas encostas arenosas protegidas e expostas a correntes (Lieske, 1994).

Distribuição: Indo-Pacífico: Mar Vermelho e África Oriental até às Ilhas da Sociedade. Desde Ryukyu e as ilhas Ogasawara até ao noroeste da Austrália e Nova Caledónia; ciguatóxica em toda a Micronésia (Fishbase, 2000).

Ecology: In colonies on sandy slopes protected and exposed to current (Lieske, 1994).

Distribution: Indo-Pacific: Red Sea and East Africa to the Society Islands, north to the Ryukyu and the Ogasawara islands, south to northwestern Australia and New Caledonia; throughout Micronesia ciguatoxic

3.4. *Gymnothorax flavimarginatus*

Nome Científico | Cientific Name • *Gymnothorax flavimarginatus* (Rüppell, 1830)
Nome Inglês | English Name • Yellow-marginated moray
Nome Português | Portuguese Name • Moreia de margens amarelas
Nome Francês | French Name • Murène marbrée

Ecologia: Recifes rasos e lagoas externas, até 50m. Alimenta-se de peixes e crustáceos (Lieske, 1994)

Distribuição: Indo-Pacifico: Mar Vermelho até à África do Sul, Tuamoto e ilhas Austrais. Desde as Ilhas Ryukyu e Havai, até à Nova Caledónia. Pacifico Este: Costa Rica, Panamá e Galápagos. Atlântico Sudeste: África do Sul (Fishbase, 2000).

Ecology: Reef flats, lagoons and seaward reefs, up to 50 m. It feeds on fish and crustaceans (Lieske, 1994)

Distribution: Indo-Pacific: Red Sea and South Africa eastward to the Tuamoto and Austral islands, north to the Ryukyu and Hawaiian islands, south to New Caledonia. Eastern Pacific: Costa Rica, Panama and the Galapagos, Southeast Atlantic: South Africa (Fishbase, 2000).

Rhimomuraena quaesita (Macho | Male)

3.5. *Rhinomuraena quaesita*

Nome Científico | Cientific Name • *Rhinomuraena quaesita* (Garman, 1888)
Nome Inglês | English Name • Ribbon moray
Nome Português | Portuguese Name • Moreia fita
Nome Francês | French Name • Murène Ruban

Ecologia: Lagoas e recifes externos do intertidal até aos 57m. Uma moreia tímida que habita as zonas de cascalho mostrando só a cabeça. Alimenta-se de peixes (Lieske, 1994).

Distribuição: Indo-Pacifico: Africa oriental até as ilhas Tuamoto , no norte até ao Japão, sul até a Nova Caledonia e Polinésia Francesa; incluindo as ilhas Marianas e Marshalls (Fishbase, 2000).

Ecology: Lagoons and seawards reefs, intertidal external up to 57 m. A moray eel shy that inhabits the gravel areas showing only the head. It feeds on fish (Lieske, 1994).

Distribution: Indo-Pacific: East Africa to the Tuamoto Islands, north to southern Japan, south to New Caledonia and French Polynesia; including Marianas and Marshalls (Fishbase, 2000).

Rhimomuraena quaesita (Fêmea | Female)

4. Peixes gatos | Cat fishes

Têm o corpo alongado sem escamas, com quatro pares de barbas que lhes dão o nome de peixe-gato. Os primeiros espinhos da barbatana dorsal e da peitoral são muito venenosos, o veneno é destruído pelo calor. Os juvenis aglomeram-se em bolas que rolam pelo fundo sendo facilmente identificados. Os adultos são solitários e normalmente escondem-se na sombra dos corais. Apesar de serem venenosos, isso não impede a população de os pescar e comer.

Cat fishes have a long body without scales. They have four pairs of barbels that give them the name of catfish. The first spines of the dorsal and pectoral fin are very poisonous; the venom is destroyed by heat. Juveniles agglomerate into ball-shaped groups that roll on the sea bottom which makes it very easy to identify them. Adults are solitary and usually hide in the shade of corals. Despite of being poisonous, this does not prevent the population from fishing and eating them.

4.1. *Plotosus lineatus*

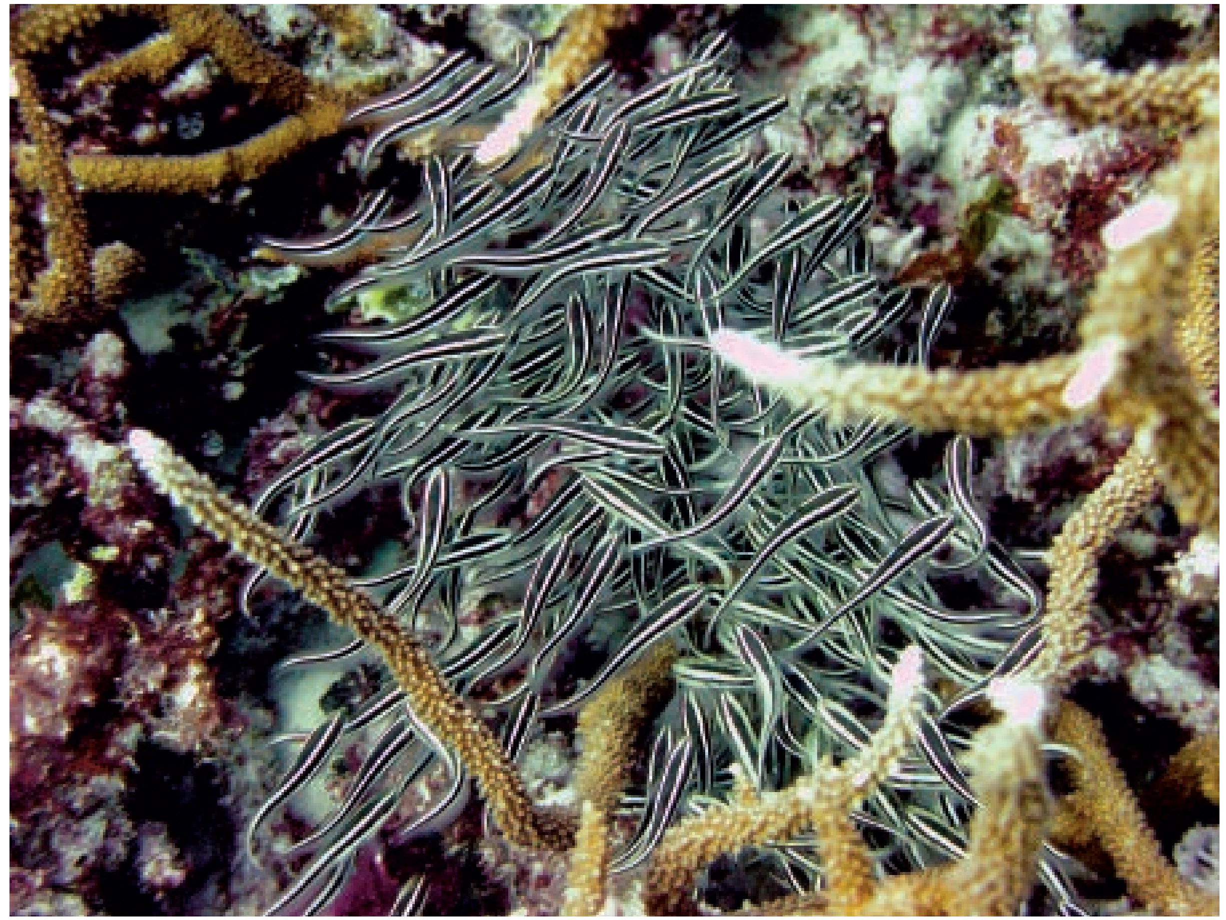
Nome Científico | Cientific Name • *Plotosus lineatus* (Thunberg, 1787)
Nome Inglês | English Name • Stripped eel catfish
Nome Português | Portuguese Name • Peixe-gato ou patunas
Nome Francês | French Name • Poisson-chat rayé

Ecologia: Recifes costeiros, geralmente entre a vegetação (Lieske, 1994)

Distribuição: Indo-Pacífico: Mar Vermelho e África Oriental até Samoa. Desde o sul do Japão, Coreia do Sul e Ilhas Ogasawara até Austrália e Ilhas Lord Howe. Palau e Yap na Micronésia. Às vezes em água doce na África Oriental (Lago Malawi) e Madagáscar (Fishbase, 2000).

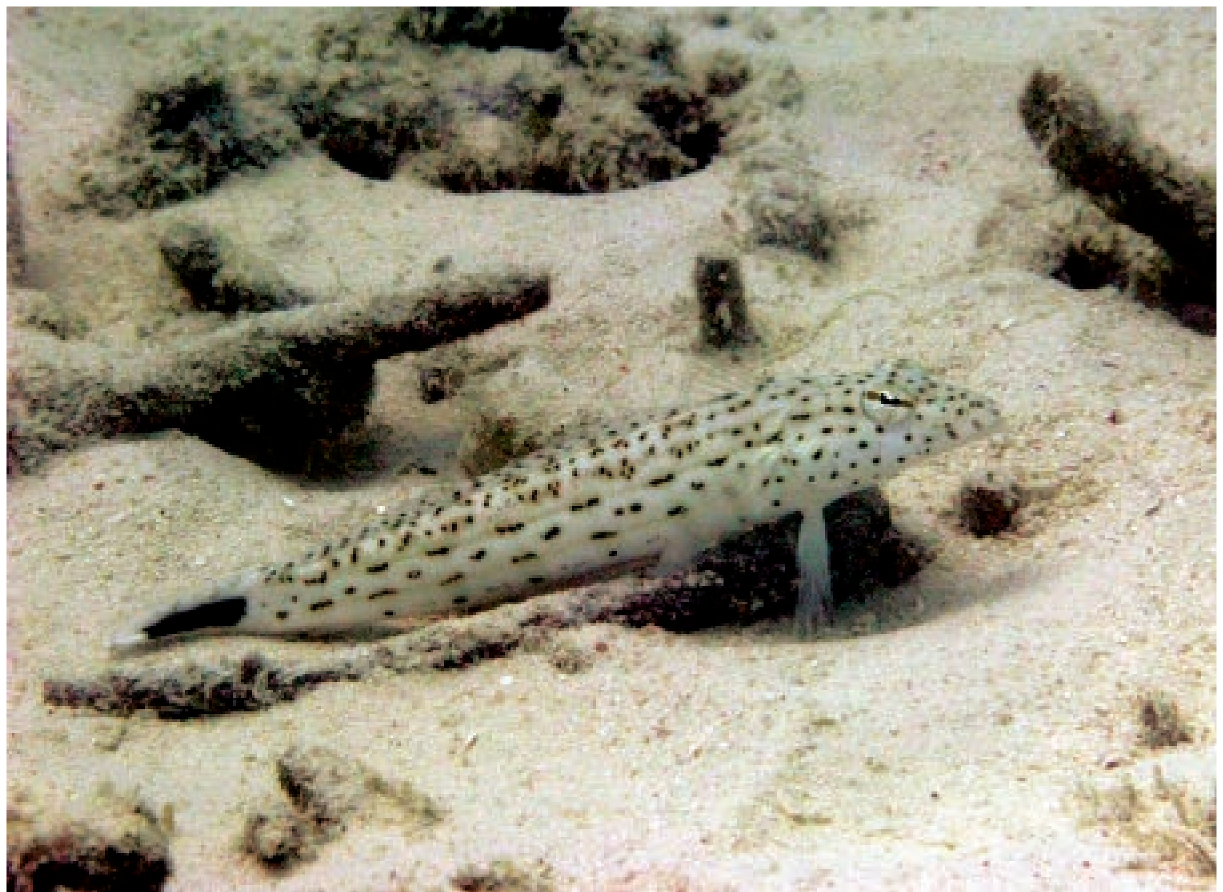
Ecology: Coastal reefs, usually between the vegetation (Lieske, 1994).

Distribution: Indo-Pacific: Red Sea and East Africa to Samoa, north to southern Japan, southern Korea, and the Ogasawara Islands, south to Australia and Lord Howe Island. Palau and Yap in Micronesia. Sometimes enters freshwaters of East Africa (Lake Malawi) and Madagascar (Fishbase, 2000).



5. Peixes lagartos | Lizardfish

esperando a presa | waiting for the prey



Os peixes lagartos são cilíndricos, e a sua cabeça termina com uma boca muito grande e de dentes afiados. Possuem um grande poder de mimetismo. Estas características fazem deles predadores de espera, capazes de engolir em segundos, presas do seu tamanho. São fáceis de aproximar em mergulho, movendo-se mal sintam o mergulhador. São de difícil identificação por fotografia, sendo quase sempre necessário examinar um individuo a seco, para ter uma identificação definitiva.

Lizardfishes are cylindrical, and their heads end with a very large mouth and extremely sharp teeth. They have great mimicry power. These characteristic makes them strong predators, waiting for their victims, able to swallow in seconds preys of their own size. They are easy to approach when diving, though they will move the moment they feel the diver. They are difficult to identify through photography, most of the times is necessary to make a dry examination in order to get a positive identification.

5.1. *Saurida gracilis*

Nome Científico | Cientific Name • *Saurida gracilis* (Quoy & Gaimard, 1824)
Nome Inglês | English Name • Gracile lizardfish
Nome Português | Portuguese Name • Peixe lagarto ou banana
Nome Francês | French Name • Poisson-lezard

Ecologia: Areia ou cascalho perto das rochas ou corais. Comum em recifes protegidos de 0-135 m (Lieske, 1994).

Distribuição: Indo-Pacífico: Mar Vermelho e África Oriental até ao Havai, ilhas Marquesas e Ducie. Desde as ilhas Ryukyu e Ogasawara até à Grande Barreira de Coral, Ilhas Lord Howe, e Rapa (Fishbase, 2000).

Ecology: Sand or rubble close to the rocks or corals. Common in coral reefs protected from 0-135 m (Lieske, 1994).

Distribution: Indo-Pacific: Red Sea and East Africa to the Hawaiian, Marquesan and Ducie islands, north to the Ryukyu and Ogasawara islands, south to the Great Barrier Reef, Lord Howe, and Rapa (Fishbase, 2000).

5.2. *Synodus jaculum*

Nome Científico | Cientific Name • *Synodus jaculum* (Russel & Cressey, 1979)
Nome Inglês | English Name • Lighthouse lizardfish
Nome Português | Portuguese Name • Peixe lagarto
Nome Francês | French Name • Poisson-lezard

Ecologia: Fundos arenosos de recifes protegidos 2-88 m (Lieske, 1994).

Distribuição: Indo-Pacífico: Leste da Africa até as Linha, Marquesas e ilhas Sociedade. Desde as ilhas Izu (Japão) até Nova Gales do sul (Austrália); Palau, Kosrae na Micronésia (Fishbase, 2000).

Ecology: Sandy bottoms of reefs protected 2-88 m (Lieske, 1994).

Distribution: Indo-Pacific: East Africa to the Line, Marquesan, and Society islands, north to the Izu Islands (Japan), south to New South Wales (Australia); Palau to Kosrae in Micronesia (Fishbase, 2000).

5.3. *Synodus variegatus*

Nome Científico | Cientific Name • *Synodus variegatus* (Lacepède, 1803)
Nome Inglês | English Name • Variegated lizardfish
Nome Português | Portuguese Name • Peixe lagarto
Nome Francês | French Name • Poisson-lezard

Ecologia: Superfícies duras da lagoa e recifes ao longo de 5 a mais de 40 m (Lieske, 1994).

Distribuição: Indo-Pacífico: Mar Vermelho e África Oriental até Havai, Ilhas Linha, Marquesas e Ducie. A norte desde as ilhas Ryukyu até ilhas Lord Howe, Kermadec e Rapa. Observado na Nova Zelândia (Fishbase, 2000).

Ecology: Hard surfaces of lagoons and reefs along 5 more than 40 m (Lieske, 1994).

Distribution: Indo-Pacific: Red Sea and East Africa to the Hawaiian, Line, Marquesan, and Ducie islands, north to the Ryukyu Islands, south to the Lord Howe, Kermadec and Rapa islands. Reported from New Zealand (Fishbase, 2000).

6. De tudo um pouco | A litle bit of everything

Neste capítulo juntaram-se espécies de meia água, pelágicos, de pequeno e grande tamanho, e outros grupos de peixes. Na sua maioria os pelágicos são difíceis de fotografar: Movem-se muito depressa; são prateados num fundo azul dando muito pouco contraste à fotografia; normalmente o mergulho passa-se junto ao fundo e muitas vezes passam despercebidos aos mergulhadores de olhar preso nos recifes de corais. Os mais famosos são com certeza a barracuda, o Atum e o Xaréu azul.

In this chapter we gathered several mid-water species, pelagic, small and large size, and other groups of fish. Most of the pelagic species are difficult to photograph: They move very quickly; they are silver on a blue background giving very little contrast to photography; when diving close to bottom they often go unnoticed by divers starring at the reefs. The most famous are certainly the Barracuda, Tuna and the Bluefin trevally.

6.1. *Kyphosus cinerascens*

Nome Científico | Cientific Name • *Kyphosus cinerascens* (Forsskal,1775)
Nome Inglês | English Name • Blue sea chub
Nome Português | Portuguese Name • Preguiçosos
Nome Francês | French Name • Calicagère bleu

Ecologia: Lagoas exteriores e recifes largos expostos e costões rochosos, em agregações em áreas de corrente até 24 m. Muitas vezes ricos junto a superfície. Solitária a noite (Lieske, 1994).

Distribuição: Indo-Pacífico: Mar Vermelho e África Oriental até Havai, ilhas Linha e Tuamotu. Desde o Japão até à Austrália (Fishbase, 2000).

Ecology: Seaward lagoons, wide reefs exposed rocky shores and in aggregations in the surf zone 24 m. Often along the surface. Solitary at night (Lieske, 1994).

Distribution: Indo-Pacific: Red Sea and East Africa to the Hawaiian, Line and Tuamoto islands, north to southern Japan, south to Australia (Fishbase, 2000).

6.2. *Gnathanodon speciosus*

Nome Científico | Cientific Name • *Gnathanodon speciosus* (Forsskal, 1775)
Nome Inglês | English Name • Golden trevally
Nome Português | Portuguese Name • Xareus dourado
Nome Francês | French Name • Carangue royale jaune

Ecologia: Minúsculos juvenis a viverem entre tentáculos da água-viva. Com mais de 5 cm, acompanham os grandes tubarões e as garoupas. Demasiado pequenos e manobráveis para serem comidos pelos seus anfitriões, ganham desta forma, proteção contra prováveis predadores. Adultos, habitam lagoas profundas e recifes largos onde se alimentam de invertebrados enterrados na areia (Lieske, 1994).

Distribuição: Indo-Pacífico, Pacífico Oriental: sudoeste da costa de Baja Califórnia Sul, México e Golfo da Califórnia ao Equador (Fishbase, 2000).

Ecology: Tiny young living between tentacles of jellyfish. With more than 5 cm, accompany the large sharks and groupers. Too small and maneuverable to be eaten by their hosts, win in this way, protection from potential predators. Adults inhabit deep lagoons and wide reefs where they feed on invertebrates buried in the sand. (Lieske, 1994).

Distribution: Indo-Pacific. Eastern Pacific: southwestern coast of Baja California Sur, Mexico and Gulf of California to Ecuador (Fishbase, 2000).

Pequenos peixes amarelos

6.3. *Caranx melampygus*

Nome Científico | Cientific Name • *Caranx melampygus* (Cuvier, 1833)
Nome Inglês | English Name • Bluefin trevally
Nome Português | Portuguese Name • Xareu azul
Nome Francês | French Name • Carangue bleue

Ecologia: Lagoa e recifes largos, linha costeira a 190 m. Solitários ou em pequenos grupos, comum em quase toda a sua distribuição. Alimentam-se de peixes e crustáceos. Adultos podem ser ciguatoxicos. Juvenis sazonais, em águas costeiras rasas de areia (Lieske, 1994)

Distribuição: Indo-Pacífico: Mar Vermelho e África Oriental até às ilhas Ducie. Desde as ilhas Ryukyu até à Nova Caledónia. Pacifico Central Oriental: Do México ao Panamá. Híbrido com *Caranx sexfasciatus* encontrados no Havaí (Fishbase, 2000).

Ecology: Lagoon and seaward reefs, coastal line up to 190 m. solitary or in small groups, common in most of its distribution. They feed on fish and crustaceans. Adults, can be ciguatoxics. Juveniles are seasonal in shallow coastal waters of sand (Lieske, 1994)

Distribution: Indo-Pacific: Red Sea and East Africa to Ducie Island, north to the Ryukyu Islands, south to New Caledonia. Eastern Central Pacific: Mexico to Panama. Hybrid with *Caranx sexfasciatus* found in Hawaii (Fishbase, 2000).

6.4. *Gymnosarda unicolor*

Nome Científico | Cientific Name • *Gymnosarda unicolor* (Ruppell, 1836)
Nome Inglês | English Name • Dogtooth tuna
Nome Português | Portuguese Name • Atum dentudo
Nome Francês | French Name • Thon dents de chien

Ecologia: Em meia-água, junto a paredes voltadas ao oceano, da superfície até 100m. Predador feroz principalmente de peixes planctíveros. Os maiores exemplares podem ser ciguatóxicos.

Distribuição: Indo-Pacífico: Mar Vermelho e África Oriental até à Polinésia Francesa. Desde o Japão até à Austrália (Fishbase, 2000).

Ecology: In half water, along the dropoff facing the ocean, from the surface to 100 m. Ferocious predator, fish mainly planktivoros. The largest specimens can be ciguatoxics.

Distribution: Indo-Pacific: Red Sea and East Africa to French Polynesia, north to Japan, south to Australia (Fishbase, 2000).

6.5. *Sphyraena jello*

Nome Científico | Cientific Name • *Sphyraena jello* (Cuvier, 1829)
Nome Inglês | English Name • Pickhandle barracuda
Nome Português | Portuguese Name • Barracuda
Nome Francês | French Name • Barracuda jello

Ecologia: Em cardumes grandes, perto de lagoas com muita movimentação de águas ou em recifes virados ao oceano (Lieske, 1994).

Distribuição: Indo-Pacífico Ocidental: Mar Vermelho, Costa sudeste da África do Sul até Nova Caledónia e Vanuatu. Recentemente foi observado em Tonga. Devido a confusão com *Sphyraena putnamae* e *Sphyraena qenie*, o intervalo exato é incerto (Fishbase, 2000).

Ecology: In large shoals, near lagoons with too much water or drive on the ocean-facing reefs (Lieske, 1994).

Distribution: Indo-West Pacific: Red Sea south to the southeastern coast of South Africa and east to New Caledonia and Vanuatu. Recently reported from Tonga. Due to a widespread confusion with *Sphyraena putnamae* and *Sphyraena qenie*, the exact range is uncertain (Fishbase, 2000).

6.6. *Sphyraena qenie*

Nome Científico | Cientific Name • *Sphyraena qenie*
Nome Inglês | English Name • Blackfin Barracuda
Nome Português | Portuguese Name • Barracuda de barbatana negra
Nome Francês | French Name • Barracuda à nageoires noires

Ecologia: Em cardumes grandes, perto de lagoas com muita movimentação de águas ou e recifes virados ao oceano (Lieske, 1994).

Distribuição: Indo-Pacífico: Mar Vermelho e África Oriental até Oceano Índico central e Polinésia Francesa. Pacífico Oriental: México e Panamá. A faixa exata é incerta por causa da confusão com *Sphyraena jello* e *Sphyraena putnamae* (Fishbase, 2000).

Ecology: In large shoals, near lagoons with too much water or drive on the ocean-facing reefs (Lieske, 1994).

Distribution: Indo-Pacific: Red Sea and East Africa to the central Indian Ocean and French Polynesia. Eastern Pacific: Mexico and Panama. The exact range is uncertain because of confusion with *Sphyraena jello* and *Sphyraena putnamae* (Fishbase, 2000).

6.7. *Echeneis naucrates*

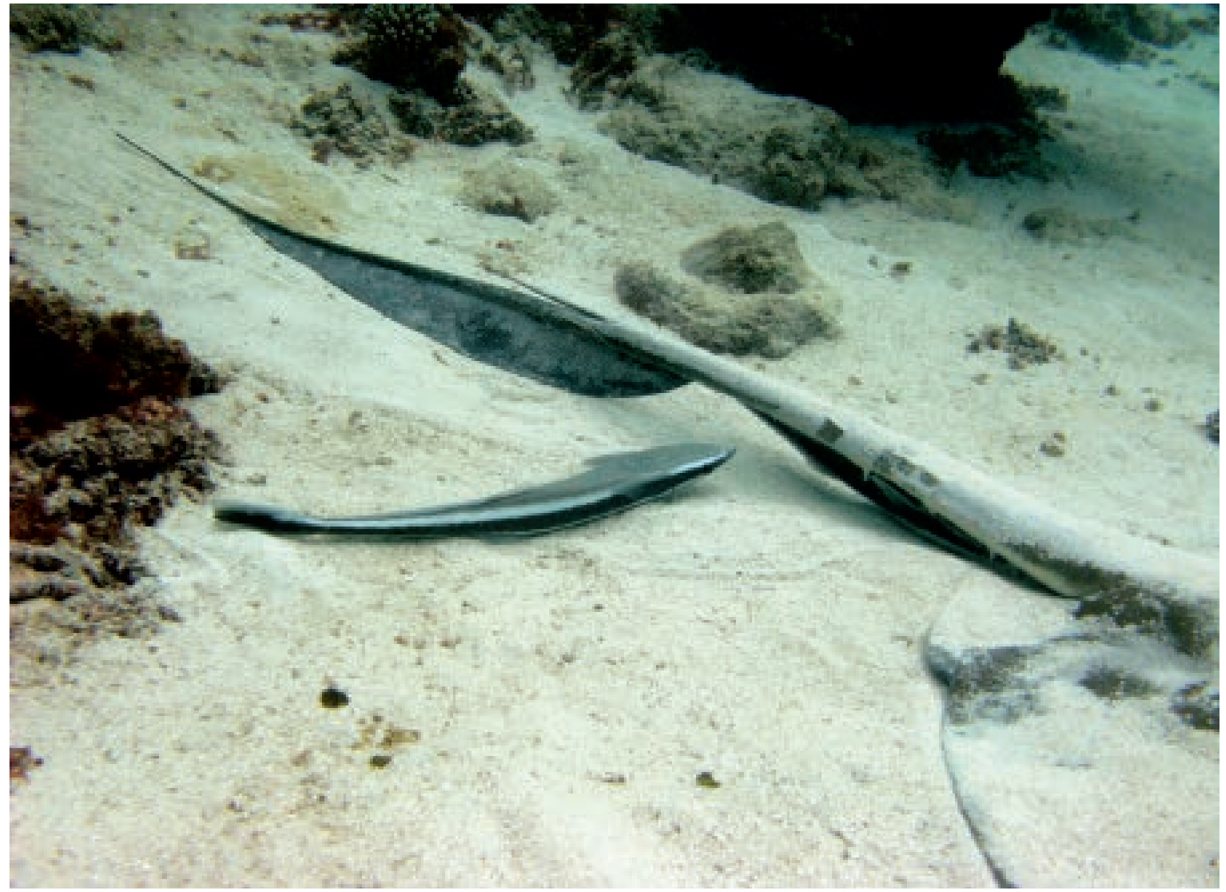
Nome Científico | Cientific Name • *Echeneis naucrates*
Nome Inglês | English Name • Live sharksucker
Nome Português | Portuguese Name • Remora
Nome Francês | French Name • Rémora

Ecologia: Ocasionalmente livre nadando sobre os recifes de coral. Geralmente estão associadas com tubarões, raias, outros grandes peixes ou tartaruga marinhas. Podem seguir mergulhadores (Lieske, 1994).

Distribuição: Circuntropical. Atlântico Ocidental: Nova Escócia, Canadá e Bermuda ao Uruguai. Atlântico Centro-Oriental: Ilha da Madeira (Fishbase, 2000).

Ecology: Occasionally free, swimming over coral reefs. Are usually associated with sharks, rays, other large fish or marine turtle. May follow divers (Lieske, 1994).

Distribution: Circumtropical. Western Atlantic: Nova Scotia, Canada and Bermuda to Uruguay. Eastern Central Atlantic: Madeira Island (Fishbase, 2000).

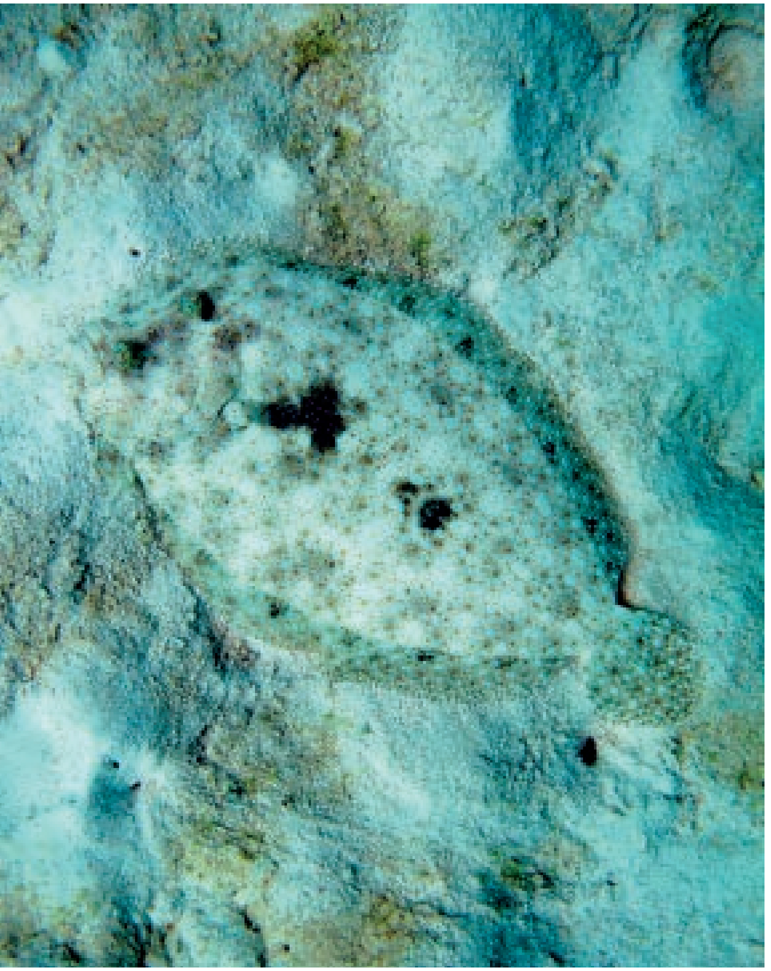


6.8. *Bothus sp.*

Nome Científico | Cientific Name • Bothus sp.
Nome Inglês | English Name • Flounder
Nome Português | Portuguese Name • Solha
Nome Francês | French Name • Turbot

Ecologia: Os Machos têm barbatanas peitorais muito compridas com as quais fazem paradas nupciais. São peixes muito rápidos que facilmente escapam dos predadores. Tem uma camuflagem perfeita tornando-os muito difícil de observar.

Ecology: IMales have very long pectoral fins that do bridal stops. Big fishes are very fast that easily escape from predators. Have a perfect camouflage making them very difficult to observe.



6.9. *Monodactylus falciformis*

Nome Científico | Cientific Name • *Monodactylus falciformis* (Lacepéde, 1801)
Nome Inglês | English Name • Full moony
Nome Português | Portuguese Name • Lunados
Nome Francês | French Name • Poisson luné

Ecologia: Áreas costeiras incluindo estuarios e lagoas. Raramente entra em água doce. Os juvenis são muitas vezes mantidos em aquários.

Distribuição: Parte ocidental do Oceano Indico: Mar Vermelho a False bay, África do Sul, Madagáscar e Reunião.

Ecology: Coastal areas including estuaries and lagoons. Rarely enters fresh water. Juveniles are often kept in aquariums.

Distribution: Western Indian Ocean: Red Sea to False Bay, South Africa, Madagascar, and Reunion (Fishbase, 2000).

7. Peixes esquilos e soldados | Soldierfish, squirrelfish

vermelhos como sangue | red as blood

Os peixes esquilos e soldados habitam fendas e grutas durante o dia e pescam à noite. Todos são vermelhos de escamas grandes. Comem crustáceos, invertebrados e pequenos peixes. Têm dimensões reduzidas, não mais de 25cm, excepto o *Sargocentrum* spiniferum que pode ultrapassar os 50 cm; no entanto tem uma importância razoável a nível da pesca de subsistência. Localmente tem o nome de Sinhamamba ou Visinjamamba. Os peixes esquilos têm uma poderosa espinha pré-opercular, que pode ser perigosa para quem manusear o peixe sem cuidado, para além disso produzem sons altos, audíveis pelos mergulhadores.

Squirrelfish and soldierfish hide in crevices and caves during the day and they hunt at night. They all are red and have large scales. They eat crustaceans, invertebrates and small fish. They have reduced dimensions, no more than 25 cm, except Sargocentrum spiniferum which can exceed 50cm; even though they have a reasonable importance to subsistence fishing. Locally they are named Sinhamamba or Visinjamamba. Squirrelfishes have a powerful pre-opercular spine, which can be dangerous for those who handle the fish without care; moreover they produce high sounds audible by divers.

7.1. *Myripristis adusta*

Nome Científico | Cientific Name • *Myripristis adusta* (Bleeker, 1853)
Nome Inglês | English Name • Shadowfin soldierfish
Nome Português | Portuguese Name • Peixe soldado
Nome Francês | French Name • Soldat pourpre

Ecologia: Em recifes e encostas de canais com rico crescimento de coral de 1 a 25 m. Ocorre isoladamente ou em pequenos grupos, algumas vezes com outras espécies (Lieske, 1994).

Distribuição: Indo-Pacífico: Leste de África até Natal, África do Sul e ilhas Linha, Sociedade e Tuamotu. Desde as ilhas Ryukyu até à Grande Barreira de Coral. Não tem sido observado no Mar Vermelho, Golfo de Aden, Oman, ou no Golfo Pérsico e está ausente nas ilhas Havaianas, Marquesas, Pitcairn Group, e na Ilha de Páscoa (Fishbase, 2000).

Ecology: In reefs and slopes of channels with rich coral growth of 1 to 25 m. Occurs singly or in small groups, sometimes with other species (Lieske, 1994).

Distribution: Indo-Pacific: East Africa south to Natal, South Africa and east to the Line, Society, and Tuamoto islands, north to the Ryukyu Islands, south to the Great Barrier Reef. It has not been reported from the Red Sea, Gulf of Aden, Oman, or the Persian Gulf and is absent in the Hawaiian Islands, Marquesas, Pitcairn Group, and Easter Island (Fishbase, 2000).

7.2. *Myripristis berndti*

Nome Científico | Cientific Name • *Myripristis berndti* (Jordan & Evermann, 1903)
Nome Inglês | English Name • Blotcheye soldierfish
Nome Português | Portuguese Name • Peixe soldado
Nome Francês | French Name • Soldat à grosses écailles

Ecologia: Recifes rasos desde o limite da maré baixa a 50 m. Em agregações soltas em, ou próximo a, abrigo durante o dia (Lieske, 1994).

Distribuição: Indo-Pacífico e Pacífico Oriental: África Oriental até Natal, África do Sul (mas não no Mar Vermelho) e até Ilha Norfolk Clipperton, Cocos e ilhas Galápagos. Desde as ilhas Ryukyu até à Grande Barreira de Coral e ilhas Lord Howe. Ao longo da Micronésia e comum em toda a Oceânia, sendo claramente ausente apenas na Ilha de Páscoa (Fishbase, 2000).

Ecology: Reef flats since the limit of low tide to 50 m. In loose aggregations in, or near, sheltered during the day (Lieske, 1994).

Distribution: Indo-Pacific and Eastern Pacific: East Africa south to Natal, South Africa (but not from the Red Sea) and east to the Clipperton, Cocos and Galapagos islands, north to the Ryukyu Islands and south to the Great Barrier Reef, Norfolk Island, and Lord Howe Island. Throughout Micronesia and common throughout Oceania, being clearly absent only from Easter Island (Fishbase, 2000).

7.3. *Myripristis kuntee*

Nome Científico | Cientific Name • *Myripristis kuntee* (valenciennes, 1831)
Nome Inglês | English Name • Shoulderbar soldierfish
Nome Português | Portuguese Name • Peixe soldado
Nome Francês | French Name • Soldat

Ecologia: Recifes rasos desde do limite da maré baixa até 30 m. Em agregações soltas em ou próximo a abrigo durante o dia (Lieske, 1994).

Distribuição: Indo-Pacífico: África Oriental até Natal, África do Sul (excepto Mar Vermelho, Golfo de Áden, Golfo Pérsico, costa indiana) e até à Polinésia Francesa e Ilhas do Havaí. Desde a baia de Tosa, Shikoku (Japão) até à Grande Barreira de Coral e ilha Lord Howe (Fishbase, 2000).

Ecology: Reefs flats since the limit of low tide to 30 m. In loose aggregations, or close to, sheltered during the day (Lieske, 1994).

Distribution: Indo-Pacific: East Africa south to Natal, South Africa (except Red Sea, Gulf of Aden, Persian Gulf, Indian coast) and east to French Polynesia and the Hawaiian Islands; north to Tosa Bay, Shikoku (Japan), south to the Great Barrier Reef and Lord Howe Island (Fishbase, 2000).

7.4. *Sargocentron praslin*

Nome Científico | Cientific Name • *Sargocentron praslin* (Lacepède, 1802)
Nome Inglês | English Name • Dark-striped squirrelfish
Nome Português | Portuguese Name • peixe esquilo
Nome Francês | French Name • Écureuil

Ecologia: Recifes rasos e recifes rasos protegidas, muitas vezes em áreas de recifes mortos (Lieske, 1994).

Distribuição: Indo-Pacífico Ocidental: África Oriental até Moçambique (mas não no Mar Vermelho) até às Marshall, com exceção das Marshalls do norte e ilhas Sociedade. Registado no Mediterrâneo (Fishbase, 2000).

Ecology: Reef flats and shallow protected reefs, often in areas of dead reefs (Lieske, 1994).

Distribution: Indo-West Pacific: East Africa south to Mozambique (but not the Red Sea) and east to the Marshall, except the northern Marshalls and Society islands. Recorded from the Mediterraneann (Fishbase, 2000).

7.5. *Sargocentron spiniferum*

Nome Científico | Cientific Name • *Sargocentron spiniferum* (Forsskal, 1775)
Nome Inglês | English Name • Sabre squirrelfish
Nome Português | Portuguese Name • Peixe esquilo
Nome Francês | French Name • Écureuil à grandes mâchoires

Ecologia: Recifes rasos, lagoas e em recifes virados para o oceano até 122 m. Solitários e geralmente sob corais durante o dia (Lieske, 1994).

Distribuição: Indo-Pacífico: Mar Vermelho e África Oriental até ao Havaí e ilhas Ducie. A norte desde o Japão, até à Austrália, toda Micronésia (Fishbase, 2000).

Ecology: Reef flats, lagoons and coral reefs on the ocean-facing until 122 m. Loners and usually under coral during the day (Lieske, 1994).

Distribution: Indo-Pacific: Red Sea and East Africa to the Hawaiian and Ducie islands, north to southern Japan, south to Australia; throughout Micronesia (Fishbase, 2000).

8. Peixes trompetas, marinhas e outros | Trumpetfish, pipefish and others

Formas estranhas, serão peixes? | Strange forms, are they fishes?

Nestas famílias agrupamos os cavalos-marinhos e marinhas juntamente com os peixes trompetas que só se assemelham entre si devido à forma.

Os cavalos-marinhos são de difícil classificação apenas com caracteres exteriores. Tem um ciclo de vida característico, os machos recebem os ovos das fêmeas no seu ventre ficando «grávidos» durante aproximadamente três semanas, dando à luz miniaturas de cavalos-marinhos. A maioria das espécies é monogâmica acasalando para toda a vida. A maioria das espécies vive nas pradarias de ervas marinhas, com algumas espécies de recife de corais. Todos os anos 60 toneladas de cavalos-marinhos são capturados para entrarem nas lojas de medicina chinesa asiática. Por este motivo, as populações asiáticas desta espécie estão em forte declínio.

Os peixes trompetas são predadores de pequenos animais, escondem-se no meio dos corais e das ervas marinhas; ou seguem outros animais maiores escondendo-se na sua sombra.

In this chapter we gathered seahorses and pipefishes together with the trumpetfishes only on the account of their resemblance in shape.

Seahorses are difficult to classify based only on their external characteristics. They have a very peculiar life cycle; males receive females' eggs in their wombs, getting «pregnant» for about three weeks, giving birth to miniature seahorses. Most species are monogamous, mating for life and live in sea grass beds, with some species of coral reef. 60 tons of seahorses are caught every year just for the Asian Chinese medicine shops. This is the reason why Asian populations of this species are in sharp decline.

The trumpetfish are predators of small animals, lurk among the corals and sea grass, or otherwise they follow larger animals hiding in their shadow.

8.1. *Aulostomus chinensis*

Nome Científico | Cientific Name • *Aulostomus chinensis var* (Linnaeus, 1766)
Nome Inglês | English Name • Chinese trumpetfish
Nome Português | Portuguese Name • Peixe trompetas
Nome Francês | French Name • Poisson-trompette

Ecologia: Entre rochas ou corais, recifes rasos a 122 m. Faz emboscadas solitárias de pequenos peixes e crustáceos. Muitas vezes nada atrás de grandes peixes herbívoros para deslocar-se sobre a presa. A boca abre o diâmetro do corpo para sugar a presa (Lieske, 1994).

Distribuição: Indo-Pacífico: África Oriental até ao Havaí e a ilha de Páscoa. Desde o Japão até à ilha de Lord Howe. Pacifico Central-Oriental: Panamá, Ilhas de Revillagigedo, ilha de Clipperton, ilha de Cocos e ilha de Malpelo (Fishbase, 2000).

Ecology: Between rocks or corals, reef flats up to 122 m. A solitary ambusher of small fish and crustaceans. Often swims behind large herbivorous fish to sneak up on their prey. The mouth opens the entire diameter of the body to suck the prey (Lieske, 1994).

Distribution: Indo-Pacific: East Africa to Hawaii and the Easter Island, north to southern Japan south to Lord Howe Island. Eastern Central Pacific: Panama, Revillagigedo Islands, Clipperton Island, Cocos Island, and Malpelo Island (Fishbase, 2000).

8.2. *Corythoichthys flavofasciatus*

Nome Científico | Cientific Name • *Corythoichthys flavofasciatus* (Roppell, 1838)
Nome Inglês | English Name • Network pipefish
Nome Português | Portuguese Name • Marinhas
Nome Francês | French Name • Syngnathe à traits jaunes

Ecologia: Lagoas subtidais e em recifes virados ao oceano até 25 m, em rochas cobertas de algas e corais (Lieske, 1994).

Distribuição: Indo-Pacífico: Mar Vermelho e África Oriental até às Ilhas Tuamotu. Desde as Ilhas Ryukyu até ao norte da Austrália e as Ilhas Austrais (Fishbase, 2000).

Ecology: Lagoons below the limit of low tide and ocean-facing reefs up to 25 m, on rocks covered with algae and corals (Lieske, 1994).

Distribution: Indo-Pacific: Red Sea and East Africa to the Tuamoto Islands, north to Ryukyu Islands, south to northern Australia and the Austral Islands (Fishbase, 2000).

8.3. *Hippocampus kuda*

Nome Científico | Cientific Name: Hippocampus kuda (Bleeker,1852)
Nome Inglês | English Name: Spotted Seahorse
Nome Português | Portuguese Name: Cavalo marinho
Nome Francês | French Name: Hippocampe d'estuaire

Ecologia: Recife de corais e estuários até 30m. Ocasionalmente em recifes exteriores e pelágico. (Lieske, 1994)

Distribuição: Do Mar Vermelho ao Havai, Japão e grande barreira de coral da Austrália.

Ecology: Coral Reef and estuaries up to 30 m. Occasionally in seaward reefs and pelagic. (Lieske, 1994)

Distribution: Red sea to hawaiian, Japan and Great Barrier Reef (Lieske, 1994).

8.4. *Aeoliscus punctulatus*

Nome Científico | Cientific Name • *Aeoliscus punctulatus* (Bianconi, 1854)
Nome Inglês | English Name • Speckled shrimpfish
Nome Português | Portuguese Name • Peixe lápis
Nome Francês | French Name • Poisson-couteau

Ecologia: Em grupos pequenos perto de ou entre os espinhos dos ouriços diadema, ramos de coral ramificado ou em buracos abrigados. Nada com a cabeça para baixo e alimenta-se de minúsculas partículas de plâncton (Lieske, 1994).

Distribuição: Oeste do Oceano Índico: Mar Vermelho e Quénia até à baia de Algoa, África do Sul (Fishbase, 2000)

Ecology: In small groups near or among the spines of diadema urchins, branched coral branches or in holes sheltered. Swims with the head down and feeds on tiny particles of plankton (Lieske, 1994).

Distribution: Western Indian Ocean: Red Sea and Kenya to Algoa Bay, South Africa (Fishbase, 2000).

8.5. *Solenostomus cyanopterus*

Nome Científico | Cientific Name • *Solenostomus cyanopterus* (Bleeker, 1854)
Nome Inglês | English Name • Ghost pipefish
Nome Português | Portuguese Name • Cavalo-marinho fantasma
Nome Francês | French Name • Poisson-fantôme robuste

Ecologia: Entre algas e ervas marinhas em águas baixas e calmas. Raro (Lieske, 1994)

Distribuição: Indo-Pacifico: Mar Vermelho e África oriental até as ilhas Fiji. Desde o sul do Japão até à Austrália (Fishbase, 2000).

Ecology: Between algae and seaweed in shallow and calm waters. Rare (Lieske, 1994)

Distribution: Indo-Pacific: Red Sea and East Africa to Fiji, north to southern Japan, south to Australia (Fishbase, 2000).

9. Peixes leões, pedras, rascassos e peixe folha | Lionfish, stonefish, scorpionfish

os peixes invisíveis | the invisible ones

Os peixes pedras e rascassos, apesar de manterem um corpo de peixe, desenvolveram cabeças grandes cheias de calosidade ósseas e espinhos e de apêndices cutâneos que tem como função mimetizar o corpo para os esconder das presas. Eles esperam, ao abrigo da camuflagem, que as presas cheguem perto e depois lançam o ataque. Desta maneira muitas vezes passam despercebidos aos mergulhadores. Os peixes leões substituíram a camuflagem por espinhos, com veneno na base, e fazem propaganda da sua perigosidade em tons de vermelho e branco, com grandes barbatanas coloridas que se vêm a distância.

Rascassos e peixes pedras estão bem camuflados e por isso o seu veneno é mais perigoso. É muito fácil um mergulhador não os ver (como se vê dos exemplos) e ser picado ao, inadvertidamente, se encostar aos seus perigosos espinhos.

Os peixes folhas, como o nome indica, parecem uma folha e movimentam-se como uma folha. Tal como os seus «primos» estão camuflados, mas sem o perigo do veneno nos espinhos da barbatana dorsal.

Stonefish and scorpionfish, although maintaining the body of a fish, developed big heads full of bone callus and spines and skin appendages whose function is to mimic the body to hide from prey. Hidden by camouflage, they wait for the preys to get close and then they launch the attack. This camouflage explains why they so often go unnoticed by divers. Lionfish replaced the camouflage by thorns, with poison at the base, and advertise their dangerousness in shades of red and white and large colored fins that are seen from a distance.

Stonefish and scorpionfish are well camouflaged and so their venom is more dangerous. It is very easy not to see them (as seen from the examples) and get stung when inadvertently the diver leans on its dangerous thorns.

The leaf fish, as the name implies, looks like a leaf and moves like a leaf. Similarly to its «cousins» it is camouflaged, but without the dangerous, poisonous spines of the dorsal fin.

9.1. *Pterois miles*

Nome Científico | Cientific Name • *Pterois miles* (Bennett, 1828)
Nome Inglês | English Name • Devil firefish
Nome Português | Portuguese Name • Peixe leão
Nome Francês | French Name • Rascasse volante

Ecologia: Vive em habitats lodosos. As espinhas finas são muito venenosas.

Distribuição: Oceano Índico: Mar Vermelho até ao sul de Porto Alfredo, África do Sul e Sumatra, na Indonésia. Oceano Atlântico. Também encontrado no leste do Mediterrâneo (Fishbase, 2000).

Ecology: Lives in muddy habitats. The thin spines are quite poisonous.

Distribution: Indian Ocean: Red Sea south to Port Alfred, South Africa and east to Sumatra, Indonesia. Atlantic Ocean. Also known in eastern Mediterranean (Fishbase, 2000).

9.2. *Synanceia verrucosa*

Nome Científico | Cientific Name • *Synanceia verrucosa* (Bloch & Schneider, 1801)
Nome Inglês | English Name • Stonefish
Nome Português | Portuguese Name • Peixe pedra ou rascasso
Nome Francês | French Name • Poisson-pierre ou Synancée

Ecologia: Recifes rasos de 20 m, muitas vezes debaixo de pedras e bordas. Podem-se enterrar na areia. Alimentam-se de peixes e crustáceos. As presas são sugadas numa fração de segundo, com um movimento quase impercetível (Lieske, 1994).

Distribuição: Indo-Pacífico: Mar Vermelho e África Oriental até à Polinésia Francesa. Desde as ilhas Ryukyu e Ogasawara até Queensland, Austrália (Fishbase, 2000).

Ecology: Reef flats up to 20 m, often under rocks and ledges. May bury in sand. Feeds on fish and crustaceans. Prey are sucked in a fraction of a second, with a movement almost imperceptable (Lieske, 1994).

Distribution: Indo-Pacific: Red Sea and East Africa to French Polynesia, north to the Ryukyu and Ogasawara islands, south to Queensland, Australia (Fishbase, 2000).


Synanceia verrucosa (camuflada vista de cima)


Synanceia verrucosa (camuflada vista de frente)


Synanceia verrucosa (camuflada vendo-se os olhos e a boca)

9.3. *Scorpaenopsis diabolus*

Nome Científico | Cientific Name • *Scorpaenopsis diabolus* (Cuvier, 1829)
Nome Inglês | English Name • False stonefish
Nome Português | Portuguese Name • Peixe pedra ou rascasso
Nome Francês | French Name • Poisson-scorpion diable

Ecologia: Recifes rasos até 70 m, frequentemente pousados no substrato, ocasionalmente em corais. Quando perturbados, abanam as barbatanas internas como um aviso. Os predadores, aprendem a associar esse comportamento com impalatabilidade e a desagradável experiência de ser picado com veneno (Lieske, 1994).

Distribuição: Indo-Pacífico: Mar Vermelho e África Oriental até às ilhas do Havai e Polinésia Francesa. Desde o sul do Japão até à Grande Barreira de Coral e Nova Caledónia (Fishbase, 2000).

Ecology: Reef flats up to 70 m, often resting on the substrate, occasionally in corals. When disturbed, flashes its inner P fins as a warning. Predators learn to associate this behavior with unpalatability and the unpleasant experience of being stung with poison (Lieske, 1994).

Distribution: Indo-Pacific: Red Sea and East Africa to the Hawaiian Islands and French Polynesia, north to southern Japan, south to the Great Barrier Reef and New Caledonia (Fishbase, 2000).

9.4. *Scorpaenopsis oxycephala*

Nome Científico | Cientific Name • *Scorpaenopsis oxycephala* (Bleeker, 1849)
Nome Inglês | English Name • Tassled scorpionfish
Nome Português | Portuguese Name • Peixe escorpião ou rascasso
Nome Francês | French Name • Poisson-scorpion à houppes

Ecologia: Em recifes virados ao oceano e canais maiores ou iguais a 35 m, em pedregulhos, rochas ou corais (Lieske, 1994).

Distribuição: Indo-Pacífico Ocidental: Mar Vermelho e baia de Sodwana, África do Sul até às Ilhas Marianas, Taiwan, Palau e Guam na Micronésia, provavelmente mais difundido (Fishbase, 2000).

Ecology: On the ocean-facing reefs and channels greater than or equal to 35 m, on rocks, boulders or corals (Lieske, 1994).

Distribution: Indo-West Pacific: Red Sea and Sodwana Bay, South Africa to the Mariana Islands, north to Taiwan; Palau and Guam in Micronesia; probably more widespread (Fishbase, 2000).

9.5. *Taenianotus triacanthus*

Nome Científico | Cientific Name • *Taenianotus triacanthus* (Lacepéde, 1802)
Nome Inglês | English Name • Leaf scorpionfish
Nome Português | Portuguese Name • Peixe folha
Nome Francês | French Name • Poisson-feuille

Ecologia: Lagoas e em recifes virados ao oceano até 134 m. Alimentam-se de pequenos crustáceos e peixes. Nada de lado a lado para imitar um pedaço de folha na corrente. Pode periodicamente lançar fora a camada externa da pele (Lieske, 1994).

Distribuição: Indo-Pacífico: África Oriental até às Ilhas Galápagos. Desde as ilhas Ryukyu e Havaí até à Austrália e Ilhas Tuamoto (Fishbase, 2000).

Ecology: Lagoons and coral reefs on the ocean facing until 134 m. Feeds on small crustaceans and fish. Swims from side to side to mimic a piece of leaf in the current. Can periodically toss out the outer layer of skin (Lieske, 1994).

Distribution: Indo-Pacific: East Africa to the Galapagos Islands, north to Ryukyu and Hawaiian islands, south to Australia and the Tuamoto Islands (Fishbase, 2000).

9.6. *Antennarius commersonni*

Nome Científico | Cientific Name • *Antennarius commersonni* (Lacepéde, 1798)
Nome Inglês | English Name • Giant frogfish
Nome Português | Portuguese Name • Peixe-sapo de Commerson
Nome Francês | French Name • Antennaire géant

Ecologia: Lagoas e recifes externos até 30 m. (Lieske, 1994).

Distribuição: Circuntropical (Fishbase, 2000)

Ecology: Lagoons and reefs up to 30 m (Lieske, 1994).

Distribution: Circuntropical (Fishbase, 2000)

10. Canários do mar | Sea Goldies

uma nuvem de cor | a cloud of color

Estes peixes, de pequeno tamanho, são muito coloridos e vivem em grupos numerosos por cima dos corais, onde se escondem quando sentem perigo. São planctivoros, comem plâncton (pequenos organismos emsuspensão na água). O macho, mais colorido, possui um harém de 15-30 fêmeas. Quando o macho dominante morre, a fêmea maior passa a macho. Não têm praticamente interesse para a pesca.

These small fishes are very colorful. They live in very large schools just above the reef, where they hide when in danger. They are planktivorous meaning that they eat plankton (tiny organisms suspended in the water).The male, with brighter colors, retains a harem of 15-30 females. When he dies, the biggest female undergoes sex reversal and takes the place of the missing male. They have no interest for commercial fishing.

10.1. *Pseudoanthias squamipinis*

Nome Científico | Cientific Name • *Pseudoanthias squamipinis* (Peters, 1855)
Nome Inglês | English Name • Sea goldie
Nome Português | Portuguese Name • Canários do mar
Nome Francês | French Name • Anthias commum

Ecologia: Grandes agregações em paredes exteriores dos recifes de 4-40m (Lieske, 1994)

Distribuição: Indo-Pacífico Ocidental: Mar Vermelho e Natal, África do Sul até Niue. Desde o Japão até à Austrália. Registado na Ilha Europa (Fishbase, 2000).

Ecology: Large shoals in dropoffs facing the ocean. From 4-40m (Lieske, 1994).

Distribution: Indo-West Pacific: Red Sea and Natal, South Africa to Niue (Ref. 37816), north to Japan, south to Australia. Recorded from Europa Island (Fishbase, 2000).

Pseudoanthias squamipinis (Fêmea)

Pseudoanthias squamipinis (em grupo)

10.2. *Pseudanthias evansi*

Nome Científico | Cientific Name • *Pseudanthias evansi* (Smith, 1959)
Nome Inglês | English Name • Yellowback anthias
Nome Português | Portuguese Name • Canário do mar
Nome Francês | French Name • Anthias bicolore

Ecologia: Grandes agregações a volta de formações de coral salientes, em lagoas ou recifes exteriores de 2-20m. Machos possuem harém e são territoriais (Lieske, 1994),

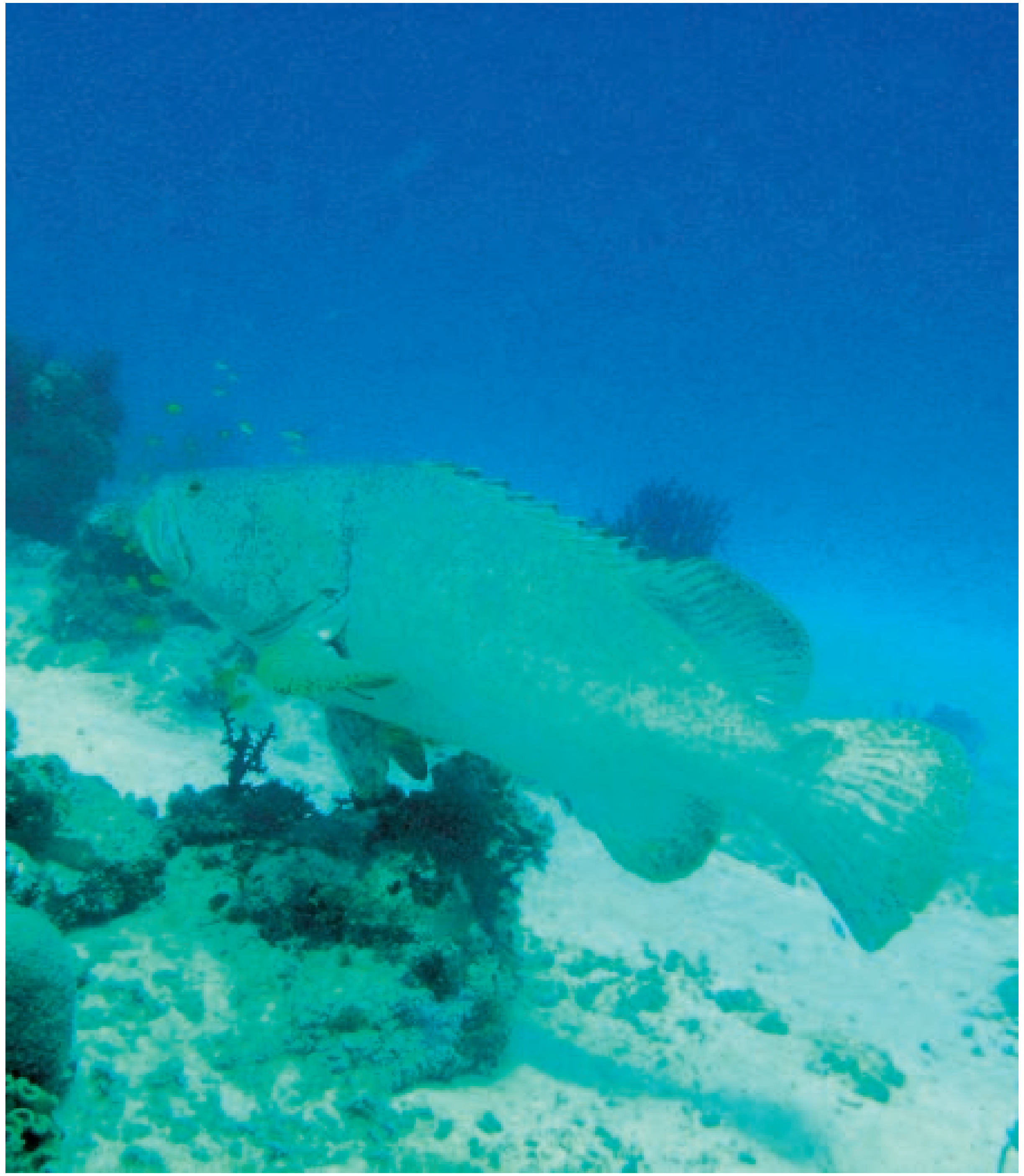
Distribuição: Africa oriental até as ilhas Cocos e Natal. Norte até ao mar de Andaman (Fishbase, 2000).

Ecology: In large shoals, in «heads» of protruding coral. Territorial males with harem. From 2-20 m (Lieske, 1994).

Distribution: Indian Ocean: East Africa to the Cocos-Keeling and Christmas islands, north to the Andaman Sea (Fishbase, 2000).

11. Garoupas | Groupers

as rainhas do azul | Queens of the blue



A família epinephelidae tem membros em águas temperadas e tropicais. São demersais e sedentários, alguns formam enormes grupos para se reproduzir, outros formam pequenos haréns. Quase sempre territoriais, gostam das zonas rochosas e coralinas. Gostam especialmente de grutas e navios afundados. As várias espécies de garoupas distribuem-se por diferentes profundidades até 300 metros. São predadores de topo e quase sempre piscívoros. Por esta razão, são muito suscetíveis à cigaterra e nas regiões afetadas por este organismo deve evitar-se comê-las. Estes peixes são muito apreciados pela sua carne saborosíssima e em quase todos os países são um prato favorito. Em Moçambique, são apanhadas pelo pescador submarino e na pesca à linha. Em Cabo Delgado são chamados de Kichewa, cabeça grande. Dentro de áreas protegidas podem rapidamente tornar-se familiares dos mergulhadores «perseguindo-os» durante o mergulho. Apesar da tentação de fazer «umas festinhas» a este animal aparentemente tão carinhoso, não se esqueça que se trata de um animal selvagem. Ao fazermos uma festinha estamos a tirar muco e abrir uma porta de entrada para bactérias. Além disso ao criarmos esta proximidade estamos a interferir com os comportamentos «defensivos» do animal: o próximo humano pode ser um caçador submarino.

Epinephelidae family lives in tropical to temperate waters. They are sedentary and demersal, some gather in huge groups for reproduction, others form small harems. Mostly territorial, they prefer coral and rocky areas. They are especially fond of caves and sunken ships. Different species live in different depths till 300m. They are top predators and nearly always piscivorous. That's the reason why they are very sensitive to ciguatoxin. Being so in areas affected by this organism one should not eat them. These fishes are highly appreciated for being very tasty; they are a favorite dish in nearly every country where available. In Mozambique, they're caught either by divers or anglers. In Cabo Delgado groupers are called «kichewa» (Big head). In protected areas they easily become familiar with the divers «swimming» along with them. If you feel tempted to «cuddle» such a nice animal, please do not forget that they are wild animals. When you touch them you are taking away mucous thus opening a gateway to bacteria. Besides when we create this sort of empathy we are interfering with the defensive behavior of the animal: The next human can be fisherman.

11.1. *Epinephelus Lanceolatus*

Nome Científico | Cientific Name • *Epinephelus Lanceolatus* (Bloch, 1790)
Nome Inglês | English Name • Giant grouper
Nome Português | Portuguese Name • Garoupa gigante
Nome Francês | French Name • Mérou lancéolé

Ecologia: Lagoas e em recifes virados ao oceano, em torno dos 100 m. Muitas vezes ocorrem em cavernas ou naufrágios. Juvenis podem ocorrer em águas salobras, adultos em estuários profundos. Alimentam-se de peixes, grandes crustáceos, como lagostas e até pequenos tubarões e tartarugas marinhas de grande porte, muitas vezes ciguatoxico (portador da poderosa toxina ciguaterra que envenena o homem) . Relatos não confirmados de ataques fatais em humanos, raro, quase dizimado em áreas de sobre pesca (Lieske, 1994).

Distribuição: Indo-Pacífico: Mar Vermelho até baía de Algoa, África do Sul, Havaí e ilhas Pitcairn. Desde o sul do Japão até à Austrália. A ausência no Golfo Pérsico é intrigante (Fishbase, 2000).

Ecology: Lagoons and the ocean-facing reef, around 100 m. Often occur in caves or wrecks. Juveniles may occur in brackish waters. Adults, in deep estuaries. Feeds on fish, large crustaceans, such as lobsters and even small sharks and turtles, often ciguatoxics (bearer of the powerful toxin ciguatoxin which poisons the man). Unconfirmed reports of fatal attacks on humans, rare, almost wiped out in fishing areas (Lieske, 1994)..

Distribution: Indo-Pacific: Red Sea to Algoa Bay, South Africa and eastward to the Hawaiian and Pitcairn islands, north to southern Japan, south to Australia. Absence in the Persian Gulf is puzzling (Fishbase, 2000).

11.2. *Epinephelus tukula*

Nome Científico | Cientific Name • *Epinephelus tukula* (Morgans, 1959)
Nome Inglês | English Name • Potato grouper
Nome Português | Portuguese Name • Garoupa batata
Nome Francês | French Name • Mérou patate

Ecologia: Locais com riqueza de coral, até águas rasas de 150 m. Alimentam-se principalmente de peixes, ocasionalmente de crustáceos e cefalópodes. Rara e localizada, mas atrevida e facilmente abordada. Alimentados por mergulhadores em determinadas áreas, mas potencialmente perigosos para os inexperientes. Um mergulhador afogou-se depois de ser batido no peito por um indivíduo grande (Lieske, 1994).

Distribuição: Indo-Pacífico Ocidental: Mar Vermelho e leste da África, ao sul do Japão e Queensland, na Austrália. Também a partir das Ilhas Paracel no Mar da China Meridional. Não há registos em Madagáscar, Maurícias, Maldivas, Laccadives e Sri Lanka, Indonésia e Filipinas (Fishbase, 2000).

Ecology: Coral-rich local, nearshore of 150 m. Feeds mainly on fish, crustaceans and occasionally cephalopods. Rare and localized, but bold and easily addressed. Fed by divers in certain areas, but potentially dangerous for the inexperienced. A diver drowned after being hit in the chest by a large individual (Lieske, 1994).

Distribution: Indo-West Pacific: Red Sea and East Africa to southern Japan and Queensland, Australia. Also from the Paracel Islands in the South China Sea. There are no records from Madagascar, Mauritius, Maldives, Laccadives, and Sri Lanka, Indonesia, and the Philippines (Fishbase, 2000).

Epinephelus tukula
(Garoupa parada na areia em posição não habitual)

11.3. *Epinephelus fuscoguttatus*

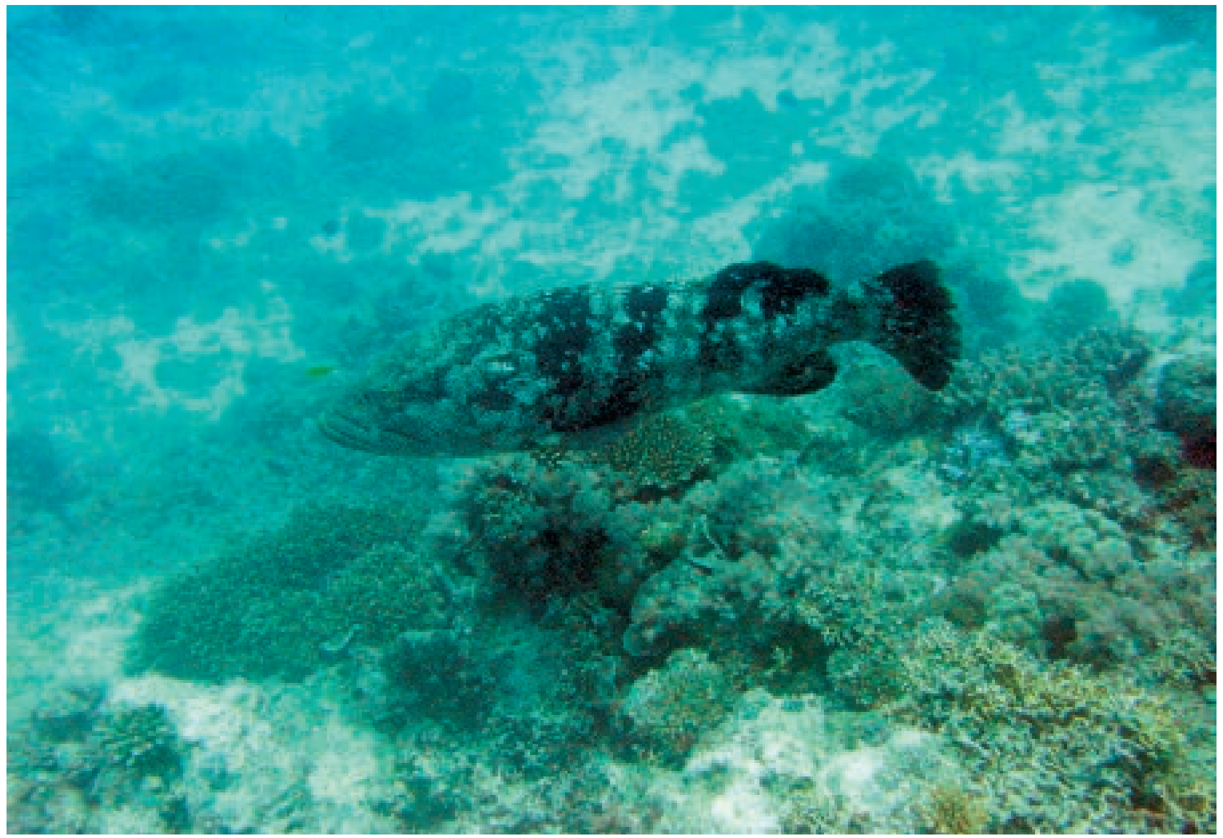
Nome Científico | Cientific Name • *Epinephelus fuscoguttatus* (Forsskal, 1775)
Nome Inglês | English Name • Brown-marbled grouper
Nome Português | Portuguese Name • Garoupa de marmore
Nome Francês | French Name • Mérou marron

Ecologia: Lagoas e em recifes virados ao oceano, em áreas com rico crescimento de corais e águas claras, 1 a 60 m. Pouco comum e timido. Alimenta-se de peixes, crustáceos, e cefalópodes. Pode ser ciguatoxico (Lieske, 1994).

Distribuição: Indo-Pacífico: Mar Vermelho e África Oriental até Samoa e Ilhas Phoenix. Desde o Japão até à Austrália. Desconhecido no Golfo Pérsico, Havaí e Polinésia Francesa. Muitas vezes confundido com *Epinephelus polyphekadion* (= *Epinephelus microdon* de autores recentes) (Fishbase, 2000).

Ecology: Lagoons and reefs facing the ocean, in areas with rich coral growth and clear waters, from 1 to 60 m. Uncommon and shy. It feeds on fish, crustaceans, and cephalopods. Can be ciguatoxic (Lieske, 1994).

Distribution: Indo-Pacific: Red Sea and East Africa to Samoa and the Phoenix Islands, north to Japan, south to Australia. Unknown from the Persian Gulf, Hawaii, and French Polynesia. Often confused with Epinephelus polyphekadion (=Epinephelus microdon of recent authors) (Fishbase, 2000).



11.4. *Epinephelus hexagonatus*

Nome Científico | Cientific Name • *Epinephelus hexagonatus* (Forster, 1801)
Nome Inglês | English Name • Starpotted grouper
Nome Português | Portuguese Name • Garoupa de manchas estreladas
Nome Francês | French Name • Mérou mélifère

Ecologia: Recifes rasos exteriores e lagoas de águas claras e em recifes virados ao oceano, geralmente encontrada em menos de 6 m (Lieske, 1994).

Distribuição: Indo-Pacífico Ocidental: nenhuma foi observada na costa Africana, exceto para espécime registadas por Randall e Heemstra 1991 no litoral Queniano no norte de Kilifi Creek. É uma espécie insular encontrada na sua maioria nas ilhas tropicais do Indo-Pacífico. Ausente no Mar Vermelho e no Golfo Pérsico (Fishbase, 2000).

Ecology: luter reef flats, clear water lagoons and reefs facing the ocean, generally found on less than 6 m (Lieske, 1994).

Distribution: Indo-West Pacific: none have been taken on the African coast, except for the specimen recorded by Randall and Heemstra 1991 from Kenyan coast north of Kilifi Creek. It is an insular species found in most tropical Indo-Pacific islands. Absent in the Red Sea and Persian Gulf (Fishbase, 2000).

11.5. *Epinephelus spilotoceps*

Nome Científico | Cientific Name • *Epinephelus spilotoceps* (Schultz, 1953)
Nome Inglês | English Name • Foursaddle grouper
Nome Português | Portuguese Name • garoupa de 4 riscas
Nome Francês | French Name • Mérou quatre selles

Ecologia: Recifes rasos exteriores e lagoas rasas e em recifes virados ao oceano até aos 30 m (Lieske, 1994).

Distribuição: Indo-Oeste-Pacifico: costa leste de África, até às Ilhas Linha. Exceto a sua ocorrência ao longo da costa Africana (Zanzibar, Tanzânia até Ponta Závora, Moçambique) parece ser principalmente uma espécie insular, ocorrendo na maior parte (provavelmente todas) as ilhas do Índico tropical e no centro-oeste do Pacífico. Não é conhecido no Mar Vermelho, Golfo Pérsico, Sri Lanka, Filipinas, Taiwan, Japão, ou em águas australianas (no entanto, ele é encontrado em Rowley Shoals ao largo da Austrália Ocidental) (Fishbase, 2000).

Ecology: Reef flats and shallow lagoons, coral reefs on the ocean-facing up to 30 m (Lieske, 1994).

Distribution: Indo-West-Pacific: East coast of Africa to the Line Islands. Except for its occurrence along the African coast (Zanzibar, Tanzania to Ponta Zavora, Mozambique) it seems to be primarily an insular species, occurring at most (probably all) of the islands of tropical Indian and west-central Pacific. Not known from the Red Sea, Persian Gulf, Sri Lanka, Philippines, Taiwan, Japan, or Australian waters (however, it is found at Rowley Shoals off Western Australia) (Fishbase, 2000).

11.6. *Epinephelus polyphekadion*

Nome Científico | Cientific Name • *Epinephelus polyphekadion* (Bleeker, 1849)
Nome Inglês | English Name • Camouflage grouper
Nome Português | Portuguese Name • Garoupa camuflada
Nome Francês | French Name • Mérou camouflage

Ecologia: Lagoas de águas claras e em recifes virados ao oceano, em áreas ricas em crescimento de coral de 1 a 46 m. Alimenta-se principalmente de crustáceos, ocasionalmente de peixes. Bastante comum (Lieske, 1994).

Distribuição: Indo-Pacífico: Mar Vermelho e costa leste de África até à Polinésia Francesa. No Pacífico ocidental distribui-se desde o sul do Japão até ao sul de Queensland e ilha Lord Howe. Muitas vezes confundido com *Epinephelus fuscoguttatus* (Fishbase, 2000).

Ecology: Clear water lagoons and reefs facing the ocean, in areas rich in coral growth of 1 to 46 m. Feeds mostly on crustaceans, fish occasionally. Quite common (Lieske, 1994).

Distribution: Indo-Pacific: Red Sea and east coast of Africa to French Polynesia. In the western Pacific it ranges from southern Japan to southern Queensland and Lord Howe Island. Often confused with Epinephelus fuscoguttatus (Fishbase, 2000).

11.7. *Epinephelus flavocaeruleus*

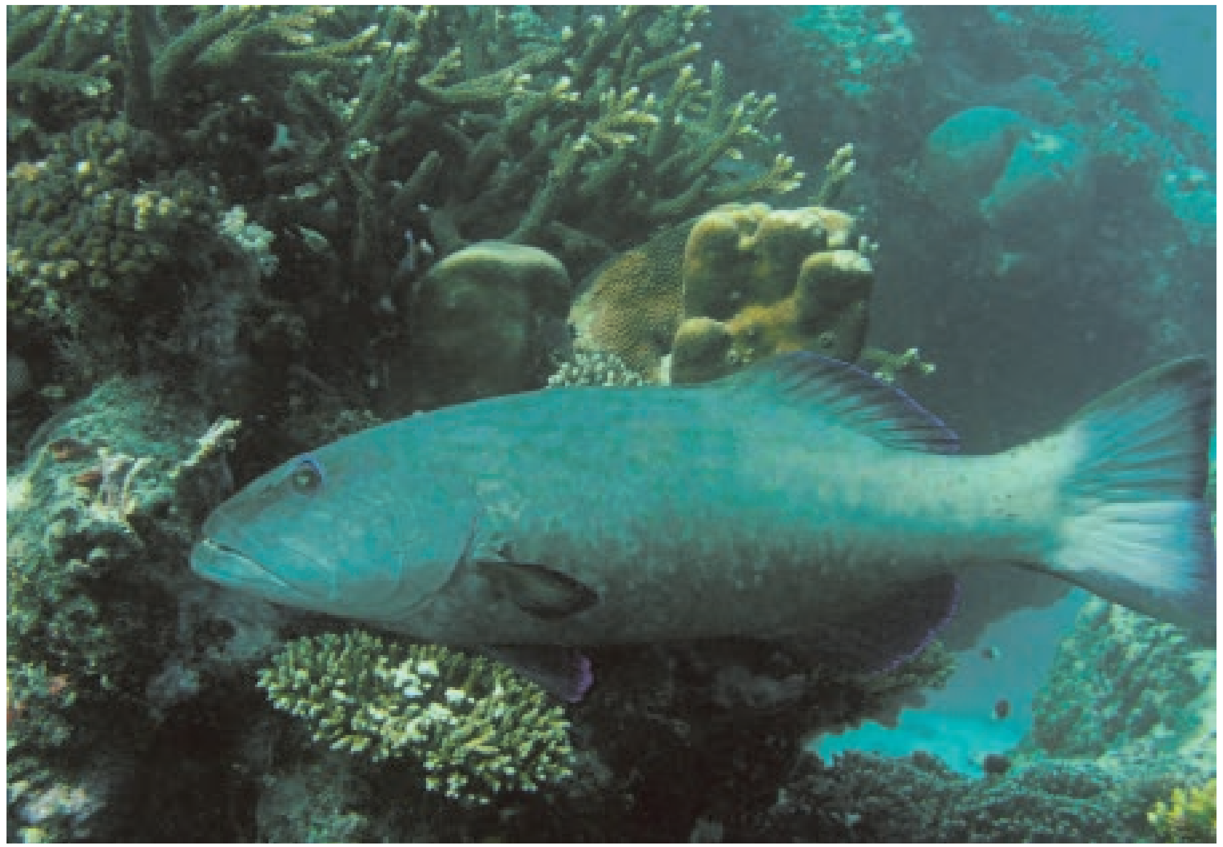
Nome Científico | Cientific Name • *Epinephelus flavocaeruleus* (Lacepéde, 1802)
Nome Inglês | English Name • Blue-and-Yellow grouper
Nome Português | Portuguese Name • Garoupa azul e amarela
Nome Francês | French Name • Mérou faraud

Ecologia: Rochas e recifes de coral de 10 a 150 m. Juvenis superficiais, adultos geralmente de profundidade. Alimentam-se principalmente de peixes, ocasionalmente de crustáceos e cefalópodes (Lieske, 1994).

Distribuição: Oceano Índico: Golfo de Aden até ao sul de Porto Alfredo, África do Sul e noroeste da ilha de Sumatra na Indonésia. Também encontrado nas ilhas do oeste do Oceano Índico, incluindo Cargados, Carajos e Rodriguez. Não conhecido no Mar Vermelho e no Golfo Pérsico (Fishbase, 2000).

Ecology: Rocky or coral reefs, from 10 to150m. Juveniles in shallow water, adults general deeper. Feeds primarily on fishes.

Distribution: Indian Ocean: Gulf of Aden south to Port Alfred, South Africa and east to the northwest tip of Sumatra, Indonesia. Also found in the islands of western Indian Ocean, including Cargados Carajos and Rodriguez. Not known from the Red Sea and Persian Gulf (Fishbase, 2000).



11.8. *Cephalopholis miniata*

Nome Científico | Cientific Name • *Cephalopholis miniata* (Forsskal,1775)
Nome Inglês | English Name • Coral hind
Nome Português | Portuguese Name • Garoupa de coral
Nome Francês | French Name • Vieille étoilée

Ecologia: Canais e em recifes virados ao oceano em áreas com riqueza de corais e águas claras, 2 a 150 m. Alimentam-se principalmente de peixes, ocasionalmente de crustáceos. Geralmente comum (Lieske, 1994).

Distribuição: Indo-Pacífico: Mar Vermelho a Durban, Áfricado Sul e Ilhas Linha, incluindo a maioria das ilhas do oceano Índico e centro-oeste Pacífico. Ausente no Golfo Pérsico e no Golfo de Omã. Identificado erroneamente como *Cephalopholis cyanostigma* em Reunião (Fishbase, 2000).

Ecology: Channels and reefs facing the ocean in coral-rich areas and clear waters, of 2 to 150 m. Feeds mainly on fish, occasionally crustaceans. Generally common (Lieske, 1994).

Distribution: Indo-Pacific: Red Sea to Durban, South Africa and eastward to the Line Islands; including most islands in the Indian and west-central Pacific oceans. Absent from Persian Gulf and Gulf of Oman. Misidentified as *Cephalopholis cyanostigma* from Reunion (Fishbase, 2000).

11.9. *Cephalopholis argus*

Nome Científico | Cientific Name • *Cephalopholis argus* (Schneider, 1801)
Nome Inglês | English Name • Peacock hind
Nome Português | Portuguese Name • Garoupa de coral
Nome Francês | French Name • Prude ou Vieille cuisinier

Ecologia: Lagoas e recifes virados ao oceano, maiores ou iguais a 40 m, áreas de águas claras e ricas em crescimento coralino. Juvenis usualmente em águas rasas com cobertura de coral. Alimentam-se principalmente de peixes. Ciguatoxicos em certas áreas. Comum em muitas áreas exceto mar vermelho (Lieske, 1994).

Distribuição: Indo-Pacífico: Mar Vermelho a Durban, África do Sul, Polinésia Francesa e grupo de Pitcairn. Desde as ilhas Ryukyu e Ogasawara, até ao norte da Austrália e ilha de Lord Howe. Pode ser confundida com *Cephalopholis cyanostigma* (Fishbase, 2000).

Ecology: Lagoons and reefs facing the ocean, greater than or equal to 40 m, areas of clear water and rich in coralline growth. Juveniles, usually in shallow waters with coral coverage. Feed mainly on fish. Ciguatoxics in certain areas. Common in many areas except the Red Sea (Lieske, 1994).

Distribution: Indo-Pacific: Red Sea to Durban, South Africa and eastward to French Polynesia and the Pitcairn group, north to the Ryukyu and Ogasawara islands, south to northern Australia and Lord Howe Island. May be confused with *Cephalopholis cyanostigma* (Fishbase, 2000).

11.10. *Variola albomarginata*

Nome Científico | Cientific Name • *Variola albomarginata* (Baissac, 1953)
Nome Inglês | English Name • White-edged lyretail
Nome Português | Portuguese Name • Garoupa de cauda branca
Nome Francês | French Name • Croissant queue blanche

Ecologia: Recifes virados ao oceano de 2 a 100 m. Raramente acima de 20 m. Incomum (Lieske, 1994).

Distribuição: Indo-Pacífico: costa leste de África (Zanzibar e ilha de Mafia, Tanzânia) até Samoa. Desde as Ilhas Ryukyu até Queensland, na Austrália (Fishbase, 2000).

Ecology: The ocean-facing reefs from 2 to 100 m. Rarely above 20 m. Uncommon (Lieske, 1994).

Distribution: Indo-Pacific: east coast of Africa (Zanzibar and Mafia Island, Tanzania) to Samoa, north to Ryukyu Islands, south to Queensland, Australia (Fishbase, 2000).

11.11. *Variola louti*

Nome Científico | Cientific Name • *Variola louti* (Forsskal, 1775)
Nome Inglês | English Name • Yellow-edged lyretail
Nome Português | Portuguese Name • Garoupa de cauda amarela
Nome Francês | French Name • Croissant quele jaune

Ecologia: Lagoas ricas em coral e recifes virados ao oceano de 1-150 m. Alimenta-se principalmente de peixes, ocasionalmente de crustáceos. Comum em muitas áreas. Talvez ciguatoxico em certas áreas (Lieske, 1994).

Distribuição: Indo-Pacífico: Mar Vermelho até África do Sul e Ilhas Pitcairn. Desde o sul do Japão, ao sul de New South Wales, na Austrália. Não foi encontrado no Golfo Pérsico, nem no Havaí (Fishbase, 2000).

Ecology: Coral-rich lagoons and reefs facing the ocean, greater than or equal to 150 m. Feeds mainly on fish, occasionally crustaceans. Common in many areas. Perhaps ciguatoxic in certain areas (Lieske, 1994).

Distribution: Indo-Pacific: Red Sea to South Africa and the Pitcairn Islands, north to southern Japan, south to New South Wales, Australia. Not found in the Persian Gulf or in Hawaii (Fishbase, 2000).

11.12. *Plectropomus laevis*

Nome Científico | Cientific Name • *Plectropomus laevis* (Lacepéde, 1801)
Nome Inglês | English Name • Blacksaddled coral grouper
Nome Português | Portuguese Name • Garoupa de listas pretas
Nome Francês | French Name • Babone ou mérou sellé

Ecologia: Lagoas ricas em coral e recifes virados ao oceano de 4 a 90 m. Encontram-se frequentemente em canais. Podem comer grandes peixes. Muitas vezes ciguatoxico em muitas áreas. Geralmente cauteloso (Lieske, 1994).

Distribuição: Indo-Pacífico: Do Quénia até Baia de Maputo, Moçambique, e Ilhas Tuamotu. Desde as ilhas Ryukyu até Queensland na Austrália, incluindo a maioria das ilhas do Oceano Índico e do Pacífico Ocidental e Central. Desconhecido no Mar Vermelho e no Golfo Pérsico. Identificado erroneamente como *Plectropomus maculatus* por alguns autores (Fishbase, 2000).

Ecology: Coral-rich lagoons and reefs facing the ocean, from 4 to 90 m. Uften find themselves in channels. Can eat surprisingly large fish. Often ciguatoxic in many areas. Usually cautious (Lieske, 1994).

Distribution: Indo-Pacific: Kenya to Delagoa Bay, Mozambique, eastward to the Tuamoto Islands, north to the Ryukyu Islands, south to Queensland, Australia and including most islands of the Indian Ocean and of western and central Pacific. Unknown in the Red Sea and Persian Gulf. Misidentified as *Plectropomus maculatus* by some authors (Fishbase, 2000).

11.13. *Gracila albomarginata*

Nome Científico | Cientific Name • *Gracila albomarginata* (Fowler & Bean, 1930)
Nome Inglês | English Name • Maked grouper
Nome Português | Portuguese Name • Garoupa
Nome Francês | French Name • Mérou bord rouge

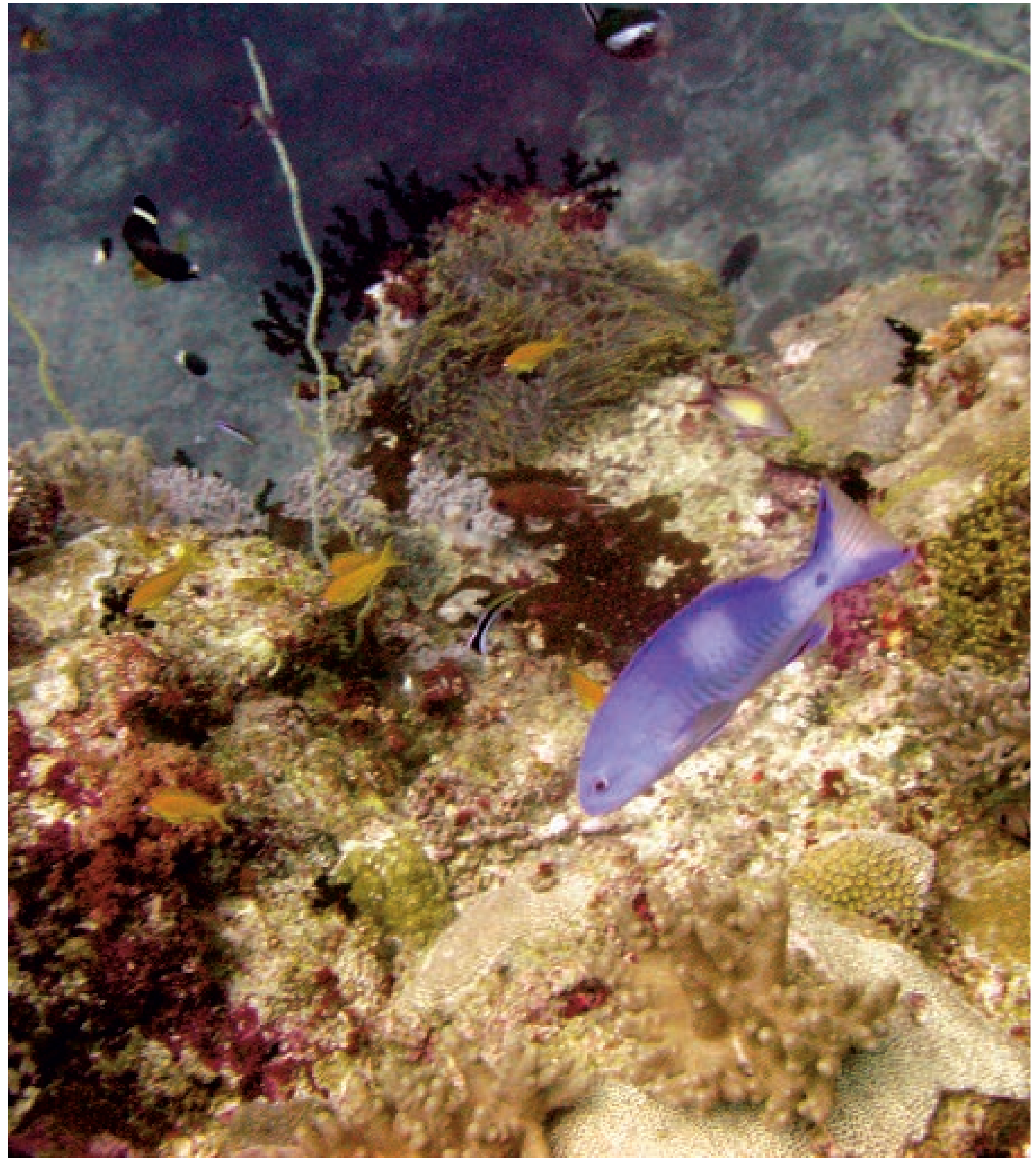
Ecologia: Em águas claras junto a inclinações exteriores do recife. Declives ricos particularmente de coral de 6 a 120, mas geralmente abaixo dos 15m. Paira sobre o fundo e provavelmente alimenta-se de peixes (Lieske, 1994).

Distribuição: Indo-Pacífico: norte de Moçambique, até Polinésia Francesa. Desde Okinawa até ao norte da Grande Barreira de Coral. Desconhecido no Mar Vermelho e no Golfo Pérsico (Fishbase, 2000).

Ecology: In clear waters along the outer reef slopes. Rich coral slopes 6 to 120 m, but generally under 50 feet. Hanging over the bottom and probably feeds on fish (Lieske, 1994).

Distribution: Indo-Pacific: northern Mozambique to French Polynesia, north to Okinawa, south to the northern Great Barrier Reef. Unknown from the Red Sea and Persian Gulf. Recorded from Europa Island (Fishbase, 2000).

Gracila albomarginata (adulto)



Gracila albomarginata (juvenil)

12. Peixes falcões | Hawkfishes

suspensos nos corais | perched upon corals

Estão normalmente pousados em cima de uma cabeça de coral. As suas poderosas barbatanas peitorais permitem-lhes fazer arranques rápidos e assim apanharem as suas presas desprotegidas. À noite, dormem no meio dos ramos dos corais. Algumas espécies são monogâmicas, mas a maioria forma pequenos haréns na altura da reprodução. São hermafroditas protogínicos: começam a sua vida como fêmeas e acabam como machos. Não são considerados um recurso pesqueiro devido ao seu tamanho diminuto e fraca densidade.

They are usually perched upon a coral head. Their powerful pectoral fins allow them quick moves in order to catch their prey unprotected. At night, they sleep among the coral branches. Some species are monogamous but most of them join in small harems for reproduction. They are protogynous hermaphrodites: they start their lives as females and they may change into males. They are not considered a fishing resource due to their small size and low density.

12.1. *Paracirrhites arcatus*

Nome Científico | Cientific Name • *Paracirrhites arcatus* (Cuvier, 1829)
Nome Inglês | English Name • Arc-eye hawkfish
Nome Português | Portuguese Name • Peixe falcão
Nome Francês | French Name • Épervier strié

Ecologia: Lagoas de águas claras e recifes virados ao oceano de 1 a 33m. Tipicamente parado em pequenas cabeças de corais stylophora, pocilopora e acropora. Alimenta-se fundamentalmente de crustáceos.

Distribuição: Indo-Pacífico: África Oriental até ao Havai, Ilhas Linha e Mangareva. Desde o sul do Japão até à Austrália e Rapa (Fishbase, 2000).

Ecology: Clear water lagoons and reefs of ocean-facing 1 to 33 m. Typically perches in small coral heads, genera: pocilopora, acropora and stylophora. It feeds mainly on crustaceans.

Distribution: Indo-Pacific: East Africa to the Hawaiian, Line and Mangaréva islands, north to southern Japan, south to Australia and Rapa (Fishbase, 2000).

12.2. *Paracirrhites forsteri*

Nome Científico | Cientific Name | Cientific Name • *Paracirrhites forsteri* (Schneider, 1801)
Nome Inglês | English Name | English Name • Blackside hawkfish
Nome Português | Portuguese Name • Peixe falcão
Nome Francês | French Name • Épervier à tête ponctuée

Ecologia: Lagoas de águas claras e recifes virados ao oceano de 1 a 33 m. Tipicamente parado em pequenas cabeças de corais stylophora, pocilopora e acropora. Alimenta-se fundamentalmente de pequenos peixes e camarão. Comum na maior parte da sua distribuição.

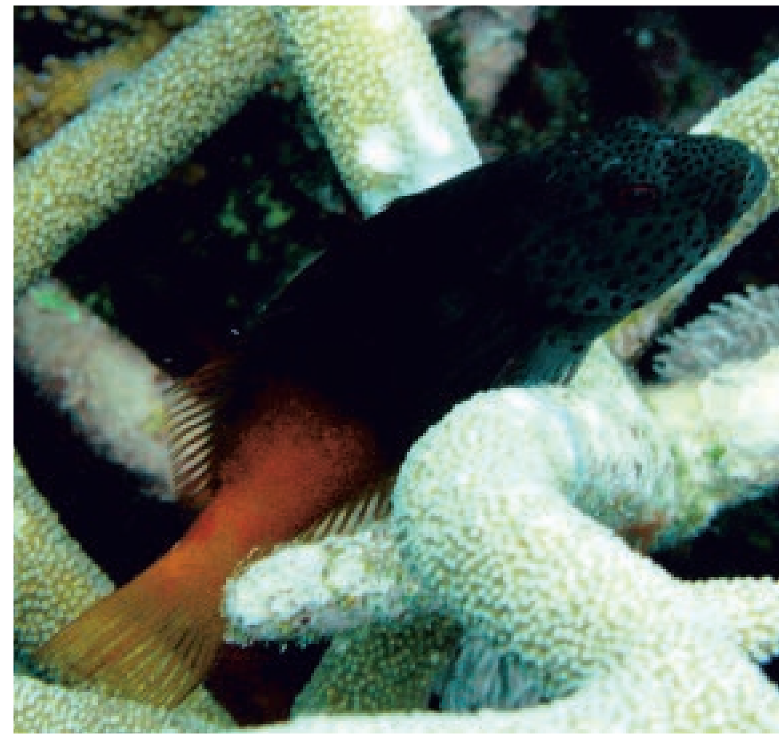
Distribuição: Indo-Pacífico: Mar Vermelho e África Oriental até Havai, ilhas Linha, Marquesas e Ducie. Desde o sul do Japão até Nova Caledónia e Ilhas Austrais. Desconhecido no Golfo Pérsico e de Omã (Fishbase, 2000).

Ecology: Clear water lagoons and reefs of ocean-facing 1 to 33 m. Typically perches in small coral heads of genera: pocilopora, acropora and stylophora. It mainly feeds on small fish and shrimp. Common in most of its distribution.

Distribution: Indo-Pacific: Red Sea and East Africa to the Hawaiian, Line, Marquesan and Ducie islands, north to southern Japan, south to New Caledonia and the Austral Islands. Unknown from the Persian and Oman gulfs (Fishbase, 2000).

Paracirrhites forsteri (Variedade clara)

Paracirrhites forsteri (Variedade escura)



13. Fuzileiros | Fusiliers

os pelotões dos corais | the coral platoons

Na sua maioria são peixes de pequeno tamanho, nadadores ativos, que se deslocam em grupos grandes na procura das suas presas planctónicas, tanto à superfície da água como junto ao fundo. À noite aproximam-se do fundo e repousam em fendas e grutas nos recifes de coral. A reprodução dá-se em plena água, ovos e larvas são planctónicos. São um recurso pesqueiro importante. Apanhados com quase todos os tipos de arte de pesca, desde a linha, arrasto, cerco emalhar, pesca submarina, etc.

They mostly are small fishes and active swimmers that move in large groups, both at the surface of the water as well as close to the bottom, in search of their planktonic prey. At night, they get close to the sea bottom and rest in crevices and caves in the coral reefs. Reproduction occurs in full water, eggs and larvae are planktonic. They are an important fishery resource, caught with almost all types of fishing gear, line, trawl, seine nets, spear fishing, etc…

13.1. *Caesio xanthonota*

Nome Científico | Cientific Name • *Caesio xanthonota* (Bleeker, 1853)
Nome Inglês | English Name • Yellowback fusilier
Nome Português | Portuguese Name • Fuzileiro de crista amarela
Nome Francês | French Name • Fusilier à dos jaune

Ecologia: Em cardumes em águas médias de lagoas profundas e ao longo dos recifes (Lieske, 1994).

Distribuição: Oceano Índico: África Oriental (não incluindo o Mar Vermelho ou o Golfo Pérsico) até à Indonésia. Registos desta espécie nas ilhas Marshall e a Austrália são provavelmente confundidos com *Caesio teres* (Fishbase, 2000).

Ecology: Schools in medium deep lagoons and waters along the reefs (Lieske, 1994).

Distribution: Indian Ocean: East Africa (not including the Red Sea or the Arabian (Persian) Gulf) to Indonesia. Records of this species from the Marshall Islands and Australia are probably misidentifications of *Caesio teres* (Fishbase, 2000).

13.2. *Caesio lunaris*

Nome Científico | Cientific Name • *Caesio lunaris* (Cuvier, 1830)
Nome Inglês | English Name • lunar fusilier
Nome Português | Portuguese Name • Fuzileiro
Nome Francês | French Name • Caesio à croissant

Ecologia: Muito mais comum ao longo dos recifes íngremes do que em lagoas. Em grandes cardumes (Lieske, 1994).

Distribuição: Indo-Pacífico Ocidental: MMar Vermelho, Golfo Pérsico e Africa oriental até ás Ilhas Salomão e o sul do Japão (Fishbase, 2000).

Ecology: Much more common along the steep reefs than in lagoons. In large shoals (Lieske, 1994).

Distribution: Indo-West Pacific: Red Sea, Persian Gulf and East Africa to the Solomon Islands, north to southern Japan (Fishbase, 2000).

13.3. *Pterocasesio tile*

Nome Científico | Cientific Name • *Pterocasesio tile* (Cuvier, 1830)
Nome Inglês | English Name • Dark-banded fusilier
Nome Português | Portuguese Name • Fuzileiro de listas pretas
Nome Francês | French Name • Caesio tricolore

Ecologia: Em cardumes, em águas médias de lagoas profundas e ao longo dos recifes. Juvenis ocasionalmente aparecem em grande número em lagoas rasas e recifes planos (Lieske, 1994).

Distribuição: Indo-Pacifico: Leste da Africa, não incluindo o Mar Vermelho ou Golfo Pérsico até ao arquipélago Tuamotu. Desde o sul do Japão até às Maurícias e as Ilhas Austrais (Fishbase, 2000).

Ecology: In schools, on average deep lagoons and water over the reef. Juveniles appear occasionally in large numbers in shallow lagoons and reefs plans (Lieske, 1994).

Distribution: Indo-Pacific: East Africa, not including the Red Sea or the Arabian (Persian) Gulf, to the Tuamoto Archipelago, as far north as southern Japan and south to Mauritius and the Austral Islands (Fishbase, 2000).

13.4. *Pterocaesio diagramma*

Nome Científico | Cientific Name • *Pterocaesio diagramma* (Bleeker, 1864)
Nome Inglês | English Name • Double-lined fusilier
Nome Português | Portuguese Name • Fuzileiro de duas linhas
Nome Francês | French Name • Fusilier à deux bandes jaunes

Ecologia: Em cardumes em águas médias de lagoas profundas e ao longo dos recifes (Lieske, 1994).

Distribuição: Ocidental Pacifico: Indonésia e oeste da Austrália até à Nova Caledónia, a norte desde o sul do Japão. Relatado recentemente na Ilha Norfolk e Tonga. Relatos em Reunião são provavelmente um erro de identificação de *Pterocaesio marri* (Fishbase, 2000).

Ecology: Schools in medium deep lagoons and waters along the reefs (Lieske, 1994).

Distribution: Western Pacific: Indonesia and western Australia to New Caledonia, north to southern Japan. Recently reported from Norfolk Island and Tonga. Report from Réunion is probably a misidentification of *Pterocaesio marri* (Fishbase, 2000).

14. Salmonetes | Goat fishes

os barbudos da areia | beards in the sand

Os salmonetes são conhecidos pelas suas barbilhas que lhe dão o nome de peixe cabra em inglês. Esta família, numerosa e de importância para a pesca, espalha-se pelos mares temperados e tropicais e por diferentes profundidades. Eles procuram, dentro da areia, pequenos crustáceos e invertebrados com a ajuda das suas barbichas. Algumas espécies têm uma fase juvenil pelágica, em grupo, mas a maioria é solitária ou agrupa-se em pequenos números sobre vários tipos de substrato, conforme a espécie.

Goat fishes are known for their barbells which inspired their name. This is a big and important family to the fishery, which spreads through temperate and tropical seas and at different depths. With the help of their barbels, they look for small crustaceans and invertebrates in the sand. Some species have a pelagic juvenile phase, in group, but most of them is solitary or gathers in small groups and on the top of different substrates, according with the species.

14.1. *Parupeneus trifasciatus*

Nome Científico | Cientific Name • *Parupeneus trifasciatus* (Lacepéde, 1801)
Nome Inglês | English Name • Doublebar goatfish
Nome Português | Portuguese Name • Salmonete de duas barras
Nome Francês | French Name • Capucin manuel

Ecologia: Lagoas e recifes virados ao oceano de 1 a 80m. Muitas vezes a descansar nos corais de dia. Alimenta-se de crustáceos de dia, e de peixes e larvas de caranguejos a noite (Lieske, 1994).

Distribuição: Incluídos no complexo *Parupeneus trifasciatus* são: *Parupeneus trifasciatus* do Oceano Índico; *Parupeneus crassilabris* do leste do Oceano Índico e do Pacífico Ocidental, desde Fiji, Tonga e as Ilhas Caroline a leste; e *Parupeneus insularis* das ilhas mais orientais da Oceânia (Fishbase, 2000).

Ecology: Lagoons and reefs of ocean-facing 1 to 80 m. Often resting on the corals of day. Feeds on crustaceans, fish and crab larvae at night (Lieske, 1994).

Distribution: Included in the Parupeneus trifasciatus complex are: Parupeneus trifasciatus from the Indian Ocean; Parupeneus crassilabris from eastern Indian Ocean and the western Pacific, east to Fiji, Tonga, and the Caroline Islands; and Parupeneus insularis from the more eastern islands of Oceania (Fishbase, 2000).

14.2. *Parupeneus barberinus*

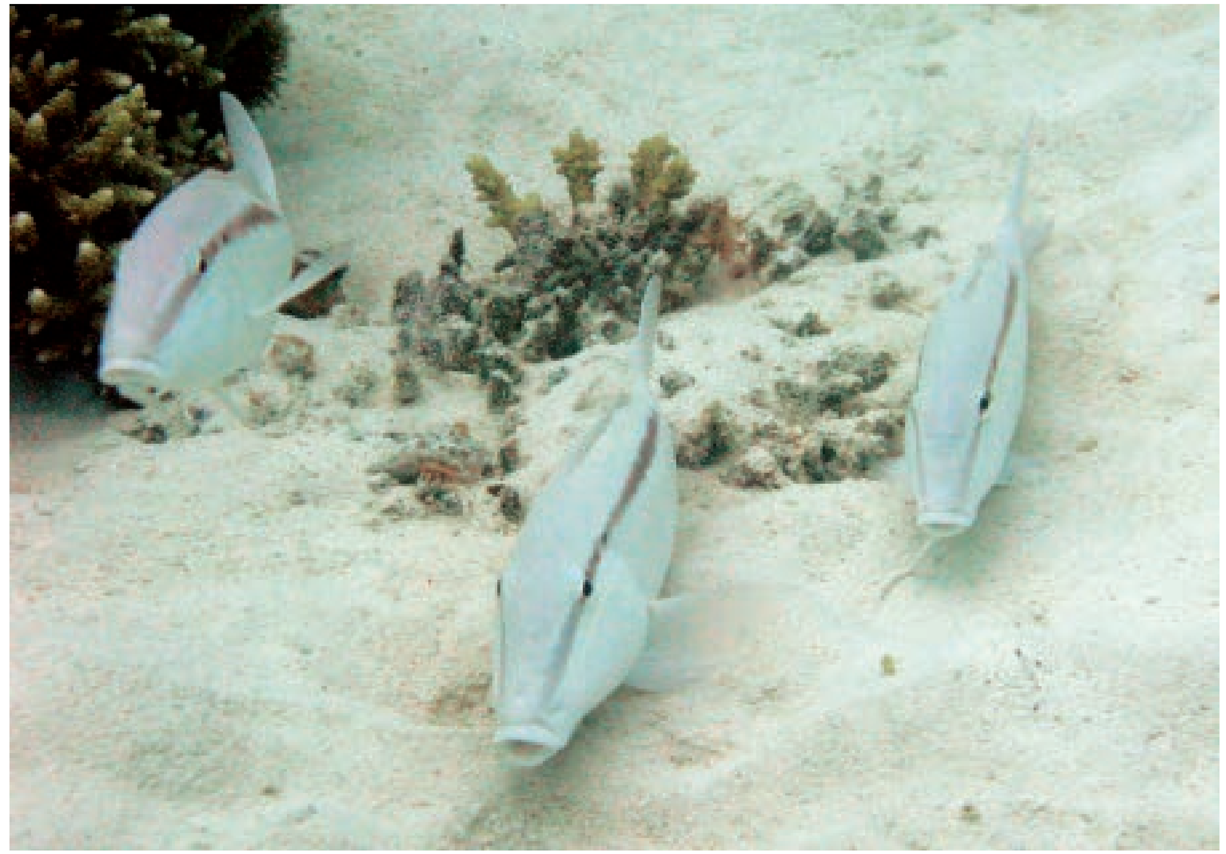
Nome Científico | Cientific Name • *Parupeneus barberinus* (Lacepéde, 1801)
Nome Inglês | English Name • Dash-and-dot goatfish
Nome Português | Portuguese Name • Salmonete com pintas
Nome Francês | French Name • Capucin barberin

Ecologia: Em áreas de areia de recifes rasos, lagoas e recifes virados ao oceano até aos 100 m. Forageia em pequenos grupos de dia. Comum (Lieske, 1994).

Distribuição: Indo-Pacífico: Golfo de Aden e Omã, até à Baia Mossel, África do Sul, a leste até às ilhas da Micronésia, ilhas Linha, Ilhas Marquesas, Arquipélago Tuamotu; desde o sul do Japão até à Austrália e Nova Caledónia. (Fishbase, 2000).

Ecology: In sandy areas of shallow reefs, lagoons and reefs facing the ocean up to 100 m. Forages in small groups during the day. Common (Lieske, 1994).

Distribution: Indo-Pacific: Gulf of Aden and Oman, south on the east coast of Africa to Mossel Bay, South Africa, east to the islands of Micronesia, Line Islands, Marquesas Islands, and Tuamotu Archipelago; and from southern Japan to Australia and New Caledonia (Fishbase, 2000).



14.3. *Parupeneus cyclostomus*

Nome Científico | Cientific Name • *Parupeneus cyclostomus* (Lacepéde, 1801)
Nome Inglês | English Name • Gold-saddle goatfish
Nome Português | Portuguese Name • Salmonete de barras douradas
Nome Francês | French Name • Capucin barbet doré

Ecologia: Áreas arenosas de recifes planos, lagoas e recifes ao largo até 100 m. Forrageia em pequenos grupos de dia (Lieske, 1994).

Distribuição: Indo-Pacífico: Mar Vermelho até Durban, África do Sul, e Havaí, ilhas Linha, Marquesas e ilhas Tuamotu. Desde as ilhas Ryukyu, até à Nova Caledónia e Rapa (Fishbase, 2000).

Ecology: Sandy areas of coral reefs, lagoons and reefs plans off up to 100 m. Forages in small groups during the day (Lieske, 1994).

Distribution: Indo-Pacific: Red Sea south to Durban, South Africa and east to the Hawaiian, Line, Marquesan, and Tuamoto islands, north to the Ryukyu Islands, south to New Caledonia and Rapa (Fishbase, 2000).

14.4. *Mulloidichthys flavolineatus*

Nome Científico | Cientific Name • *Mulloidichthys flavolineatus* (Lacepéde, 1801)
Nome Inglês | English Name • Yellowstripe goatfish
Nome Português | Portuguese Name • Salmonete
Nome Francês | French Name • Capucin nain ou capucin carême

Ecologia: Áreas arenosas e planas de lagoa em recifes ao largo até 35 m. Muitas vezes em grandes agregações inativos de dia. Alimentam-se individualmente ou em pequenos grupos de invertebrados bentónicos de dia ou de noite. Quando se alimentam, a faixa amarela é substituída por manchas médio-laterais a volta do oblongo. Comum em quase toda a sua distribuição (Lieske, 1994).

Distribuição: Indo-Pacífico: Mar Vermelho e África Oriental até ao Havai, ilhas Marquesas e Ducie. Desde as Ilhas Ryukyu e Bonin até ilha Lord Howe e Rapa. Comum em quase toda a sua distribuição (Fishbase, 2000).

Ecology: Sandy and flat areas of reef lagoon off up to 35 m. Often in large aggregations, inactive during the day. Feeds individually or in small groups of benthic invertebrates by day or night. When feeding, the yellow stripe is replaced by medium-lateral spots around the oblong. Common in almost all its distribution (Lieske, 1994).

Distribution: Indo-Pacific: Red Sea and East Africa to the Hawaiian, Marquesan, and Ducie islands, north to the Ryukyu and Bonin Islands, south to Lord Howe and Rapa Islands. Common throughout most of its range (Fishbase, 2000).

14.5. *Mulloidichthys vanicolensis*

Nome Científico | Cientific Name • *Mulloidichthys vanicolensis* (Valenciennes, 1831)
Nome Inglês | English Name • Yellowfin goatfish
Nome Português | Portuguese Name • Salmonte de barbatanas amarelas
Nome Francês | French Name • capucin à nageoires jaunes

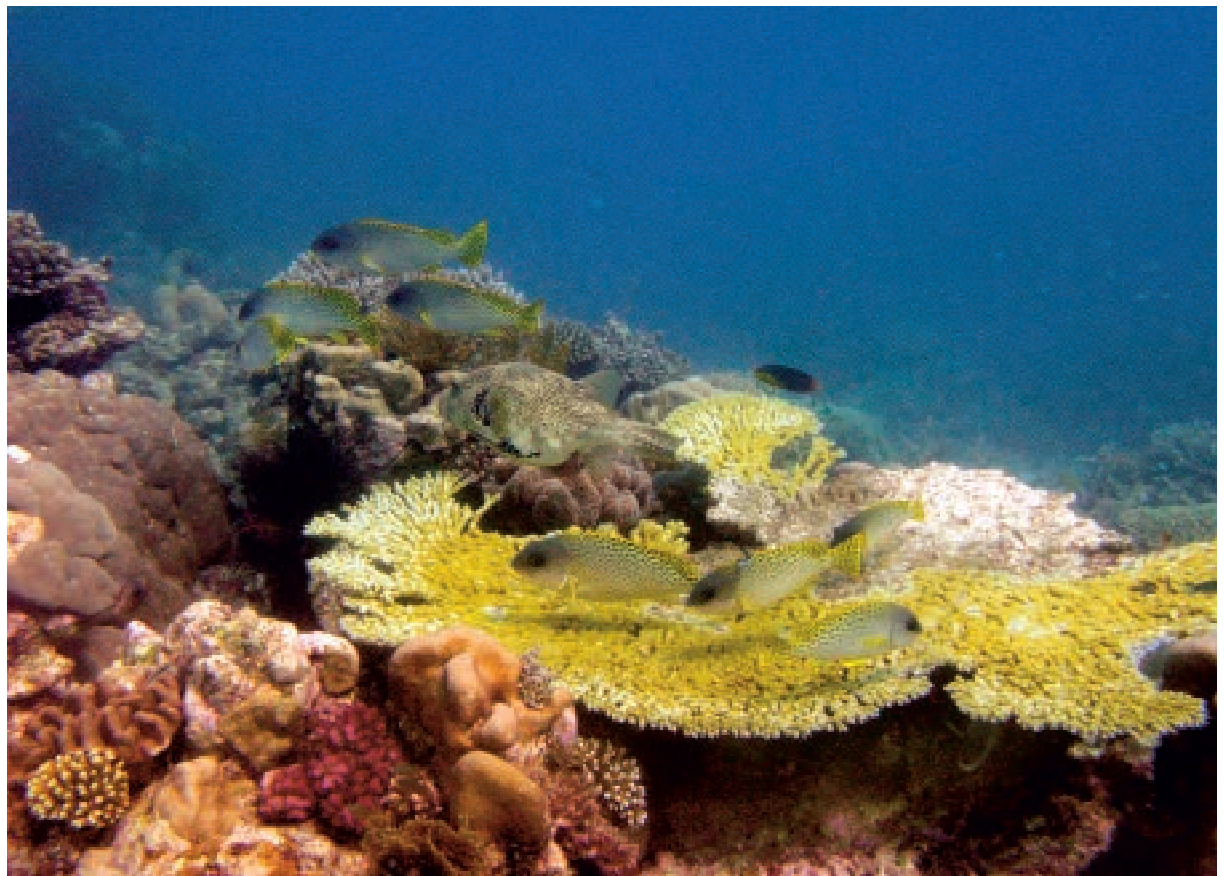
Ecologia: Recifes rasos e lagoas e recifes ao largo até 113 m. Muitas vezes em grandes agregações, inativos de dia. Alimentam-se individualmente ou em pequenos grupos de invertebrados bentónicos de dia ou de noite. Dispersam a areia plana para se alimentar de invertebrados bentónicos de noite. Comum em quase toda a sua distribuição (Lieske, 1994).

Distribuição: Indo-Pacífico: Mar Vermelho até ao Havaí, ilhas Marquesas e Tuamotu. Desde o sul do Japão até ilha de Lord Howe (Fishbase, 2000).

Ecology: Reef flats, lagoons and coral reefs off the coast until 113 m. often in large aggregations, inactive day. feed individually or in small groups of benthic invertebrates by day or night. Scatter on flat sand to feed on benthic invertebrates at night. Common in almost all its distribution (Lieske, 1994).

Distribution: Indo-Pacific: Red Sea to the Hawaiian, Marquesan, and Tuamoto Islands, north to southern Japan, south to Lord Howe Island (Fishbase, 2000).

15. Pargos e peixes pedra | Snapper and sweetlips



Neste grupo incluímos duas famílias de grande importância para a pesca: haemulidae (peixes pedra) e lutjanidae (pargos).

Os lutjanídeos apresentam grande variedade de tamanhos e colorações entre as suas espécies. São predadores de peixes e crustáceos e as espécies maiores estão sujeitas a terem cigaterra. Os pargos não são hermafroditas e os sexos estão bem separados. Gostam de zonas acidentadas, da crista do recife e das paredes.

Os haemulidea apresentam juvenis quase sempre de coloração muito diversa dos adultos. Nadam normalmente em pequenos grupos, frequentemente nos mesmos locais que os lutjanídeos.

Ambos os grupos são pescados ativamente com vários tipos de artes de pesca, que vão desde pesca à linha às diversas redes, passando pela pesca submarina. Tem grande procura pelos pescadores.

In this chapter we included 2 families of major value for fishing haemulidae (Sweetlips) and lutjanidae (snappers). Lutjanidae present a wide variety of sizes and colorations between their species. They are predators of fish and shellfish and the larger species are prone to ciguatoxin. Snappers are not hermaphrodites and gender are well separated. They like hilly areas on the reef crest and walls

Haemulidae juveniles usually present a different coloring from adults. They usually swim in small groups, often in the same places that the snappers.

Both groups are actively fished with various types of fishing gear, ranging from trolling and various types of nets, to divers. They have great demand by fishermen.

15.1. *Lutjanus bohar*

Nome Científico | Cientific Name • *Lutjanus bohar* (Forsskal, 1775)
Nome Inglês | English Name • Two-spot red snapper
Nome Português | Portuguese Name • Pargo vermelho de pintas
Nome Francês | French Name • Vivaneau chien rouge ou Vara vara

Ecologia: Lagoas exteriores, canais e recifes ao longo das lagoas de 1-80m. Isoladamente ou em grupos itinerantes. Um predador voraz de peixes que também come crustáceos e cefalópodes. Está entre os peixes mais frequentemente ciguatoxicos em muitas áreas. Comum em atóis (Lieske, 1994).

Distribuição: Indo-Pacífico: África Oriental até às ilhas Marquesas e Linha. Desde as ilhas Ryukyu até à Austrália. Mais comum em torno das ilhas oceânicas do que em áreas continentais (Fishbase, 2000).

Ecology: Outdoor lagoons, channels and reefs along the lagoons of 1-80 m. Single or in roving groups. A voracious fish predator that also eats crustaceans and cephalopods. Among the most frequently ciguatoxics fishes in many areas. Common in atolls (Lieske, 1994).

Distribution: Indo-Pacific: East Africa to the Marquesas and Line islands, north to the Ryukyu Islands, south to Australia. More common around oceanic islands than in continental areas (Fishbase, 2000).

15.2. *Lutjanus monostigma*

Nome Científico | Cientific Name • *Lutjanus monostigma* (Cuvier, 1828)
Nome Inglês | English Name • One-spot snapper
Nome Português | Portuguese Name • Pago de uma pinta
Nome Francês | French Name • Vivaneau églefin

Ecologia: Lagoas exteriores, canais e recifes ao longo de das laoas de 1-60 m. Em recifes rasos à noite alimenta-se principalmente de peixes. Comum ao longo das margens de recifes em rachas e furos no recife. Podem ser ciguatoxicos (Lieske, 1994).

Distribuição: Indo-Pacífico: África Oriental até às ilhas Marquesas e Linha. Desde as ilhas Ryukyu até à Austrália (Fishbase, 2000).

Ecology: Seaward lagoons, channels and reefs along lagoons of 1-60 m. In shallow reefs at night, feeds mainly on fish. Common along the banks of coral reefs with deep cuts and holes. Can be ciguatoxics (Lieske, 1994).

Distribution: Indo-Pacific: East Africa to the Marquesas and Line islands, north to the Ryukyu Islands, south to Australia (Fishbase, 2000).

15.3. *Lutjanus rivulatus*

Nome Científico | Cientific Name • *Lutjanus rivulatus* (Cuvier, 1828)
Nome Inglês | English Name • Blubberlip snapper
Nome Português | Portuguese Name • Pargo de lábios carnudos
Nome Francês | French Name • Vivaneau maori

Ecologia: Recifes grandes até 100 m. Ocasionalmente em costas rasas. Solitários ou em pequenos grupos. Adultos com 45 cm. Incomum em toda sua extensão (Lieske, 1994).

Distribuição: Indo-Pacífico: África Oriental até ao Taiti. A norte, desde o sul do Japão até à Austrália, a sul (Fishbase, 2000).

Ecology: Large reefs up to 100 m. Occasionally in shallow coasts. Solitary or in small groups. Adults with 45 cm. Uncommon across its distribution (Lieske, 1994).

Distribution: Indo-Pacific: East Africa to Tahiti, north to southern Japan, south to Australia (Fishbase, 2000).

15.4. *Lutjanus fulvus*

Nome Científico | Cientific Name • *Lutjanus fulvus* (Forster, 1801)
Nome Inglês | English Name • Blacktail snapper
Nome Português | Portuguese Name • Pargo de cauda preta
Nome Francês | French Name • Vivaneau à quele noire

Ecologia: Lagoas e recifes semi-protegidos de 1 a 75 m. Em áreas estuarinas. Alimentam-se de invertebrados bentónicos e peixes (Lieske, 1994).

Distribuição: Indo-Pacífico: África Oriental até às Marquesas e ilhas Linha. Desde o sul do Japão até à Austrália (Fishbase, 2000).

Ecology: Lagoons and semi-protected seaward reefs, 1 to 15 m. Estuaries. Feeds in benthic invertebrates and fish. (Lieske, 1994).

Distribution: Indo-Pacific: East Africa to the Marquesas and Line islands, north to southern Japan, south to Australia (Fishbase, 2000).

15.5. *Lutjanus kasmira*

Nome Científico | Cientific Name • *Lutjanus kasmira* (Forsskal, 1775)
Nome Inglês | English Name • Common bluestripe snapper
Nome Português | Portuguese Name • Pargo de listas azuis
Nome Francês | French Name • Vivaneau à raies blueues

Ecologia: Recifes rasos ou recifes protegidos expostos até aos 265 m. Durante o dia, movimentam-se em grandes agregações em torno de formações de coral. Dispersam-se à noite para se alimentar de crustáceos bentónicos e peixes. Juvenis em pradarias de ervas marinhas ou em torno dos recifes (Lieske, 1994).

Distribuição: Indo-Pacífico: Mar Vermelho e África Oriental até às ilhas Marquesas e Linha. Desde o sul do Japão até à Austrália. Atlântico Sudeste: leste de Londres, África do Sul (Fishbase, 2000).

Ecology: Shallow reefs or protected reefs exposed up to 265 m during the day they move in large aggregations around coral formations. Disperse at night to feed on benthic crustaceans and fish. Juveniles in seagrass meadows or around the reefs dispersed. (Lieske, 1994).

Distribution: Indo-Pacific: Red Sea and East Africa to the Marquesas and Line islands, north to southern Japan, south to Australia. Southeast Atlantic: East London, South Africa (Fishbase, 2000).

15.6. *Plectorhinchus gaterinus*

Nome Científico | Cientific Name • *Plectorhinchus gaterinus* (Forsskal, 1775)
Nome Inglês | English Name • Blackspotted rubberlip
Nome Português | Portuguese Name • Pargo de lábios grossos
Nome Francês | French Name • Gaterin moucheté

Ecologia: Frequentemente em grandes grupos debaixo de bordas ou ao longo de encostas de corais durante o dia (Lieske, 1994).

Distribuição: Mar Vermelho até Natal, África do Sul, Ilhas Maurícias, Madagáscar e Ilhas Comores. Reportado como provável em Seychelles, mas Randall e van Egmond 1994 acreditam no contrário (Fishbase, 2000).

Ecology: Often in large groups, under edges or along slopes of coral reefs during the day (Lieske, 1994).

Distribution: Western Indian Ocean: Red Sea south to Natal, South Africa, Mauritius, Madagascar and Comoro Islands. Reported as likely at Seychelles but Randall and van Egmond 1994 believe otherwise (Fishbase, 2000).

15.7. *Plectorhinchus flavomaculatus*

Nome Científico | Cientific Name • *Plectorhinchus flavomaculatus* (Cuvier, 1830)
Nome Inglês | English Name • Lemonfish
Nome Português | Portuguese Name • Pargo
Nome Francês | French Name • Gaterin citron

Ecologia: Juvenis em áreas de algas, adultos em recifes costeiros abrigados abaixo dos 4 m (Lieske, 1994).

Distribuição: Indo-Pacífico Ocidental: Mar Vermelho até Transkei, África do Sul e Papua-Nova Guiné. Desde o sul do Japão até à Austrália Ocidental e Nova Gales do Sul (Fishbase, 2000).

Ecology: Juveniles in areas of seaweeds, adults in sheltered coastal reefs under 4 m (Lieske, 1994).

Distribution: Indo-West Pacific: Red Sea south to Transkei, South Africa and east to Papua New Guinea, north to southern Japan, south to western Australia and New South Wales (Fishbase, 2000).

15.8. *Plectorhinchus orientalis / Vittatus*

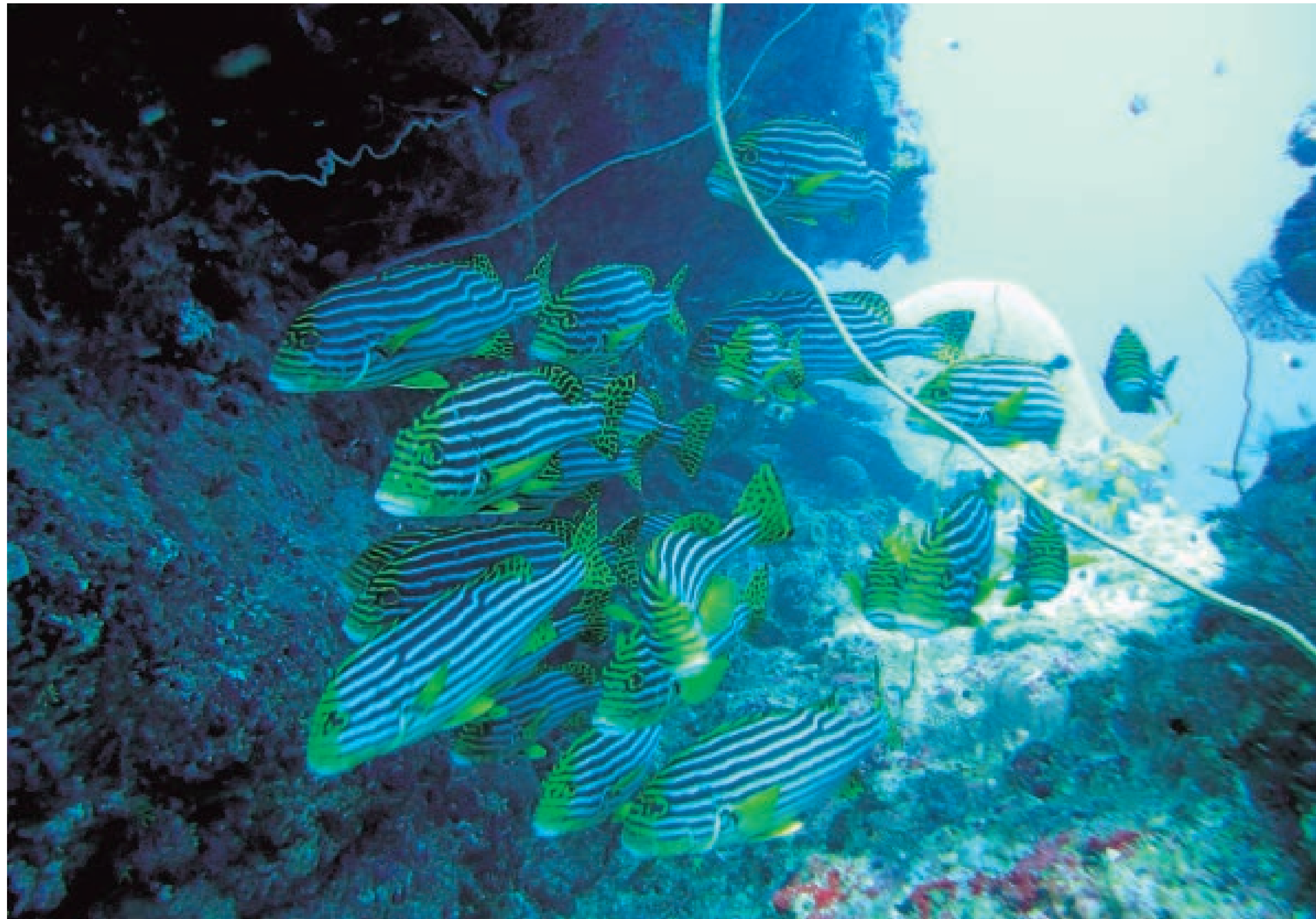
Nome Científico | Cientific Name • *Plectorhinchus orientalis* (Linnaeus, 1758)
Nome Inglês | English Name • Indian Ocean oriental sweetlips
Nome Português | Portuguese Name • Pargo oriental
Nome Francês | French Name • Gaterin bagnard

Ecologia: Adultos em lagoas exteriores de água clara e recifes ao largo de 2-25m. Juvenis em áreas abrigadas e de águas claras. Geralmente solitários, mas ocasionalmente ocorrem em grandes grupos (Lieske, 1994).

Distribuição: Indo-Pacífico Ocidental: África Oriental até ao oeste do Oceano Índico, Papua Nova Guiné e Nova Caledónia (Fishbase, 2000).

Ecology: Adults in lagoons of clear water and coral reefs off the coast of 2-25 m. Juveniles in sheltered areas and clear waters. Usually solitary, but occasionally occur in large groups (Lieske, 1994).

Distribution: Indo-West Pacific: East Africa to western Indian Ocean to Papua New Guinea and New Caledonia (Fishbase, 2000).



15.9. *Plectorhinchus playfairi*

Nome Científico | Cientific Name • *Plectorhinchus playfairi* (Pellegrin, 1914)
Nome Inglês | English Name • Whitebarred rubberlip
Nome Português | Portuguese Name • Pargo ou pedra
Nome Francês | French Name • Gaterin à barres blanches

Ecologia: Recifes de coral e poças de maré até 80 m. Solitário (Lieske, 1994).

Distribuição: Oeste do Oceano Índico: Mar Vermelho e sul do Oman à África do Sul e Madagáscar (Fishbase, 2000).

Ecology: Coral reefs, tide pools up to 80 m. Solitary (Lieske, 1994).

Distribution: Western Indian Ocean: Red Sea and southern Oman to South Africa and Madagascar (Fishbase, 2000).

15.10. *Macolor niger*

Nome Científico | Cientific Name • *Macolor niger* (Forsskal, 1775)
Nome Inglês | English Name • Black and white snapper
Nome Português | Portuguese Name • Pargo ou pedra
Nome Francês | French Name • Vivaneau plate

Ecologia: Adultos em grandes agregações ao longo de canais exteriores de lagoa, canais e ao longo de encostas de 3-90 m. Juvenis solitários. Alimentam-se principalmente de grandes zooplânctontes à noite (Lieske, 1994).

Distribuição: Indo-Pacífico: Leste de Africa até à Samoa. Desde a região central do Japão até à Austrália (Fishbase, 2000).

Ecology: Adults in large aggregations along outer lagoons, channel and seaward slopes, 3 to 90 m. Juveniles solitary. Feeds in zooplankton (Lieske, 1994).

Distribution: Indo-Pacific: East Africa to Samoa, north to central Japan, south to Australia (Fishbase, 2000).

16. Peixes ladrões ou Imperadores? | Emperors

Estes peixes, muito procurados pelos pescadores, vivem solitários ou em pequenos grupos. Deslocam-se em vários tipos de substratos e caçam normalmente à noite. Algumas espécies fazem agrupamentos de reprodução. A sua longevidade é grande o que requer uma gestão pesqueira muito cuidadosa

These fish are highly sought by fishermen; they live alone or else in small groups. They move in various types of substrates and usually hunt at night. Some species gather in groups for reproduction. Due to its great longevity, they require very careful fisheries management.

Monotaxis grandoculis (Adulto em grupo)

16.1. *Monotaxis grandoculis*

Nome Científico | Cientific Name • *Monotaxis grandoculis* (Forsskal, 1775)
Nome Inglês | English Name • Humpnose big-eye bream
Nome Português | Portuguese Name • Sargo de olho grande
Nome Francês | French Name • Capitaine bossu ou gueule pavée

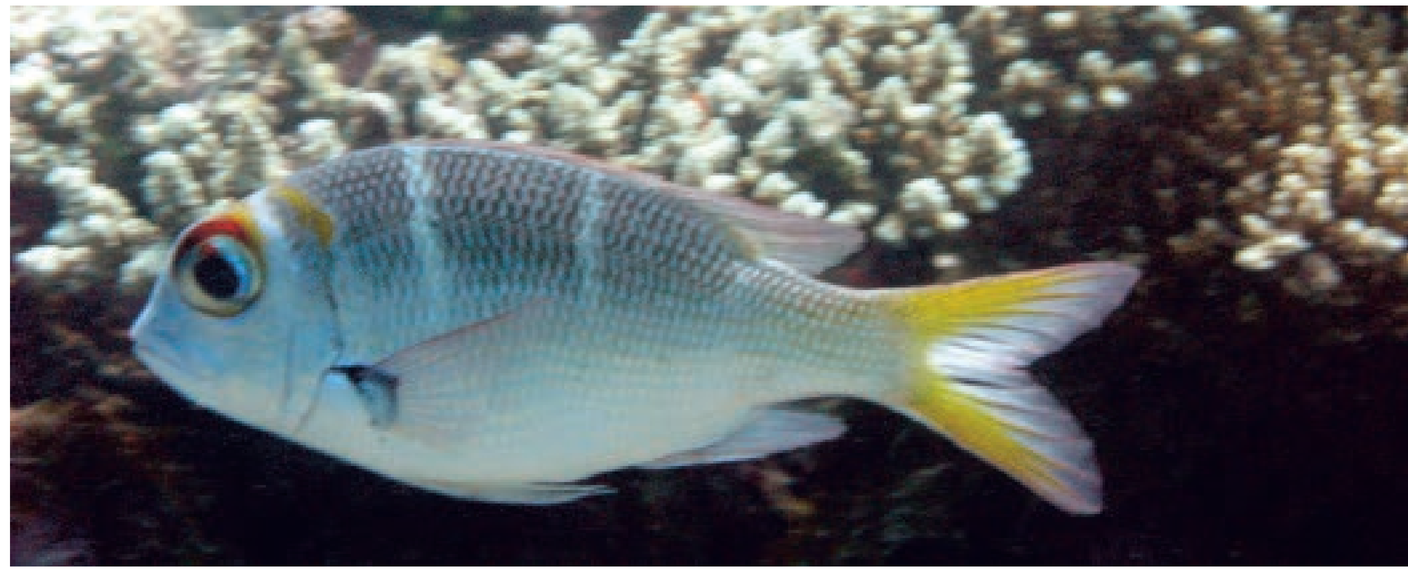
Ecologia: Lagoas e recifes interiores perto da areia de 1 a 100 m. Juvenis são solitários, adultos solitários ou em agregação em encostas de recifes, perto da areia durante o dia. Dispersam-se por cima da areia, à noite para se alimentar de invertebrados de casca dura (Lieske, 1994).

Distribuição: Indo-Pacífico: Mar Vermelho e leste de África até às ilhas havaianas e sudeste da Oceânia. Desde o Japão até à Austrália (Fishbase, 2000).

Ecologia: Lagoons and reefs near the sand interior of 1 to 100 m. Juveniles are solitary. The adults live solitary or in aggregation in slopes of coral reefs near the sand during the day. disperse over the sand at night to feed on invertebrates of hard shell (Lieske, 1994).

Distribuição: Indo-Pacific: Red Sea and East Africa to the Hawaiian Islands and southeastern Oceania, north to Japan, south to Australia (Fishbase, 2000).

Monotaxis grandoculis (Juvenil)



Monotaxis grandoculis (Fase de transição)

16.2. *Gnathodentex aureolineatus*

Nome Científico | Cientific Name • *Gnathodentex aureolineatus* (Lacepède, 1802)
Nome Inglês | English Name • Striped large-eye bream
Nome Português | Portuguese Name • Sargo de riscas
Nome Francês | French Name • Capitaine strié

Ecologia: Recifes abaixo da maré baixa, recifes rasos, lagoas e recifes interiores até 30 m. Circulam em agregações perto de corais durante o dia. Dispersos durante a noite para se alimentar de invertebrados bentónicos. Comum em toda sua distribuição (Lieske, 1994).

Distribuição: Indo-Pacífico: Leste de África até às ilhas Tuamotu (excluindo as ilhas havaianas). Desde o Japão até à Austrália. Recentemente relatado a partir da ilha Norfolk (Fishbase, 2000).

Ecology: Coral reefs below low tide, shallow reefs, lagoons and interiors to 30 m. Circulating in aggregations around coral reefs during the day. Dispersed during the night to feed on benthic invertebrates. Common across its distribution (Lieske, 1994).

Distribution: Indo-Pacific: East Africa to the Tuamoto Islands (excluding the Hawaiian Islands), north to Japan, south to Australia. Recently reported from Norfolk Island (Fishbase, 2000).

16.3. *Lethrinus nebulosus*

Nome Científico | Cientific Name • *Lethrinus nebulosus* (Forsskal, 1775)
Nome Inglês | English Name • Spangled emperor
Nome Português | Portuguese Name • Ladrões ou imperadores
Nome Francês | French Name • Capitaine blanc

Ecologia: Mangais, pradarias de ervas marinhas, recifes rasos pouco desenvolvidos, lagoas e recifes interiores até 75 m. Alimentam-se principalmente de equinodermes, crustáceos, e moluscos. Frequentemente em grupo (Lieske, 1994).

Distribuição: Indo-Pacífico Ocidental: Mar Vermelho, Golfo Pérsico e leste de África até ao sul do Japão e Samoa. De acordo com um estudo genético, *Lethrinus nebulosus* e *Lethrinus choerorynchus* são duas espécies distintas na Austrália Ocidental (Fishbase, 2000).

Ecology: Mangroves, seagrass meadows, shallow reefs, lagoons and underdeveloped interior reefs up to 75 m. Feeds mainly on echinoderms, crustaceans, and molluscs. Often in groups (Lieske, 1994).

Distribution: Indo-West Pacific: Red Sea, Persian Gulf and East Africa to southern Japan and Samoa. According to a genetic study, Lethrinus nebulosus and Lethrinus choerorynchus are two distinct species in Western Australia (Fishbase, 2000).

16.4. *Lethrinus obsoletus*

Nome Científico | Cientific Name • *Lethrinus obsoletus* (Forsskal, 1775)
Nome Inglês | English Name • Orange-striped emperor
Nome Português | Portuguese Name • Ladrões ou imperadores
Nome Francês | French Name • Capitaine à bandes orange

Ecologia: Pradarias de ervas marinhas e areia ou áreas de cascalho de lagoas rasas e recifes interiores até aos 30 m. Alimentam-se principalmente de invertebrados bentónicos de conchas duras. Solitários ou em grupo. Comum (Lieske, 1994).

Ecology: Meadows of seagrass and sand or gravel areas of shallow lagoons and reefs interiors up to 30 m. feed mainly of benthic invertebrates from hard shells. Solitary or in groups. Common (Lieske, 1994).

Distribuição: Indo-Pacífico: Mar Vermelho e leste da África às ilhas Ryukyu, Tonga e Samoa (Fishbase, 2000)

Distribution: Indo-Pacific: Red Sea and East Africa to the Ryukyu Islands, Tonga, and Samoa (Fishbase, 2000).

16.5. *Lethrinus erythracanthus*

Nome Científico | Cientific Name • *Lethrinus erythracanthus* (Valenciennes, 1830)
Nome Inglês | English Name • Orange-spotted emperor
Nome Português | Portuguese Name • Ladrões ou imperadores
Nome Francês | French Name • Capitaine empereur

Ecologia: Lagoas profundas, e recifes interiores até 18 a 120 m. Solitários e ou perto de saliências ou cavernas durante o dia. Alimentam-se de invertebrados bentónicos protegidos por conchas ou outros esqueletos rígidos, principalmente a noite (Lieske, 1994).

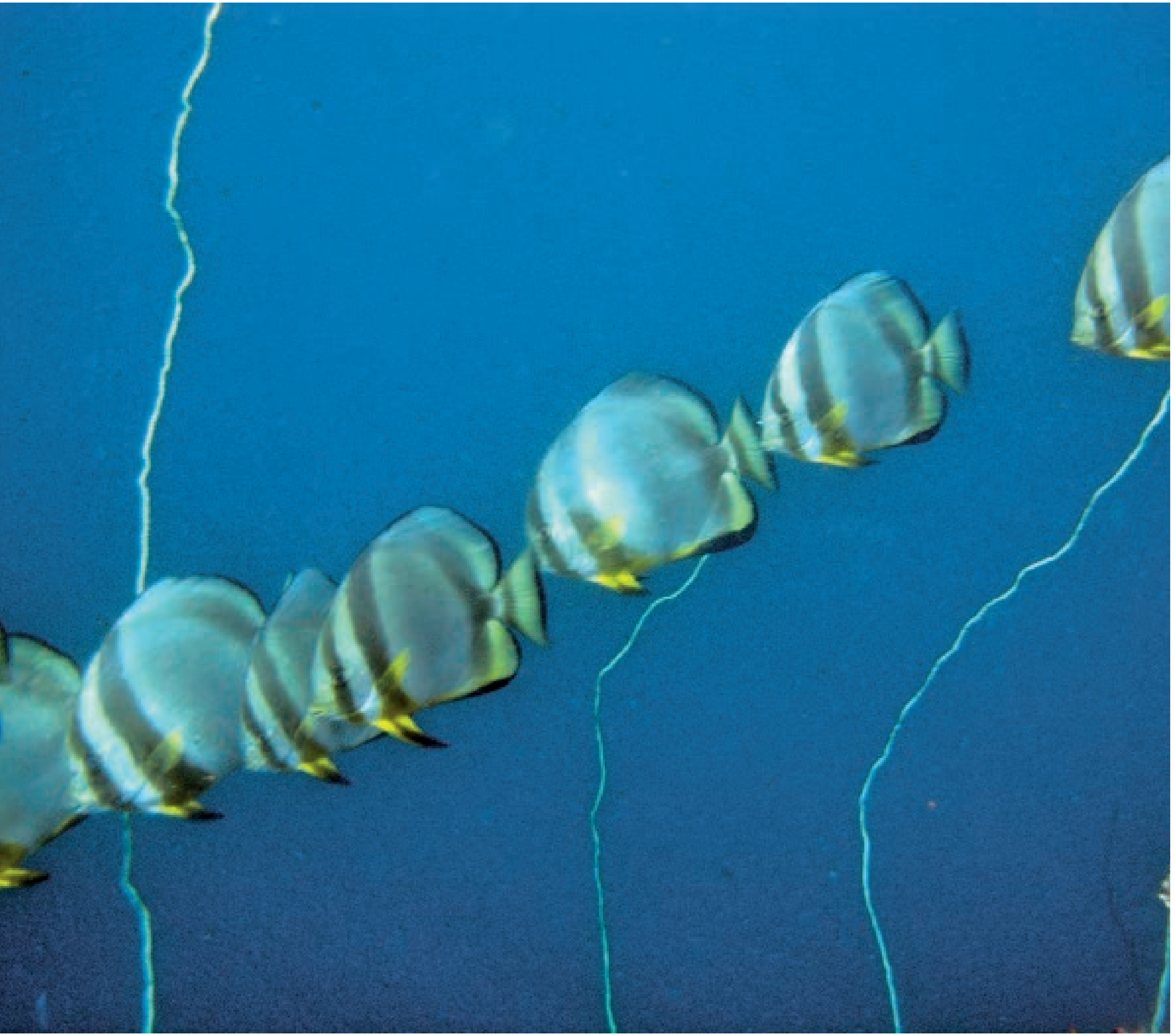
Ecology: Deep lagoons, inner reefs 18 to 120 m. Solitary and near overhangs or caves during the day. Feeds on benthic invertebrates protected by husks or shells, especially at night (Lieske, 1994).

Distribuição: Indo-Pacífico: Leste de África até às ilhas Sociedade e Tuamotu. Desde as ilhas Ryukyu até ao nordeste da Austrália. O nome *Lethrinus kallopterus* tem sido muito aplicado a esta espécie. *Lethrinus cinnabarinus* Richardson também parece ser sinónimo desta espécie (Fishbase, 2000).

Distribution: Indo-Pacific: East Africa to the Society and Tuamoto islands, north to the Ryukyu Islands, south to northeastern Australia. The name *Lethrinus kallopterus* has long been applied to this species. *Lethrinus cinnabarinus* Richardson also appears to be synonymous with this species (Fishbase, 2000).

17. Peixes Morcegos | Batfishes

pairando sobre o azul | hovering over the blue



Estes peixes, de fácil identificação, são comprimidos lateralmente, tendo uma forma discoide característica. As suas formas juvenis têm ainda as barbatanas mais alongadas e são bastantes diferentes do indivíduo adulto. Podem viver solitários ou em grupos.

They are easily identifiable, due to their characteristic discoid and laterally-compressed shape. Juveniles are quite different from adults with rather long fins. They can live in groups or solitary.

17.1. *Platax orbicularis*

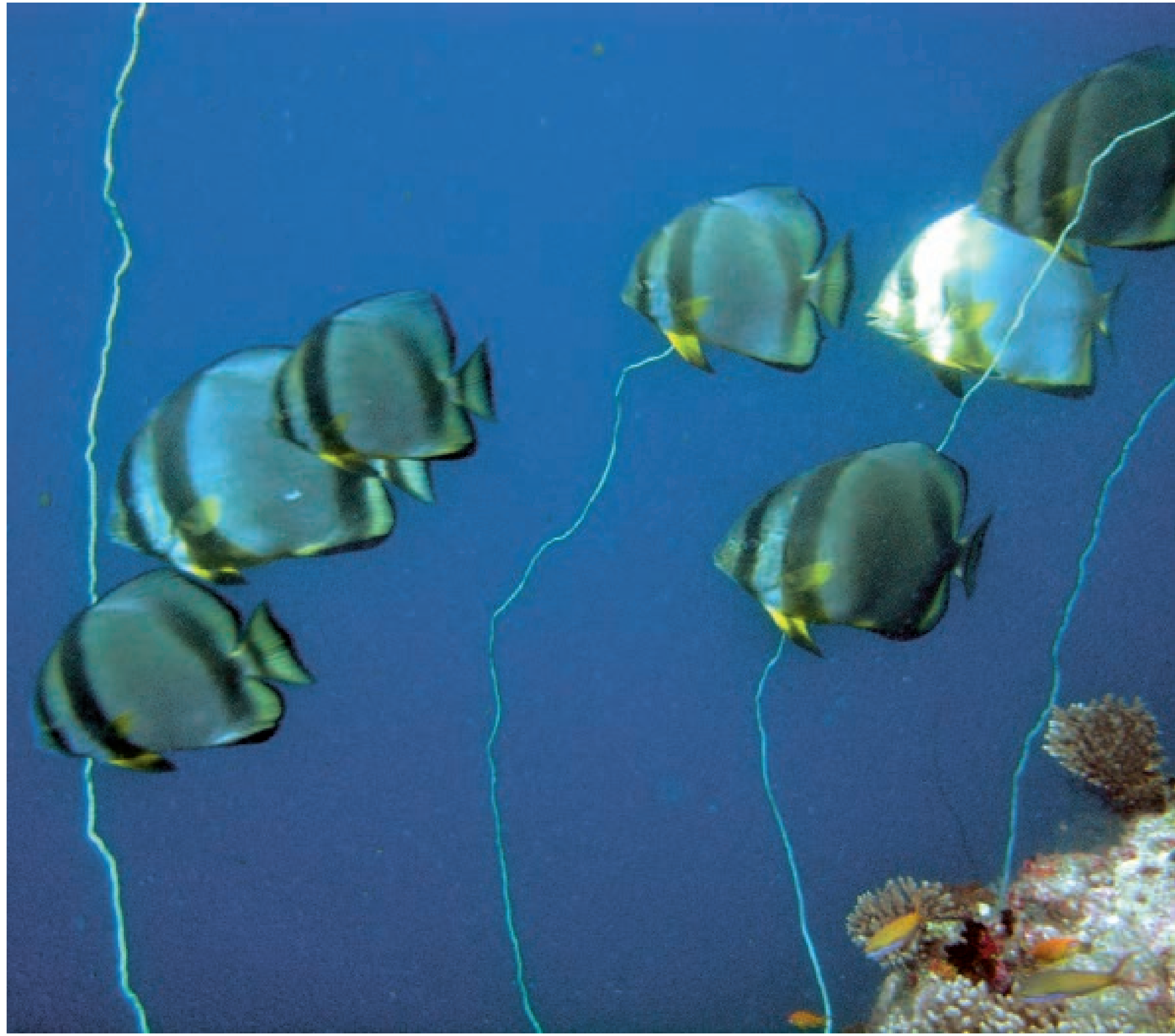
Nome Científico | Cientific Name • *Platax orbicularis* (Forsskal, 1775)
Nome Inglês | English Name • Orbicular batfish
Nome Português | Portuguese Name • Peixe morcego
Nome Francês | French Name • Platax rond

Ecologia: Juvenis entre mangais e em abrigos protegidos em lagoas. Assemelham-se a uma folha a flutuar tanto na aparência como no comportamento. Sub-adultos movem-se para zonas profundas da lagoa e canais. Os adultos são solitários ou em grupos em águas abertas sobre áreas arenosas de lagoas profundas e em recifes exteriores até 30 m. Alimentam-se de algas, invertebrados e pequenos peixes (Lieske, 1994).

Distribuição: Indo-Pacífico: Mar Vermelho e África Oriental até às Ilhas Tuamotu. Desde o sul do Japão até ao norte da Austrália e da Nova Caledónia. Observado ao longo da costa da Flórida na Central do Atlântico Ocidental (Fishbase, 2000).

Ecology: Juveniles, between mangrove swamps and in protected shelters in lagoons. They resemble a leaf floating in both appearance and his behaviour. Sub-adults move to deeper lagoons and channels. Large adults solitary or in groups, in open water on sandy areas of deep lagoons and seaward reefs to 30 m. Feeds on algae, invertebrates and small fish (Lieske, 1994).

Distribution: Indo-Pacific: Red Sea and East Africa to the Tuamoto Islands, north to southern Japan, south to northern Australia and New Caledonia. Recorded off the coast of Florida in the Western Central Atlantic (Fishbase, 2000).



18. Peixes borboletas | Butterflyfishes

as estrelas dos corais | the stars of the corals

Os peixes desta família devem o nome às suas cores fortes. Tal como as borboletas, suas homónimas terrestres frequentemente, possuem falsos olhos na cauda e riscas a cobrir os olhos verdadeiros. Estes falsos olhos servem para confundir os predadores e as riscas nos olhos ajudam a escondê-los dos predadores. São peixes demersais de pequeno tamanho, no máximo 10 cm, com poucas espécies chegando aos 30 cm.Têm os sexos separados e na idade adulta vivem frequentemente em pares, nas zonas de recife coral. Alguns, mas poucos, podem viver em águas turvas ou com ervas marinhas. Conforme as espécies alimentam-se de pólipos de corais, pequenos invertebrados, ovos de outras espécies, tudo que possa ser sugado pelo seu pequeno bico. Devido à sua alimentação, sobretudo à base de pólipos de corais, são considerados um bom indicador da qualidade e quantidade de coral na área.

They own their name to their bright colors. Like their terrestrial homonymous, they frequently present false eyes in their tails and stripes covering their eyes. These false eyes confound the predators and the stripes help them to hide from the predators. They are small demersal fish no longer than 10 cm, with a few species reaching 30 cm. Gender are separated and in adulthood they often live in pairs in coral reef. Some, but few, can live in muddy waters or sea grass. According with the different species they feed on coral polyps, small invertebrates, eggs of other species, everything that can be sucked by their little beak. Due to its feeding, mainly based on coral polyps, they are considered a good indicator of the quality and quantity of coral in the area

18.1. *Chaetodon auriga*

Nome Científico | Cientific Name • *Chaetodon auriga* (Forsskal, 1775)
Nome Inglês | English Name • Threadfin butterflyfish
Nome Português | Portuguese Name • Peixe borboleta
Nome Francês | French Name • Papillon cocher

Ecologia: Recifes rasos e lagoas e recifes interiores de 30 m. Áreas de mistura de areia de coral e cascalho. Alimentam-se de pedaços dilacerados de poliquetas, anémonas, pólipos de coral e algas. Comum na maior parte da sua distribuição (Lieske, 1994).

Distribuição: Indo-Pacífico: Mar Vermelho e África Oriental (estendendo-se até Baia de Mossel, África do Sul, até ao Havai, ilhas Marquesas e Ducie. Desde o sul do Japão até as ilhas Lord Howe e Rapa (Fishbase, 2000).

Ecology: Reef flats and lagoons and seaward reefs to 30 m in areas of mixed coral sand and gravel. They feed on torn pieces of polychaetes, anemones, coral polyps, and algae. Common troughout most of the range (Lieske, 1994).

Distribution: Indo-Pacific: Red Sea and East Africa (extending to Mossel Bay, South Africa), to the Hawaiian, Marquesan, and Ducie islands, north to southern Japan, south to Lord Howe and Rapa islands (Fishbase, 2000).

18.2. *Chaetodon melannotus*

Nome Científico | Cientific Name • *Chaetodon melannotus* (Bloch & Schneider, 1801)
Nome Inglês | English Name • Blackback butterflyfish
Nome Português | Portuguese Name • Peixe borboleta
Nome Francês | French Name • Papillon à dos noir

Ecologia: Recifes rasos e lagoas e recifes interiores em áreas de rico crescimento coralino até 20 m. Solitários ou aos pares, alimentam-se principalmente de pólipos de coral mole e duro (Lieske, 1994)

Distribuição: Indo-Pacífico: Mar Vermelho e África Oriental até Samoa. Desde o sul do Japão até ilhas Lord Howe. Ao longo da Micronésia (Fishbase, 2000).

Ecology: Reef flats and lagoons and coral reefs rich areas Interior coralline growth up to 20 m. Solitary or in pairs, feeds mainly of soft and hard coral polyps (Lieske, 1994)

Distribution: Indo-Pacific: Red Sea and East Africa to Samoa, north to southern Japan, south to Lord Howe Island. Throughout Micronesia (Fishbase, 2000).

18.3. *Chaetodon interruptus*

Nome Científico | Cientific Name • *Chaetodon interruptus* (Ahl, 1923)
Nome Inglês | English Name • Yellow teardrop butterflyfish
Nome Português | Portuguese Name • Peixe borboleta
Nome Francês | French Name • Papillon à larme de l'océan Indien

Ecologia: Recifes rasos e lagoas até 60m. Alimenta-se principalmente de corais duros e moles, assim como de outros invertebrados e algas. Comum onde existem corais moles (Lieske, 1994).

Distribuição: Oceano Índico: generalizada, de leste a Sumatra, na Indonésia (Fishbase, 2000).

Ecology: Reef flats and lagoons up to 60 m. It feeds on hard and soft coral, as well as other invertebrates and algae. Common in soft coral abundance areas.

Distribution: Indian Ocean: widespread, ranging east to Sumatra, Indonesia (Fishbase, 2000).

18.4. *Chaetodon Madagaskariensis*

Nome Científico | Cientific Name • *Chaetodon Madagaskariensis* (Ahl, 1923)
Nome Inglês | English Name • Seychelles butterflyfish
Nome Português | Portuguese Name • Peixe borboleta de Madagascar
Nome Francês | French Name • Papillon de Madagascar

Ecologia: Áreas de coral e cascalho de 4 a 30 m. Aos pares ou em grupos. Alimentam-se de pólipos de coral mole e duro, algas, poliquetas e crustáceos (Lieske, 1994).

Distribuição: Oceano Índico: África Oriental, incluindo Porto Elizabeth, África do Sul, até Cocos-Keeling e ilhas Natal até ao Sri Lanka a norte (Fishbase, 2000.

Ecology: Coral areas and gravel, of 4 to 30 m. in pairs or in groups. They feed on soft and hard coral polyps, algae, polychaetes and crustaceans (Lieske, 1994)..

Distribution: Indian Ocean: East Africa, including Port Elizabeth, South Africa to the Cocos-Keeling and Christmas islands, north to Sri Lanka (Fishbase, 2000).

18.5. *Chaetodon trifascialis*

Nome Científico | Cientific Name • *Chaetodon trifascialis* (Quoy & Gaimard, 1825)
Nome Inglês | English Name • Chevron butterflyfish
Nome Português | Portuguese Name • Peixe borboleta
Nome Francês | French Name • Papillon à chevrons

Ecologia: Áreas de lagoas rasas com riquezas de coral, recifes interiores semi-protegidos até 20 m. Alimentam-se exclusivamente de pólipos de coral. Geralmente aos pares e muito territorial (Lieske, 1994)

Distribuição: Indo-Pacífico: Mar Vermelho e leste da África até às ilhas havaianas e Sociedade (Fishbase, 2000).

Ecology: Areas of shallow lagoons with riches of coral, coral reefs semi-protected interiors to 30 m. Feeds exclusively on coral polyps. Usually in pairs and highly territorial (Lieske, 1994).

Distribution: Indo-Pacific: Red Sea and East Africa to the Hawaiian and Society islands (Fishbase, 2000).

18.6. *Chaetodon xanthocephalus*

Nome Científico | Cientific Name • *Chaetodon xanthocephalus* (Bennett, 1833)
Nome Inglês | English Name • Yellowhead butterflyfish
Nome Português | Portuguese Name • Peixe borboleta
Nome Francês | French Name • Papillon à tête jaune

Ecologia: Rochas cobertas de algas e áreas ricas em coral, 1 a 25 m. Geralmente solitários, ocasionalmente aos pares. Híbrido desta espécie e Chaetodon ephippium tem sido encontrado na ilha Similan e Sri Lanka (Lieske, 1994).

Distribuição: Oeste do Oceano Índico: África Oriental ao Sri Lanka e Maldivas (Fishbase, 2000).

Ecologia: Rocks covered with algae and coral-rich areas, 1 to 25 m. usually solitary, occasionally in pairs. Hybrids of this species and Chaetodon ephippium have been found on Similan island and Sri Lanka (Lieske, 1994).

Distribuição: Western Indian Ocean: East Africa to Sri Lanka and the Maldives.

18.7. *Chaetodon guttatissimus*

Nome Científico | Cientific Name • *Chaetodon guttatissimus* (Bennett, 1833)
Nome Inglês | English Name • Peppered butterflyfish
Nome Português | Portuguese Name • Peixe borboleta
Nome Francês | French Name • Papillon moucheté

Ecologia: Lagoas e recifes interiores até 25 m. Aos pares ou pequenos grupos. Alimentam-se de poliquetas, pólipos de coral e algas (Lieske, 1994).

Distribuição: Oceano Índico: Mar Vermelho até Durban, África do Sul, e ilhas Natal. Encontrado na Tailândia ocidental e Bali, na Indonésia (Fishbase, 2000).

Ecology: Lagoons and Seaward reefs up to 25 m. In pairs or small groups. Feeds on polychaetes, coral polyps, and algae (Lieske, 1994).

Distribution: Indian Ocean: Red Sea south to Durban, South Africa and east to Christmas Island. Reported from western Thailand and Bali, Indonesia (Fishbase, 2000).

18.8. *Chaetoddon kleinii*

Nome Científico | Cientific Name • *Chaetoddon kleinii* (Bloch, 1790)
Nome Inglês | English Name • Sunburst butterflyfish
Nome Português | Portuguese Name • Peixe borboleta
Nome Francês | French Name • Papillon de Klein

Ecologia: Lagoas e recifes interiores de 4 a 61 m. Geralmente abaixo dos 10 m. Alimentam-se principalmente de coral mole, algas e zooplâncton. Solitários, aos pares, e frequentemente em grupo (Lieske, 1994).

Distribuição: Indo-Pacífico: Mar Vermelho e África Oriental (sul da Baia de Coffee na África do Sul), até Ilhas do Havaí e Samoa. Desde o sul do Japão até Nova Gales do Sul, Austrália e Nova Caledónia. Pacífico Oriental: Ilhas Galápagos (Fishbase, 2000).

Ecology: Lagoons and seaward reefs 4 to 61 m. Generally under 10 m. Feeds mainly soft coral, algae and zooplankton. Solitary, in pairs, or in group (Lieske, 1994).

Distribution: Indo-Pacific: Red Sea and East Africa (south to Coffee Bay, South Africa) to the Hawaiian Islands and Samoa, north to southern Japan, south to New South Wales, Australia and New Caledonia. Eastern Pacific: Galapagos Islands (Fishbase, 2000).

18.9. *Chaetodon bennetti*

Nome Científico | Cientific Name • *Chaetodon bennetti* (Cuvier, 1831)
Nome Inglês | English Name • Bluelashed butterflyfish
Nome Português | Portuguese Name • Peixe borboleta de bennett
Nome Francês | French Name • Papillon de Bennett

Ecologia: Lagoas e recifes interiores em áreas de rico crescimento coralino de 5 a 30 m. Solitários ou aos pares. Juvenis ocasionalmente entre corais rasos. Alimentam-se principalmente de pólipos de coral (Lieske, 1994).

Distribuição: Indo-Pacífico: África Oriental até ao Grupo de Pitcairn. Desde o Japão até às ilhas Lord Howe e Rapa (Fishbase, 2000).

Ecology: Lagoons and seaward reefs in rich coralline growth areas from 5 to 30 m. Solitary or in pairs. Juveniles occasionally between shallow corals. Feed mainly of coral polyps (Lieske, 1994).

Distribution: Indo-Pacific: East Africa to the Pitcairn Group, north to Japan, south to Lord Howe and Rapa islands (Fishbase, 2000).

18.10. *Chaetodon lunula*

Nome Científico | Cientific Name • *Chaetodon lunula* (Lacepède, 1802)
Nome Inglês | English Name • Raccon butterflyfish
Nome Português | Portuguese Name • Peixe borboleta
Nome Francês | French Name • Papillon raton laveur

Ecologia: Lagoas e recifes interiores de 0 a 30 m, principalmente em encostas rochosas expostas. Juvenis frequentemente nas rochas entre as marés. Frequentemente em agregações inativas durante o dia. Alimentam-se de noite assim como de dia de nudibrânquios, tentáculos de minhoca, pólipos de coral e algas (Lieske, 1994).

Distribuição: Indo-Pacífico: África Oriental até ao Havai, ilhas Marquesas e Ducie. Desde o sul do Japão até ilhas Lord Howe e Rapa. Atlântico Sudeste: Leste de Londres, África do Sul (Fishbase, 2000).

Ecology: Lagoons and seaward reefs from 0 to 30 m, especially in exposed Rocky slopes. Juveniles, often on the rocks between the tides. Often in inactive aggregations during the day. Feeds at night as well as day of Nudibranch, tentacles of earthworm, coral polyps, and algae (Lieske, 1994).

Distribution: Indo-Pacific: East Africa to the Hawaiian, Marquesan, and Ducie islands, north to southern Japan, south to Lord Howe and Rapa islands. Southeast Atlantic: East London, South Africa (Fishbase, 2000).

18.11. *Chaetodon trifasciatus*

Nome Científico | Cientific Name • *Chaetodon trifasciatus* (Park, 1797)
Nome Inglês | English Name • Melon butterflyfish
Nome Português | Portuguese Name • Peixe borboleta
Nome Francês | French Name • Papillon côtelé indien

Ecologia: Áreas de lagoas rasas com riqueza de coral, e recifes interiores semi-protegidos até 20 m. Alimentam-se exclusivamente de pólipos de coral. Geralmente aos pares e com variedades conforme o habitat (Lieske, 1994).

Distribuição: Indo-Pacífico: África Oriental ao Oriente havaiano e ilhas Tuamotu. No entanto, a população do Pacífico tem sido reconhecida como uma subespécie distinta (*Chaetodon Trifasciatus lunulatus* Quoy & Gaimard, 1825 por Burgess 4855), mas de acordo com Randall, pers. comm 1995, *Chaetodon trifasciatus* ocorre apenas no Oceano Índico, enquanto *Chaetodon lunulatus* ocorre apenas no Pacífico (Fishbase, 2000).

Ecology: Reef flats areas, rich in corals, semi-protected reefs to 20 m. Feeds exclusively on coral polyps. Usually in pairs with homerange (Lieske, 1994).

Distribution: Indo-Pacific: East Africa to the Hawaiian and Tuamoto islands. However, the Pacific population has been recognized as a distinct subspecies (Chaetodon trifasciatus lunulatus Quoy & Gaimard, 1825) by Burgess (Ref. 4855) while according to Randall, pers. comm. 1995, Chaetodon trifasciatus occurs only in the Indian Ocean, while Chaetodon lunulatus occurs only in the Pacific (Fishbase, 2000).

18.12. *Chaetodon vagabundus*

Nome Científico | Cientific Name • *Chaetodon vagabundus* (Linnaeus, 1758)
Nome Inglês | English Name • Vagabond butterflyfish
Nome Português | Portuguese Name • Peixe borboleta
Nome Francês | French Name • Papillon vagabond

Ecologia: Recifes rasos, lagoas e recifes interiores até 30 m. As vezes em áreas túrbidas de recifes mortos. Não é comum em qualquer lugar. Frequentemente em pares e alimentam-se principalmente de anémonas, pólipos de coral, poliquetas e algas (Lieske, 1994).

Distribuição: Indo-Pacífico: Mar Vermelho e África Oriental até às ilhas Linha e Tuamotu. Desde o sul do Japão até às ilhas Lord Howe e Austral Intimamente relacionado com *Chaetodon decussatus* (Fishbase, 2000).

Ecology: Reef flats, lagoons and seaward reefs up to 30 m. Sometimes in túrbidas waters of dead reefs. It is common throughout its distribution. Often in pairs and feeds mainly of anemones, polychaetes, coral polyps and algae (Lieske, 1994).

Distribution: Indo-Pacific: Red Sea and East Africa to the Line and Tuamoto islands, north to southern Japan, south to the Lord Howe and the Austral islands. Closely related to *Chaetodon decussates* (Fishbase, 2000).

18.13. *Chaetodon zanzibariensis*

Nome Científico | Cientific Name • *Chaetodon zanzibariensis* (Playfair, 1867)
Nome Inglês | English Name • Zanzibar butterflyfish
Nome Português | Portuguese Name • Peixe borboleta de Zanzibar
Nome Francês | French Name • Papillon de zanzibar

Ecologia: Áreas de lagoas com riqueza de coral e recifes interiores, particularmente entre coberturas de acropora de 3 a 40 m. Geralmente solitários, ocasionalmente aos pares ou em pequenos grupos. Alimentam-se principalmente de pólipos de coral (Lieske, 1994).

Distribuição: Oeste do Oceano Índico: Leste de África até Durban. Também encontrado em ilhas oceânicas (Fishbase, 2000).

Ecology: Areas of coral-rich lagoons and seaward reefs, particularly among acropora coverings from 3 to 40 m. Usually solitary, occasionally in pairs or in small groups. Feed mainly of coral polyps (Lieske, 1994).

Distribution: Western Indian Ocean: East Africa south to Durban, South Africa. Also found in oceanic islands (Fishbase, 2000).

18.14. *Chaetodon meyeri*

Nome Científico | Cientific Name • *Chaetodon meyeri* (Bloch & Schneider, 1801)
Nome Inglês | English Name • Scrawled butterflyfish
Nome Português | Portuguese Name • Peixe borboleta de Meyer
Nome Francês | French Name • Papillon de Meyer

Ecologia: Áreas de lagoas de águas claras e ricas em coral e recifes interiores de 2 a 25 m. Juvenis geralmente entre coral esbranquiçado, adultos geralmente aos pares e com variedade de áreas de uso. Alimentam-se exclusivamente de pólipos de coral (Lieske, 1994).

Distribuição: Indo-Pacífico: Leste de África até às Ilhas Linha. Desde as Ilhas Ryukyu até à Grande Barreira de Coral, incluindo Micronésia e as Ilhas Galápagos (Fishbase, 2000).

Ecology: Areas of clear water lagoons and seaward reefs with rich coral areas from 2 to 25 m. Juveniles, typically between whitish coral. Adults, usually in pairs and with a homerange. They feed exclusively on coral polyps (Lieske, 1994).

Distribution: Indo-Pacific: East Africa to the Line Islands; north to the Ryukyu Islands; south to the Great Barrier Reef; including Micronesia and the Galapagos Islands (Fishbase, 2000).

18.15. *Forcipiger flavissimus*

Nome Científico | Cientific Name • *Forcipiger flavissimus* (Jordan & McGregor, 1898)
Nome Inglês | English Name • Longnose butterfls fish
Nome Português | Portuguese Name • Peixe borboleta narigudo
Nome Francês | French Name • Poisson pincette à long nez

Ecologia: Recifes interiores expostos de 2 a 114 m. Ocasionalmente em recifes de lagoas. Solitários ou em pequenos grupos perto de saliências e grutas. Alimentam-se de invertebrados bentónicos, particularmente pedaços de partes moles cortado a partir de formas sedentárias (Lieske, 1994).

Distribuição: Indo-Pacífico: Mar Vermelho e África Oriental até ao Havai e ilha de Páscoa. Desde o sul do Japão até à Ilha Lord Howe; toda a Micronésia. Pacífico Oriental: sul da Baixa Califórnia, no México e nas ilhas Revillagigedo e Galápagos (Fishbase, 2000).

Ecology: Seaward reefs from 2 to 114 m. Occasionally in coral reefs lagoons. Solitary or in small groups near overhangs and caves. They feed on benthic invertebrates, particularly pieces of soft parts cut from sedentary forms (Lieske, 1994).

Distribution: Indo-Pacific: Red Sea and East Africa to the Hawaiian and Easter islands, north to southern Japan, south to Lord Howe Island; throughout Micronesia. Eastern Pacific: southern Baja California, Mexico and from the Revillagigedo and Galapagos Islands (Fishbase, 2000).

18.16. *Hemitauricthys zoster*

Nome Científico | Cientific Name • *Hemitauricthys zoster* (Bennett, 1831)
Nome Inglês | English Name • Brown-and-white butterflyfish
Nome Português | Portuguese Name • Peixe borboleta pirâmide
Nome Francês | French Name • Papillon pyramide noir

Ecologia: Recifes inclinados virados ao mar e encostas de canais de recifes, em profundidades maiores ou iguais a 35 m. Em grandes agregações acima das bordas superiores das encostas ou corais dispersos na areia. Alimentam-se de zooplâncton. Comum em toda a sua distribuição (Lieske, 1994).

Distribuição: Oceano Índico: África Oriental até Guam; da Índia até às Maurícias (Fishbase, 2000).

Ecology: The sea-facing inclined reefs and slopes of coral reefs, at depths greater than or equal to 35 m. In large aggregations above the top edges of the slopes or corals scattered in the sand. They feed on zooplankton. Common throughout its distribution. (Lieske, 1994).

Distribution: Indian Ocean: East Africa to Guam, north to India, south to Mauritius (Fishbase, 2000).

18.17. *Heniochus acuminatus*

Nome Científico | Cientific Name • *Heniochus acuminatus* (Linnaeus, 1758)
Nome Inglês | English Name • Pennant coralfish
Nome Português | Portuguese Name • Peixe borboleta
Nome Francês | French Name • Poisson cocher commun

Ecologia: Lagoas profundas e recifes interiores de 2 a 75 m, geralmente abaixo de 15 m. Adultos são solitários ou em pares, raramente em grupo. Juvenis as vezes catam parasitas dos corpos de outros peixes, adultos alimentam-se principalmente de zooplâncton, ocasionalmente de invertebrados bentónicos (Lieske, 1994).

Ecology: Deep lagoons and seaward reefs from 2 to 75 m , usually below 15 m. Adults are solitary or in pairs, rarely in group. Juveniles sometimes catch parasites of other fish, adults feed mainly on zooplankton, benthic invertebrates occasionally (Lieske, 1994).

Distribuição: Indo-Pacífico: Leste de África e Golfo Pérsico até às Ilhas Sociedade. Desde o sul do Japão até às ilhas Lord Howe. Ao longo da Micronésia (Fishbase, 2000).

Distribution: Indo-Pacific: East Africa and Persian Gulf to the Society Islands, north to southern Japan, south to Lord Howe Island. Throughout Micronesia (Fishbase, 2000).

18.18. *Heniochus diphreutes*

Nome Científico | Cientific Name • *Heniochus diphreutes* (Jordan, 1903)
Nome Inglês | English Name • False moorish idol
Nome Português | Portuguese Name • Falso ídolo mourisco
Nome Francês | French Name • Poisson-cocher

Ecologia: Recifes interiores de 5 a 210 m, geralmente em águas rasas apenas nas áreas de afloramento nos trópicos. Juvenis em agregações em torno de recifes isolados e dispersos, adultos em grandes cardumes bem acima do fundo. Alimenta-se principalmente de zooplâncton. Os juvenis podem agir como limpadores. (Lieske, 1994).

Ecology: Seaward reefs 5 to 210m, usually below 15m. Generally shallow only in cool upwellings areas in the tropics. Juveniles in aggregations around isolated patch reefs, adults inlarge schools above the bottom. Feeds primarily in zooplankton. (Lieske, 1994).

Distribuição: Indo-Pacífico: Mar Vermelho e África do Sul até à Austrália temperada quente e as ilhas havaianas (Fishbase, 2000).

Distribution: Indo-Pacific: Red Sea and South Africa to warm-temperate Australia and the Hawaiian Islands (Fishbase, 2000).

19. Peixe-anjos ou lebres | Angelfishes

Os peixes-anjo têm cores vivas e uma forma oval quase retangular. Quase todas as espécies têm juvenis com colorações diferentes dos adultos. A boca é pequena como a dos borboletas, mas a sua alimentação é à base de algas, esponjas e ocasionalmente plâncton. Os peixes-anjo crescem mais que os borboletas, chegando a tamanhos de 50 cm e longevidades em cativeiro de 25 anos. Infelizmente fazem parte das capturas artesanais acessórias e maioria das vezes são consumidos em vez de devolvidos ao mar. Noutras regiões tropicais são muito procurados para exportação de peixes de aquários, pelo que grandes esforços de aquacultura com resultados satisfatórios tem contribuído para o alívio da pressão nas populações naturais.

Angelfishes have bright colors and an oval shape near rectangular. In most of the species juveniles have different coloring from the adults. They have small mouths just like butterflyfishes, but they feed mostly on algae, sponges and occasionally plankton. They grow bigger then butterflyfishes reaching sizes of 50 cm and life spans in captivity for 25 years. Unfortunately they are fished in the artisanal fishery and most often are consumed instead of returned to the sea. In other tropical regions they are very popular as fish aquariums for export and being so great efforts in aquaculture with satisfactory results have contributed to the relief of pressure on natural populations.

19.1. *Pomacanthus imperator*

Nome Científico | Cientific Name • *Pomacanthus imperator* (Bloch, 1787)
Nome Inglês | English Name • Emperor angelfish
Nome Português | Portuguese Name • Peixe-anjo imperador
Nome Francês | French Name • Poisson-ange empereur

Ecologia: Juvenis solitários, em rachas ou buracos de recifes rasos, lagoas e canais. Adultos geralmente em áreas ricas de coral em lagoas profundas e recifes interiores, 3 a 70 m, geralmente perto de grutas ou cascalho e grandes pedregulhos. Haremicos, mas geralmente vistos isoladamente ou em pares. Comum (Lieske, 1994).

Distribuição: Indo-Pacífico: Mar Vermelho e África Oriental até ao Havai, ilhas Linha e Tuamotu. Desde o sul do Japão e Ilhas Ogasawara até à Grande Barreira de Coral, Nova Caledónia e ilhas Austrais. Não foi encontrado na Ilha de Páscoa, Rapa e as ilhas Marquesas (Fishbase, 2000).

Ecology: Juveniles, solitaries and in borders or in holes in shallow reefs, lagoons and channels. Adults usually in rich areas of coral in deep lagoons and coral reefs singlets, 3 to 70 m, usually near caves or gravel and large boulders. In harems, but usually single or in pairs. It is not uncommon (Lieske, 1994).

Distribution: Indo-Pacific: Red Sea and East Africa to the Hawaiian, Line and Tuamoto islands, north to southern Japan and the Ogasawara Islands, south to the Great Barrier Reef, New Caledonia, and the Austral Islands. Not found in Easter Island, Rapa and the Marquesan Islands (Fishbase, 2000). and Galapagos Islands (Fishbase, 2000).

19.2. *Pygoplites diacanthus*

Nome Científico | Cientific Name • *Pygoplites diacanthus* (Boddaert, 1772)
Nome Inglês | English Name • Rogal angelfish
Nome Português | Portuguese Name • Peixe-anjo real
Nome Francês | French Name • Poisson-ange duc

Ecologia: Lagoas de águas claras com riqueza de corais e recifes interiores de 1 a 48 m. Frequentemente perto de grutas e fendas. Solitários ou em pares. Alimentam-se de esponjas e tunicados. Juvenis timidos, geralmente em grutas ao longo de declives (Lieske, 1994).

Distribuição: Indo-Pacífico: Mar Vermelho e leste de África até às ilhas Tuamotu. Desde as ilhas Ryukyu e Ogasawara até à Grande Barreira de Coral e Nova Caledónia (Fishbase, 2000).

Ecology: Clear water lagoons with wealth of corals and seaward reefs from 1 to 48 m. Often near caves and crevices. Solitary or in pairs. They feed on sponges and tunicates. Juvenils secretives, generally in caves along the slopes (Lieske, 1994).

Distribution: Indo-Pacific: Red Sea and East Africa to the Tuamoto Islands, north to Ryukyu and Ogasawara islands, south to the Great Barrier Reef and New Caledonia (Fishbase, 2000).

19.3. *Pomacanthus chrysurus*

Nome Científico | Cientific Name • *Pomacanthus chrysurus* (Cuvier, 1831)
Nome Inglês | English Name • Goldtail angelfish
Nome Português | Portuguese Name • Peixe-imperador de cauda dourada
Nome Francês | French Name • Poisson-ange à oreille tachée

Ecologia: Recifes ricos em coral de 1 a 25 m. Hibridizado com *Pomacanthus maculosus.* Incomum (Lieske, 1994).

Distribuição: Oeste do Oceano Índico: Golfo de Aden a Natal, África do Sul e Seychelles, incluindo Comores e Madagáscar (Fishbase, 2000).

Ecology: Coral-rich reef, 1 to 25 m. Hybridized with Pomacanthus maculosus. Uncommon (Lieske, 1994).

Distribution: Western Indian Ocean: Gulf of Aden to Natal, South Africa and including Seychelles, Comoros and Madagascar (Fishbase, 2000).

19.4. *Pomacanthus semicirculatus*

Nome Científico | Cientific Name • *Pomacanthus semicirculatus* (Cuvier, 1831)
Nome Inglês | English Name • Semicircle angelfish
Nome Português | Portuguese Name • Peixe-anjo semicircular
Nome Francês | French Name • Poisson-ange à demi-cercles

Ecologia: Juvenis entre rochas ou corais de areias rasas de recifes protegidos de 30 m, reservados quando pequenos. Adultos em áreas com riqueza de coral em recifes costeiros, geralmente em grutas ou destroços. Solitários. Comum nas Seychelles, sul de Japão a GBR na Austrália (Lieske, 1994).

Distribuição: Indo-Pacífico Ocidental: MMar Vermelho e África Oriental até Samoa. Desde o sul do Japão até ao sul da Austrália Ocidental e Nova Gales do Sul, incluindo a Ilha Lord Howe (Fishbase, 2000).

Ecology: Juveniles, between rocks or corals from shallow sands of coral reefs protected up to 30 m, reserved when small. Adults, in coral-rich areas in coastal reefs, usually in caves or wrecks. Solitaries. Common in Seychelles, and from southern Japan to Australia's great barrier reef (Lieske, 1994).

Distribution: Indo-West Pacific: Red Sea and East Africa to Samoa, north to southern Japan, south to Western Australia and New South Wales, including Lord Howe Island (Fishbase, 2000).

19.5. *Apolemichthys trimaculatus*

Nome Científico | Cientific Name • *Apolemichthys trimaculatus* (Cuvier, 1831)
Nome Inglês | English Name • Threespot angelfish
Nome Português | Portuguese Name • Peixe-anjo trimaculado
Nome Francês | French Name • Poisson-ange trois taches

Ecologia: Lagoas de águas claras e recifes interiores de 3 a 40 m. Tem preferência por áreas de relevo vertical e alimentam-se principalmente de esponjas e tunicados (Lieske, 1994).

Distribuição: Indo-Pacífico Ocidental: Leste de África até a 28º S e a leste, até Samoa. Desde o sul do Japão até à Austrália (Fishbase, 2000).

Ecology: Clear water lagoons and reefs of interiors 3 to 40 m. Has a preference for areas of vertical relief and feed mainly on sponges and tunicates (Lieske, 1994).

Distribution: Indo-West Pacific: East Africa south to 28ºS and east to Samoa, north to southern Japan, south to Australia (Fishbase, 2000).

19.6. *Centropyge bispinosa*

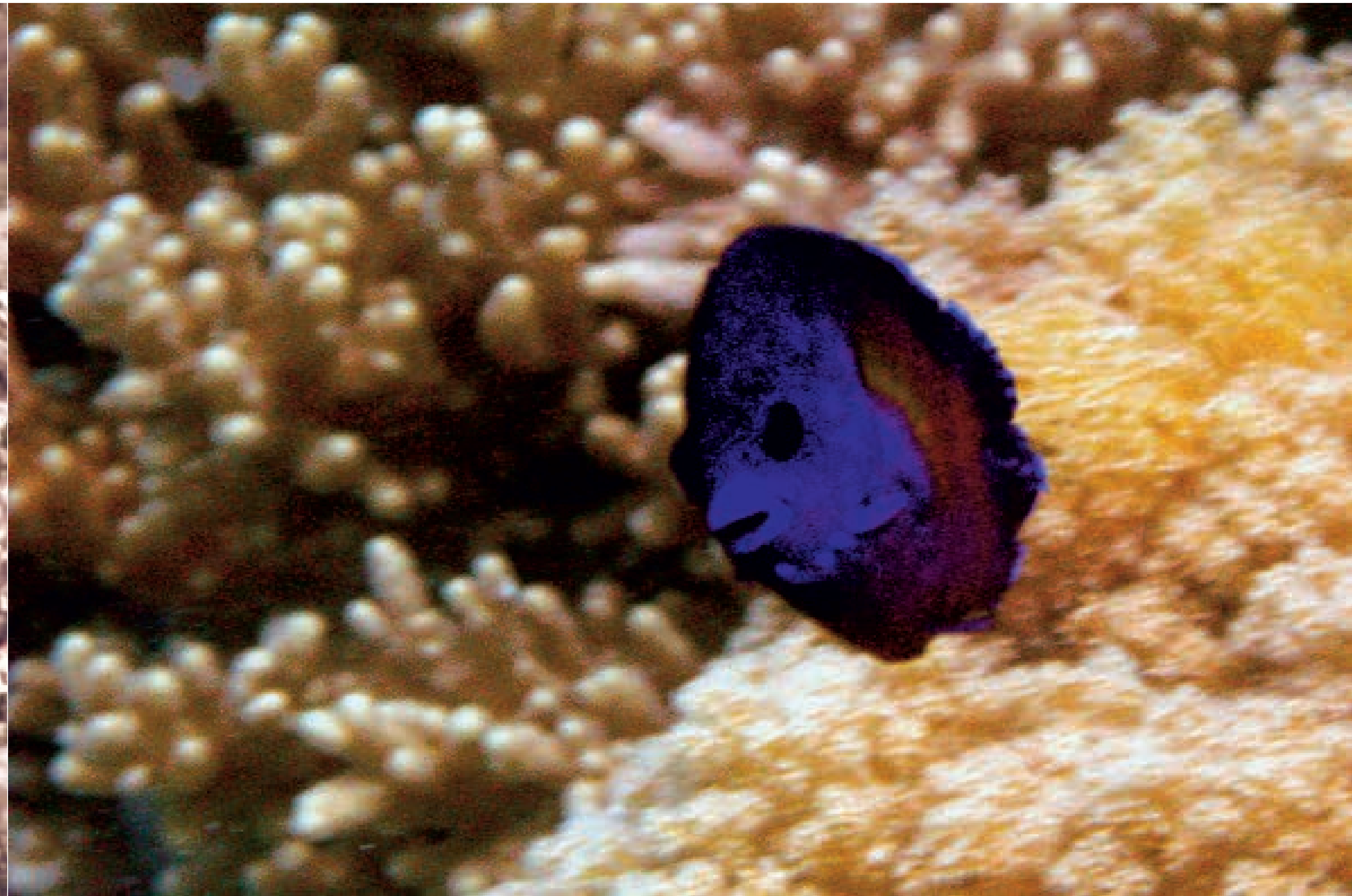
Nome Científico | Cientific Name • *Centropyge bispinosa* (Gonther, 1860)
Nome Inglês | English Name • Twospined angelfish
Nome Português | Portuguese Name • Peixe-anjo de duas espinhas
Nome Francês | French Name • Poisson-ange nain à deux épines

Ecologia: Áreas de lagoa com riqueza de coral e recifes interiores de 5 a 45 m. Comum em Seychelles, Indonésia, Filipinas e ilhas Marshall. Em Guam onde esta espécie é rara tem sido conhecida a reproduzir-se com a espécie *Centropyge Shepard* comum nesta área (Lieske, 1994).

Distribuição: Indo-Pacífico: Leste de África até às Ilhas Tuamotu. Desde a Ilha de Izu até ilha Lord Howe. Não foi encontrado no Mar Vermelho, no Havaí, e no sul do Oceano Pacífico (Fishbase, 2000).

Ecology: Lagoons with coral reefs and seaward reefs, of 5 to 45 m. common in Seychelles, Indonesia, Philippines and the Marshall Islands. In Guam where this species is rare has been known to breed with the resplendent Pygmy species common in this area Shepard (Lieske, 1994).

Distribution: Indo-Pacific: East Africa to the Tuamoto Islands, north to the Izu Island, south to Lord Howe Island. Not found in the Red Sea, Hawaii, and the southern Pacific Ocean (Fishbase, 2000).



20. Castanhetas e peixes palhaços das anémonas | Chromis and anemones clownfish

Umas das mais numerosas famílias de peixes, os pomacentridae, exibem uma grande variedade de géneros e formas de vida. Exceto raros espécimes, todos os membros são demersais e costeiros. A região do indo-pacifico é a região que mais espécies têm desta família. Os géneros Pleroglyphidon, Hemiglyphidon e stegaste são herbívoros e defendem energeticamente os campos de algas filamentosas de que se alimentam. Os visitantes não são bem-vindos e são mesmo ativamente expulsos com mordidelas se for preciso, não importa o tamanho do intruso.

Os géneros Chromis, Dascyllus et lepidozygus vivem na coluna de água onde se alimentam de pequenos organismos. O peixe palhaço, celebrizado no filme da Disney «Em busca de Nemo», é apanhado para um aquário e depois volta ao mar à procura da sua anémona, a sua casa. Como o filme mostra, os peixes palhaços vivem numa anémona cheia de células urticantes. Para não serem picados pelas células urticantes, o seu muco tem que possuir compostos químicos que os

Pomacentridae is one of the biggest fish families. They exhibit a wide variety of shapes kinds of life. With few exceptions, all its members are demersal and coastal. The region with most species of this family is the Indo-pacific. Pleroglyphidon, Hemiglyphidon e Stegaste are herbivores and vigorously defend the fields of filamentous algae on which they feed. Visitors are not welcome and are even actively expelled with nibbles if needed, no matter the size of the intruder.

Chromis, Dascyllus and Lepidozygus live in the water column where they feed on small organisms. The clown fish, made famous in the Disney movie «In search of Nemo», is taken to an aquarium and then back to the sea in search of its anemone, its home. As depicted on the film, clownfishes live in anemones full of stinging cells. In order not to be affected by the stinging cells, its mucus contains chemical compounds that make them go unnoticed to the sensory systems of anemones. Thus they gain a protected home and the anemone feeds on the leftovers and the feces of the clownfish. But the

fazem passar despercebidos aos sistemas sensoriais da anémona. Deste modo eles ganham uma casa com proteção e a anémona pode aproveitar os restos de comida e as fezes dos peixes palhaço para se alimentar. Mas o peixe palhaço não para de nos surpreender: ele tem um ciclo de vida protândrico, começa por ser macho e depois muda para fêmea. Na realidade, numa mesma anémona, vive uma fêmea grande com vários machos e juvenis. Quando ela desaparece, o macho maior passa a fêmea e fica a controlar a anémona. Na verdade a hormona do stress, o cortisol, é mantida elevada no macho pela fêmea que o «stressa». Quando a fêmea desaparece os níveis de cortisol baixam e os machos "correm" para mudar de sexo, o primeiro a desenvolver-se em fêmea volta a impor os mesmo regime e todos voltam a ser machos.

clown fish keeps surprising us: he has a life cycle protandric; he begins as male and then change to female. In fact, in the same anemone, live a large female with several males and juveniles. When she disappears, the largest male becomes female and controls the anemone. Indeed the stress hormone, cortical, is kept high in the male by the female that «stresses» him. When the female disappears cortisol levels fall and males «run» to change sex, the first to develop into a female, again imposes the same rules and all of the others return to male.

20.1. *Chromis dimidiata*

Nome Científico | Cientific Name • *Chromis dimidiata* (Klunzinger, 1871)
Nome Inglês | English Name • Chocolatedip chromis
Nome Português | Portuguese Name • Castanheta chocolate
Nome Francês | French Name • Chromis à deux couleurs

Ecologia: Lagoas e recifes interiores, 1 a 36 m. Abundante, em grande agregação na parte superior de recifes e bordas superiores de declives (Lieske, 1994).

Distribuição: Oeste do Oceano Índico: restrito ao Mar Vermelho (Fishbase, 2000).

Ecology: Lagoons and reefs, from 1 to 36 m. Abundant in large aggregation on top of reefs and top edges of slopes (Lieske, 1994).

Distribution: Western Indian Ocean: restricted to the Red Sea (Fishbase, 2000).

Chromis dimidiata (Indivíduo)

Chromis dimidiata (Grupo)

20.2. *Chromis ternatensis*

Nome Científico | Cientific Name • *Chromis ternatensis* (Bleeker, 1856)
Nome Inglês | English Name • Ternate chromis
Nome Português | Portuguese Name • Castanheta
Nome Francês | French Name • Chromis à quele d'hirondelle

Ecologia: Margem superior de lagoas de águas claras e recifes interiores de 2 a 36 m. Em agregação por cima de corais ramificados (Lieske, 1994).

Distribuição: Indo-Pacífico: Mar Vermelho e África Oriental até Samoa e Tonga. Desde as Ilhas Ryukyu até à Nova Caledónia (Fishbase, 2000).

Ecology: Top margin of clear water lagoons and seaward reefs from 2 to 36 m. Aggregate over branched corals (Lieske, 1994).

Distribution: Indo-Pacific: Red Sea and East Africa to Samoa and Tonga, north to the Ryukyu Islands, south to New Caledonia (Fishbase, 2000).

20.3. *Chromis opercularis*

Nome Científico | Cientific Name • *Chromis opercularis* (Gonther, 1867)
Nome Inglês | English Name • Doublebar chromis
Nome Português | Portuguese Name • Castanheta com duas barras
Nome Francês | French Name • Chromis à tache operculaire noire

Ecologia: Recifes interiores e lagoas profundas de 4 a 40 m (Lieske, 1994).

Distribuição: Oceano Índico: generalizada no oeste do Oceano Índico e no Mar Andaman, também conhecido na ilha de Natal (Fishbase, 2000).

Ecology: Seaward reefs and deep lagoons, 4 to 40 m (Lieske, 1994).

Distribution: Indian Ocean: widespread in the western Indian Ocean and Andaman Sea; also known from Christmas Island. Western Pacific: Taiwan, Australia and Vanuatu Island (Fishbase, 2000).

20.4. *Abudefduf sparoides*

Nome Científico | Cientific Name • *Abudefduf sparoides* (Quoy & Gaimard, 1825)
Nome Inglês | English Name • False-eye sergeant
Nome Português | Portuguese Name • Sargento de olho falso
Nome Francês | French Name • Sergent-major à tache ovale

Ecologia: Coral e recifes rochosos com moderada acção das ondas de 1 a 12 m. Juvenis em lagoas rasas entre corais moles de 0.3 a 2 m. Solitários ou em agregações soltas (Lieske, 1994).

Distribuição: Oeste do Oceano Índico: entre Quénia e Natal, África do Sul, também Aldabra, Madagáscar, Reunião e Maurícias (Fishbase, 2000).

Ecology: Coral and rocky reefs with moderate wave action of 1 to 12 m. Juveniles in shallow lagoons between soft corals of 0.3 to 2 m. Solitary or in loose aggregations (Lieske, 1994).

Distribution: Western Indian Ocean: between Kenya and Natal, South Africa; also Aldabra, Madagascar, Réunion and Mauritius (Fishbase, 2000).

20.5. *Abudefduf vaigiensis*

Nome Científico | Cientific Name • *Abudefduf vaigiensis* (Quoy & Gaimard, 1825)
Nome Inglês | English Name • Indo-Pacific sergeant
Nome Português | Portuguese Name • Sargento do indo-pacífico
Nome Francês | French Name • Poisson bagnard

Ecologia: Lagoas de costas rochosas, lagoas e recifes interiores até 12 m. Alimentam-se de zooplâncton, algas betónicas e pequenos invertebrados, frequentemente em grandes agregações na água (Lieske, 1994).

Distribuição: Indo-Pacífico: Mar Vermelho e leste de África até às ilhas Linha e Tuamotu. Desde o sul do Japão até à Austrália. Registado em Bay of Islands, Nova Zelândia. Muitas vezes confundido com a espécie Atlântica *Abudefduf saxatilis*. Substituído por *Abudefduf abdominalis* nas ilhas havaianas (Fishbase, 2000).

Ecology: Lagoons of rocky shores, reefs and lagoons interiors until 12 m. feed on zooplankton, algae, betónicas and small invertebrates, often in large shoals in the water (Lieske, 1994).

Distribution: Indo-Pacific: Red Sea and eastern Africa to the Line and Tuamoto islands, north to southern Japan, south to Australia. Recorded in Bay of Islands, New Zealand. Often confused with the closely related Atlantic species Abudefduf saxatilis. Replaced by Abudefduf abdominalis in the Hawaiian Islands (Fishbase, 2000).

20.6. *Dascyllus aruanus*

Nome Científico | Cientific Name • *Dascyllus aruanus* (Linnaeus, 1758)
Nome Inglês | English Name • Whitetail dascyllus
Nome Português | Portuguese Name • Castanheta de cauda branca
Nome Francês | French Name • Demoiselle à trois bandes noires

Ecologia: Águas abrigadas de 0.5 a 20 m. Entre ramificações de coral, principalmente nos recifes rasos junto ao limite da maré baixa (Lieske, 1994).

Distribuição: Indo-Pacífico Ocidental: Mar Vermelho e África Oriental até às Linhas Marquesas e Tuamotu. Desde o sul do Japão até Sydney na Austrália (Fishbase, 2000).

Ecology: Sheltered waters of 0.5 to 20 m. Between coral branches, mainly in shallow reefs along the edge of the low tide (Lieske, 1994).

Distribution: Indo-West Pacific: Red Sea and East Africa to the Line, Marquesan and Tuamoto islands, north to southern Japan, south to Sydney, Australia (Fishbase, 2000).

20.7. *Pomacentrus caeruleus*

Nome Científico | Cientific Name • *Pomacentrus caeruleus* (Quoy & Gaimard, 1825)
Nome Inglês | English Name • Caerulean damsel
Nome Português | Portuguese Name • Castanheta
Nome Francês | French Name • Demoiselle blue

Ecologia: Lagoas e encostas de recifes exteriores, no cascalho perto da base dos recifes de 1 a 20 m. Em agregações soltas (Lieske, 1994).

Distribuição: Oeste do Oceano Índico: Leste de África até Durban e Maldivas. Registado numa fotografia em Bali, na Indonésia (Fishbase, 2000).

Ecology: Lagoons and outer reef slopes in the gravel near the base of the coral reefs 1 to 20 m. In loose aggregations (Lieske, 1994).

Distribution: Western Indian Ocean: East Africa (south to Durban) to Maldives. Recorded from a photo in Bali, Indonesia (Fishbase, 2000).

20.8. *Pomacentrus sulfureus*

Nome Científico | Cientific Name • *Pomacentrus sulfureus* (Klunzinger, 1871)
Nome Inglês | English Name • Sulphur damsel
Nome Português | Portuguese Name • Castanheta azul
Nome Francês | French Name • Demoiselle blue

Ecologia: Recifes de coral perto da costa em áreas de rico crescimento de coral de 0.5 a 15 m (Lieske, 1994).

Distribuição: Oeste do Oceano Índico: Mar Vermelho e África Oriental (até cerca de 21° S) e Madagáscar, Maurícias, Comores e Seychelles (Fishbase, 2000).

Ecology: Coral reefs close to shore in areas of rich coral growth of 0.5 to 15 m (Lieske, 1994).

Distribution: Western Indian Ocean: Red Sea and East Africa (to about 21° S) and Madagascar, Mauritius, Comoros, and Seychelles (Fishbase, 2000).

20.9. *Pomacentrus philippinus*

Nome Científico | Cientific Name • *Pomacentrus philippinus* (Evermann & Seale, 1907)
Nome Inglês | English Name • Philippine damsel
Nome Português | Portuguese Name • Castanheta
Nome Francês | French Name • Demoiselles des Philippines

Ecologia: Lagoas, canais e encostas de recifes interiores de 1 a 12 m. Em grupos perto de saliências (Lieske, 1994).

Distribuição: Indo-Pacífico Ocidental: Maldivas até Rowley Shoals, Nova Caledónia e Fiji. Desde as Ilhas Ryukyu. Recentemente registado em Tonga (Fishbase, 2000).

Ecology: Lagoons, canals and slopes of seaward reefs from to 12 m. In groups, near protrusions (Lieske, 1994).

Distribution: Indo-West Pacific: Maldives to Rowley Shoals, New Caledonia, and Fiji, north to the Ryukyu Islands. Recently recorded from Tonga(Fishbase, 2000).

20.10. *Plectroglyphidodon lacrymatus*

Nome Científico | Cientific Name • *Plectroglyphidodon lacrymatus* (Quoy & Gaimard, 1825)
Nome Inglês | English Name • whitespotted devil
Nome Português | Portuguese Name • Castanheta
Nome Francês | French Name • Demoiselle à points bleus

Ecologia: Lagoas de águas e recifes interiores de 1 a 40 m em áreas de mistura de coral e pedregulho ou pedras de coral morto. Ocupam substratos entre corais cobertos por algas (Lieske, 1994).

Distribuição: Indo-Pacífico: Mar Vermelho e África Oriental até às ilhas Marshall e Sociedade. Desde as ilhas Ryukyu, até à Austrália (Fishbase, 2000).

Ecology: Water lagoons and seaward reefs from1 to 40 m in areas of mixed coral and boulder or dead coral stones. Occupy substrates between corals covered by algae (Lieske, 1994).

Distribution: Indo-Pacific: Red Sea and East Africa to the Marshall and Society islands, north to the Ryukyu Islands, south to Australia (Fishbase, 2000).

20.11. *Plectroglyphidodon dickii*

Nome Científico | Cientific Name • *Plectroglyphidodon dickii* (Lionard, 1839)
Nome Inglês | English Name • Blackbar devil
Nome Português | Portuguese Name • Castanheta
Nome Francês | French Name • Demoiselle à barre noire

Ecologia: Áreas ricas em coral de recifes interiores de 1 a 12 m. Entre robustos poliplacoforas ramificados e corais de acropora, frequentemente em áreas de rebentação. As espécies de Plectroglyphidodon são omnívoros e territoriais, alimentam-se principalmente de algas filamentosos e pequenos invertebrados bentónicos (Lieske, 1994).

Distribuição: Indo-Pacífico: África Oriental até às ilhas Linha e Tuamotu. Desde o Japão até à Austrália (Fishbase, 2000).

Ecology: Areas rich in seaward reefs from 1 to 12 m. Between robust branched coral acropora and poliplacoforas, often in areas of surf. Plectroglyphidodon species are territorial and omnívoras, feeding mostly on algae and small invertebrates benthic filamentous (Lieske, 1994).

Distribution: Indo-Pacific: East Africa to the Line and Tuamoto islands, north to Japan, south to Australia (Fishbase, 2000).

20.12. *Neoglyphidodon melas*

Nome Científico | Cientific Name • *Neoglyphidodon melas (juvenil)* (Cuvier, 1830)
Nome Inglês | English Name • Bowtie damselfish
Nome Português | Portuguese Name • Castanheta negra
Nome Francês | French Name • Demoiselle noire

Ecologia: Lagoas e recifes interiores perto de coral mole de 1 a 12 m. Juvenis entre coral Acropora. Alimentam-se de coral mole. Adultos frequentemente encontram-se perto das ameijoas gigantes e podem alimentar-se das suas próprias fezes (Lieske, 1994).

Distribuição: Indo-Pacífico Ocidental: Mar Vermelho e África Oriental ao arquipélago de Indo-Malaio, Filipinas, Taiwan, Ilhas Ryukyu, Palau, Nova Guiné, Ilhas Salomão, Vanuatu, e no norte da Austrália (Fishbase, 2000).

Ecology: Lagoons and seaward reefs near soft coral from 1 to 12 m. Juveniles, between coral Acropora. They feed on soft coral. Adults often find themselves near the giant clams and can feed off of his own feces (Lieske, 1994).

Distribution: Indo-West Pacific: Red Sea and East Africa to the Indo-Malayan Archipelago, Philippines, Taiwan, Ryukyu Islands, Palau, New Guinea, Solomon Islands, Vanuatu, and northern Australia (Fishbase, 2000).

20.13. *Amblyglyphidodon leucogaster*

Nome Científico | Cientific Name • *Amblyglyphidodon indicus* (Bleeker, 1847)
Nome Inglês | English Name • Yellowbelly damselfish
Nome Português | Portuguese Name • Castanheta de barriga amarela
Nome Francês | French Name • Demoiselle jeune

Ecologia: Individuais ou em pequenos grupos em áreas de lagoas profundas com riqueza de coral e recifes interiores de 2 a 34 m (Lieske, 1994).

Distribuição: Indo-Pacífico Ocidental: Mar Vermelho e leste de África até à Melanésia Micronésia e as Ilhas Samoa. Desde as Ilhas Ryukyu até às Rowley Shoals e Grande Barreira de Coral. Mais estudos são necessários para determinar se a população no Oceano Índico-Mar Vermelho representa uma espécie distinta (Fishbase, 2000).

Ecology: Solitary or in small groups in areas of deep coral-rich lagoons and seaward reefs from 2 to 34 m (Lieske, 1994).

Distribution: Indo-West Pacific: Red Sea and eastern Africa to Melanesia, Micronesia and the Samoa Islands; Ryukyu Islands south to Rowley Shoals and Great Barrier Reef. Further study is required to determine if the Indian Ocean-Red Sea population represents a distinct species (Fishbase, 2000).

20.14. *Amphiprion allardi*

Nome Científico | Cientific Name • *Amphiprion allardi* (Klausewitz, 1970)
Nome Inglês | English Name • Twobar anemonefish
Nome Português | Portuguese Name • Peixe palhaço de Allard
Nome Francês | French Name • Poisson-clown d'Allard

Ecologia: Recifes protegidos de 1 a 30 m. Com as anémonas *Entacmaea quadricolor, Heteractis aurora,* e *Stichodactyla mertensii.* Comum no Quénia (Lieske, 1994).

Distribuição: Oeste do Oceano Índico: Quénia a Durban, África do Sul, a leste das Maurícias (Fishbase, 2000).

Ecology: Coral reefs protected from 1 to 30 m. Im the anemones Entacmaea quadricolor, Heteractis aurora, and Stichodactyla mertensii. Common in Kenya (Lieske, 1994).

Distribution: Western Indian Ocean: Kenya to Durban, South Africa, east to Mauritius (Fishbase, 2000).

20.15. *Amphiprion akallopisos*

Nome Científico | Cientific Name • *Amphiprion akallopisos* (Bleeker, 1853)
Nome Inglês | English Name • Skunk clownfish
Nome Português | Portuguese Name • Peixe palhaço
Nome Francês | French Name • Poisson-clown mouffette

Ecologia: De 3 a 25 m, com *Amphiprion allardi* nas anémonas *Heteractis magnifica* e *Stichodactyla mertensii* (Lieske, 1994).

Distribuição: Indo-Pacífico Ocidental: Leste da África, Madagáscar, Ilhas Comores, Seychelles, Mar de Andaman, Sumatra e as Ilhas Seribu (Mar de Java). Não foi encontrado nas Maldivas e Sri Lanka (Fishbase, 2000).

Ecology: From 3 to 25 m, with Amphiprion allardi in anemone Stichodactyla mertensii and Heteractis magnifica (Lieske, 1994).

Distribution: Indo-West Pacific: East Africa, Madagascar, Comoro Islands, Seychelles, Andaman Sea, Sumatra and the Seribu Islands (Java Sea). Not found in Maldives and Sri Lanka (Fishbase, 2000).

21. Bodiões | Wrasses

uma miríade de formas e de cores | a miriad of shapes and colors

Os bodiões têm a forma típica de peixe, a maior parte das vezes com uma barbatana dorsal única e longa. Os seus lábios são grossos e proeminentes e por isso o seu nome em latim é Labridae. É uma família importante de peixes exibindo grande diversidade de tamanhos, formas e cores. A coloração normalmente muda com a idade, mas também com o sexo e mesmo com as regiões. Estas variações complicam a identificação das espécies. A maioria é de tamanho reduzido, no entanto o maior deles, o bodião napoleão (cheilinus undulatus) pode chegar a medir 2 m e pesar 20 kg. Este bodião napoleão tem uma função ecológica nos recifes de corais controlando a perigosa estrela-do-mar acanthigaster plancii que come corais, mas também os ouriços que podem proliferar excessivamente se houver algas. Outros, como o peixe limpador (labroides dimidiatus), executam o trabalho de limpeza dos parasitas, em estações de limpeza estabelecidas onde os peixes aparecem e fazem postura especial para serem limpos. Estes bodiões entram dentro da boca, nas branquias, reduzindo a carga para-

Wrasses have the typical fish shape, most of the times with a single long dorsal fin. Due to their typical thick and prominent lips their Latin name is Labroid. It is an important family including a wide variety of sizes, shapes and colors. The coloring changes not only with the age but also with the sex (gender) and region. These variations difficult species identification. Most of them have a small size, however the biggest of them, napoleon wrasse (cheilinus undulatus) can reach the 2 m and weight 20 kg. This Napoleon Wrasse has an important ecological function in coral reefs by keeping under control the dangerous starfish acanthigaster plancii that eats corals, but also sea urchins that can proliferate excessively if there are enough algae. Others such as the cleaner wrasse (labroides dimidiatus), perform the parasite cleaning job in cleaning stations established in places where fishes pass by and make a special poise for cleanning. These wrasses get into the mouth and gills, thus reducing the parasites charge and being of good service for the coral reef fishes. At night síticas dos peixes prestando um serviço importantes aos peixes de recife. Estes peixes dormem à noite escondidos no coral ou mesmo enterrados na areia. Alimentam-se de invertebrados, zooplâncton ou ainda de pequenos peixes, conforme a espécie. Grande número de bodiões é hermafrodita protogínico isto é, começa por ser fêmea e depois passa a macho. Ao final do dia, executam paradas reprodutivas muito características. Podem também formar grupos de várias fêmeas dominadas por um macho, que provem da reversão sexual da maior das fêmeas. Numa espécie podem existir dois tipos de machos: os que nasceram machos e que serão machos toda a vida; e os machos secundários, provenientes da inversão sexual da fêmea. Para complicar, os comportamentos sexuais da mesma espécie de bodião podem mudar conforme a região. Não são espécies de grande interesse pesqueiro, exceto as de maior tamanho como o bodião napoleão. No entanto as espécies mais coloridas e pequenas são importante para o comércio de peixes de aquário devido à sua resistência, cor, tamanho e comportamento. Em Moçambique não são consideradas importantes para a pesca comercial, mas sim como pesca de subsistência, normalmente à linha sendo consumidos localmente.

they sleep hidden in the coral or even buried in the sand. They feed on invertebrate, zooplankton small fishes, according with the species. A great number of wrasses are protoginic hermaphrodite, this is, they start by being a female and then turn into a male. They execute very characteristic, reproductive parades at the end of the day. They can also gather in groups of several females dominated by one male fruit of the sexual reversion of the biggest of the females. In one species there may exist 2 types of males: the ones that were born males and will be males for the rest of their lives; and the secondary males, fruit of the sexual reversion of the female. Moreover the sexual behaviors of the same species can change according with region. From the commercial point of view they are not very important, exception made for the large species such as the Napoleon wrasse. However the smaller and very colorful species are very important for the aquarium industry due to their resistance, color, size and behavior. In Mozambique they're not considered important for commercial fishery, only for subsistence fishery, usually caught by anglers and consumed locally.

21.1. *Anampses meleagrides*

Nome Científico | Cientific Name • *Anampses meleagrides* (Valenciennes, 1840)
Nome Inglês | English Name • Spotted wrasse
Nome Português | Portuguese Name • Bodião pintado de cauda amarela
Nome Francês | French Name • Labre à quele jaune

Ecologia: Recifes interiores em áreas de mistura de coral, pedregulho, rochas ou areia, de 4 a 60 m (Lieske, 1994).

Distribuição: Indo-Pacífico: Mar Vermelho e África Oriental até à Samoa e Ilhas Tuamotu. Desde o sul do Japão (Fishbase, 2000).

Ecology: Seaward reefs of mixed coral, gravel, rocks or sand, from 4 to 60 m (Lieske, 1994).

Distribution: Indo-Pacific: Red Sea and East Africa to Samoa and the Tuamoto Islands, north to southern Japan (Fishbase, 2000).

21.2. *Anampsse twistii*

Nome Científico | Cientific Name • *Anampses twistii* (Bleeker, 1856)
Nome Inglês | English Name • Yellowbreasted wrasse
Nome Português | Portuguese Name • Bodião de ventre amarelo
Nome Francês | French Name • Labre à poitrine jaune

Ecologia: Lagoas de águas claras e recifes interiores em áreas de mistura de coral, entulho, rochas ou areia. Desda zona com ondas até 30 m (Lieske, 1994).

Distribuição: Indo-Pacífico: Mar Vermelho até às Ilhas Tuamoto. Desde as Ilhas Ryukyu até Rapa (Fishbase, 2000).

Ecology: Clear water lagoons and seaward reefs of mixed coral, gravel, rocks or sand. From the zone with waves up to 30 m (Lieske, 1994).

Distribution: Indo-Pacific: Red Sea to the Tuamoto Islands, north to Ryukyu Islands, south to Rapa (Fishbase, 2000).

21.3. *Anampses lineatus*

Nome Científico | Cientific Name • *Anampses lineatus* (Randall, 1972)
Nome Inglês | English Name • Lined wrasse
Nome Português | Portuguese Name • Bodião listado
Nome Francês | French Name • Labre à tirets blancs

Ecologia: Lagoas e recifes interiores, geralmente mais profundo do que 20 até 42 m, em áreas de coral e cascalho (Lieske, 1994).

Distribuição: Indo-Pacífico Ocidental: Mar Vermelho até Natal, África do Sul, e Bali, na Indonésia (Fishbase, 2000).

Ecology: Lagoons and reefs, usually deeper than 20 m and up to at least 42 m, in coral and gravel (Lieske, 1994).

Distribution: Indo-West Pacific: Red Sea south to Natal, South Africa and east to Bali, Indonesia (Fishbase, 2000).

21.4. *Bodianus anthioides*

Nome Científico | Cientific Name • *Bodianus anthioides* (Bennett, 1832)
Nome Inglês | English Name • Lyretail anthioides
Nome Português | Portuguese Name • Bodião de cauda em lira
Nome Francês | French Name • Labre lyre

Ecologia: Recifes interiores, geralmente à volta de paredes de 6 a 60 m. Espécies de Bodianus são geralmente solitárias e alimentam-se principalmente de invertebrados bentónicos que são esmagados com os dentes da faringe (Lieske, 1994).

Distribuição: Indo-Pacífico: Mar Vermelho até à África do Sul e ilhas Linha e Tuamotu. Desde o sul do Japão até à Nova Caledónia e Ilhas Australis (Fishbase, 2000).

Ecology: Seaward reefs, usually around 6 to 60 m. Species of Bodianus are usually solitary and feed mainly of benthic invertebrates which are crushed with the pharyngeal teeth (Lieske, 1994).

Distribution: Indo-Pacific: Red Sea to South Africa and east to the Line and Tuamoto islands, north to southern Japan, south to New Caledonia and the Austral Islands (Fishbase, 2000).

21.5. *Bodianus axillaris*

Nome Científico | Cientific Name • *Bodianus axillaris* (Bennett, 1832)
Nome Inglês | English Name • Axilspot hogfish
Nome Português | Portuguese Name • Bodião axillar
Nome Francês | French Name • Labre à tache axillaire

Ecologia: Lagoas de águas claras e recifes interiores de 2 a 40 m. Juvenis geralmente em grutas ou debaixo de saliências onde por vezes são limpadores (Lieske, 1994).

Distribuição: Indo-Pacífico: Mar Vermelho até à África do Sul, as ilhas Marshall, Marquesas e Tuamotu, a norte desde o Japão (Fishbase, 2000).

Ecology: Clear water lagoons and seaward reefs from 2 to 40 m. Juveniles generally in caves or under ledges where sometimes are cleaners (Lieske, 1994).

Distribution: Indo-Pacific: Red Sea to South Africa, east to the Marshall, Marquesan and Tuamoto islands, north to Japan (Fishbase, 2000).

21.6. *Cheilinus fasciatus*

Nome Científico | Cientific Name • *Cheilinus fasciatus* (Bloch, 1791)
Nome Inglês | English Name • Redbreast wrasse
Nome Português | Portuguese Name • Bodião de ventre vermelho
Nome Francês | French Name • Labre maori rayé

Ecologia: Lagoas e recifes interiores de 4-40m. Comum em áreas de mistura de coral, areia e pedregulho. Frequentemente seguem mergulhadores para caçar invertebrados expostos pelas barbatanas dos mergulhadores (Lieske, 1994).

Distribuição: Indo-Pacífico: Mar Vermelho e África Oriental até à Micronésia e Samoa. A norte desde as ilhas Ryukyu (Fishbase, 2000).

Ecology: Lagoons and seaward reefs from 4 to at least 40 m. Common in areas of mixed coral, sand and gravel. Often follows divers to hunt invertebrates exposed by the diver's fins (Lieske, 1994).

Distribution: Indo-Pacific: Red Sea and East Africa to Micronesia and Samoa, north to the Ryukyu Islands (Fishbase, 2000).

21.7. *Cheilinus undulatus*

Nome Científico | Cientific Name • *Cheilinus undulatus* (Roppel, 1835)
Nome Inglês | English Name • Humphead wrasse
Nome Português | Portuguese Name • Bodião Napoleão
Nome Francês | French Name • Napoléon

Ecologia: Lagoas e recifes interiores de 1 a pelo menos 60m. Juvenis ocorrem entre corais ramificados em lagoas rasas, adultos preferem margens superiores de pináculos em lagoas de águas claras e encostas com canais de coral e geralmente em grutas onde repousam. Geralmente solitários. Alimentam--se principalmente de moluscos e uma ampla variedade de invertebrados com boas conchas; chegam mesmo a comer presas toxicas, tais como a estrela-do-mar coroa de espinhos, peixe caixa, ou lebres do mar. Extremamente cautelosos, exceto quando protegidos e alimentados por mergulhadores. Podem ser tóxicos em certas áreas (Lieske, 1994).

Ecology: Lagoons and seaward reefs from1 at least 60 m. Juveniles occur between branched corals in shallow lagoons adults. Prefer upper margins of pinnacles in clear water lagoons and slopes with coral channels and caves where they lie. Usually solitary. Feed mainly on shellfish and a wide variety of invertebrates with good shells; actually eating toxic prey, such as starfish, Crown of thorns, box fish or sea hares. Extremely cautious, except when protected and fed by divers. May be toxic in certain areas (Lieske, 1994).

Distribuição: Indo-Pacífico: Mar Vermelho até à África do Sul e Ilhas Tuamotu. Desde as Ilhas Ryukyu até Nova Caledónia. Anteriormente conhecido como Vulnerável (A1d 2 cd) (Y. Sadovy), mas agora listado como ameaçado pela IUCN 2004 e no Apêndice II da CITES (Fishbase, 2000).

Distribution: Indo-Pacific: Red Sea to South Africa and to the Tuamoto Islands, north to the Ryukyu Islands, south to New Caledonia. Formerly known as Vulnerable (A1d+2cd) (Y. Sadovy) but now listed as Endangered in IUCN 2004 and listed in Appendix II of CITES (Fishbase, 2000).

21.8. *Coris aygula*

Nome Científico | Cientific Name • *Coris aygula* (Lacepède, 1801)
Nome Inglês | English Name • Clown coris
Nome Português | Portuguese Name • Bodião palhaço
Nome Francês | French Name • Girelle-clown

Ecologia: Recifes rasos expostos, lagoas e recifes interiores até pelo menos 30m, geralmente perto de área de areia e cascalho. Alimentam-se de invertebrados com conchas duras tais como: moluscos, crustáceos, e ouriços-do-mar (Lieske, 1994).

Ecology: Exposed flat reefs, lagoons and seaward reefs to 30 m, usually near patches of sand and gravel. They feed on invertebrates with hard shells such as molluscs, crustaceans, and sea urchins (Lieske, 1994).

Distribuição: Indo-Pacífico: Mar Vermelho e África Oriental até às ilhas Linha e Ducie. Desde o sul do Japão até Lord Howe e Rapa (Fishbase, 2000).

Distribution: Indo-Pacific: Red Sea and East Africa to the Line and Ducie islands, north to southern Japan, south to Lord Howe and Rapa islands (Fishbase, 2000).

Coris aygula (adulto)

Coris aygula (Juvenil)

21.9. *Coris formosa*

Nome Científico | Cientific Name • *Coris formosa* (Bennett, 1830)
Nome Inglês | English Name • Queen coris
Nome Português | Portuguese Name • Bodião rainha
Nome Francês | French Name • Girelle reine

Distribuição: Oeste do Oceano Índico: sul do Mar Vermelho até Natal, África do Sul e Sri Lanka.

Distribution: Western Indian Ocean: southern Red Sea to Natal, South Africa and east to Sri Lanka.

(Juvenil)

21.10. *Coris cuvieri*

Nome Científico | Cientific Name • *Coris cuvieri* (Bennett, 1831)
Nome Inglês | English Name • African coris
Nome Português | Portuguese Name • Bodião africano
Nome Francês | French Name • Girelle africaine

Ecologia: Áreas de corais misturados, com areia e cascalho de recifes expostos, e lagoas exteriores até 50 m (Lieske, 1994)

Ecology: Coral areas mixed with sand and gravel reefs exposed, and ponds outside the air 50 m (Lieske, 1994)

Distribuição: Oceano índico: Mar Vermelho e ao longo do sul da Península Arábica, até Zanzibar e África do Sul (30º S). Para Este: arquipélagos das Laccadivas, Chago, Maldivas, Sri Lanka e ilhas Similan e mar de Andaman (Fishbase, 2000).

Distribution: Indian Ocean: Red Sea and along the southern Arabian Peninsula south to Zanzibar and South Africa (30º S) and east to the Laccadive Archipelago, Chagos Archipelago, Maldives, Sri Lanka, and the Similan Islands, eastern Andaman Sea (Fishbase, 2000).

21.11. *Epibulus insidiator*

Nome Científico | Cientific Name • *Epibulus insidiator* (Pallas, 1770)
Nome Inglês | English Name • Sling-jaw wrasse
Nome Português | Portuguese Name • Bodião de mandibula amovível
Nome Francês | French Name • Labre traître

Ecologia: Lagoas e recifes interiores em áreas ricas em coral de 1 a 42m. Usam a boca tubular para se alimentar de pequenos crustáceos que habitam corais e peixes (Lieske, 1994).

Distribuição: Indo-Pacífico: Mar Vermelho até à África do Sul, Havaí e Tuamoto. Desde o sul do Japão até Nova Caledónia (Fishbase, 2000).

Ecology: Lagoons and reefs coral-rich areas interior of 1 to 42 m. Use the tubular mouth to feed on small crustaceans that inhabit coral reefs and fish (Lieske, 1994).

Distribution: Indo-Pacific: Red Sea to South Africa and the Hawaiian and Tuamoto islands, north to southern Japan, south to New Caledonia (Fishbase, 2000).

21.12. *Gomphosus caeruleus*

Nome Científico | Cientific Name • *Gomphosus caeruleus* (Lacepède, 1801)
Nome Inglês | English Name • Green birdmouth wrasse
Nome Português | Portuguese Name • Bodião pássaro
Nome Francês | French Name • Labre oiseau indien

Ecologia: Áreas de lagoas ricas em coral e recifes interiores de pelo menos 30 m (Lieske, 1994).

Distribuição: Oceano Índico: África Oriental até Natal, África do Sul, e Mar de Andaman (Fishbase, 2000).

Ecology: Areas of coral-rich lagoons and seaward reefs of at least 30 m (Lieske, 1994).

Distribution: Indian Ocean: East Africa south to Natal, South Africa and east to the Andaman Sea (Fishbase, 2000).

(fêmea)

21.13. *Halichoeres hortulans*

Nome Científico | Cientific Name • *Halichoeres hortulans* (Lacepède, 1801)
Nome Inglês | English Name • Checkerboard wrasse
Nome Português | Portuguese Name • Bodião
Nome Francês | French Name • Labre échiquier

Ecologia: Em áreas de areia em lagoas de águas claras e recifes interiores de 1 -30 m. Juvenis frequentemente no fundo dos canais de ondas. Comum (Lieske, 1994).

Distribuição: Indo-Pacífico: Mar Vermelho até Baia de Sodwana, África do Sul, e a leste até ilhas Linha, Marquesas e Tuamoto. Desde o sul do Japão até ao sudoeste da Grande Barreira de Coral (Fishbase, 2000).

Ecology: Sandy spots in clear water lagoons and seaward reefs 1 -30 m. Juveniles often at the bottom of the wave channels. Common (Lieske, 1994).

Distribution: Indo-Pacific: Red Sea south to Sodwana Bay, South Africa and east to the Line, Marquesan and Tuamoto islands, north to southern Japan, south to the southern Great Barrier Reef (Fishbase, 2000).

21.14. *Halichoeres iridis*

Nome Científico | Cientific Name • *Halichoeres iridis* (Randall & Smith, 1982)
Nome Inglês | English Name •
Nome Português | Portuguese Name • Bodião arco-iris
Nome Francês | French Name • Labre arc-en-ciel

Ecologia: Nos canais de recifes interiores de 6 a 43 m. Geralmente em areia e áreas de cascalho abaixo de 20 m. Vive junto ao substrato (Lieske, 1994).

Distribuição: Oceano Índico Ocidental: Costa Leste de Africa até Natal, África do Sul, também Madagáscar, Seychelles e Arquipélago de Chagos (Fishbase, 2000).

Ecology: Reef channels 6 to 43 m. Usually in sand and gravel areas below 20 m. Lives in the substrate (Lieske, 1994).

Distribution: Western Indian Ocean: East African coast south to Natal, South Africa; also from Madagascar, Seychelles and Chagos Archipelago (Fishbase, 2000).

21.15. *Halichoeres scapularis*

Nome Científico | Cientific Name • *Halichoeres scapularis* (Bennett, 1832)
Nome Inglês | English Name • Zigzag wrasse
Nome Português | Portuguese Name • Bodião zig-zag
Nome Francês | French Name • Labre zigzag

Ecologia: Recifes rasos e lagoas rasas de recifes em áreas de mistura de areia, cascalho ou coral (Lieske, 1994).

Distribuição: Indo-Pacífico Ocidental: Mar Vermelho e África Oriental até Papua Nova Guiné. Desde o Japão até à Grande Barreira de Coral, Austrália (Fishbase, 2000).

Ecology: Reef flats and shallow lagoons to coral reefs in areas of mixed sand, gravel or coral (Lieske, 1994).

Distribution: Indo-West Pacific: Red Sea and East Africa to Papua New Guinea, north to Japan, south to the Great Barrier Reef in Australia (Fishbase, 2000).

(Fêmea)

21.16. *Hemigymnus melapterus*

Nome Científico | Cientific Name • *Hemigymnus melapterus* (Bloch, 1791)
Nome Inglês | English Name • Blackeye thicklip
Nome Português | Portuguese Name • Bodião de olho negro
Nome Francês | French Name • Tamarin bicolore

Ecologia: Lagoas e recifes interiores de 1 até 30 m. Juvenis geralmente entre coral ramificado e alimentam-se de crustáceos planctónicos bentónicos. Adultos em áreas de mistura de areia, cascalho e coral. Alimentam-se de invertebrados bentónicos, especialmente formas com conhas duras (Lieske, 1994).

Distribuição: Indo-Pacífico: Mar Vermelho e África Oriental a Micronésia, Samoa, e Polinésia (Fishbase, 2000).

Ecology: Lagoons and reefs, 1 to 30 m. Juveniles between branched coral usually feed on demersal planktonic crustaceans. Adults in areas of mixed sand, gravel and coral. They feed on benthic invertebrates (Lieske, 1994).

Distribution: Indo-Pacific: Red Sea and East Africa to Micronesia, Samoa, and Polynesia (Fishbase, 2000).

21.17. *Hemigymnus fasciatus*

Nome Científico | Cientific Name • *Hemigymnus fasciatus* (Bloch, 1792)
Nome Inglês | English Name • Barred thicklip
Nome Português | Portuguese Name • Bodião de barras
Nome Francês | French Name • Tamarin à bandes

Ecologia: Lagoas e recifes interiores de 1 até 30 m. Juvenis geralmente entre coral ramificado e alimentam-se de crustáceos planctónicos bentónicos. Adultos em áreas de mistura de areia, cascalho e coral. Alimentam-se de invertebrados bentónicos de conhas duras (Lieske, 1994).

Distribuição: Indo-Pacífico: Mar Vermelho ao sul da Ilha de Inhaca, Moçambique e a leste de Taiti (Fishbase, 2000).

Ecology: Lagoons and reefs, 1 to 18 m. Juveniles between branched coral usually feed on planktonic crustaceans. Adults in areas of mixed sand, gravel and coral. They feed on benthic invertebrates, especially forms with hard shells (Lieske, 1994).

Distribution: Indo-Pacific: Red Sea south to Inhaca Island, Mozambique and east to Tahiti (Fishbase, 2000).

21.18. *Iniistius pavo*

Nome Científico | Cientific Name • *Iniistius pavo* (Valenciennes, 1840)
Nome Inglês | English Name • Peacock wrasse
Nome Português | Portuguese Name • Bodião pavão
Nome Francês | French Name • Rason commun

Ecologia: Normalmente solitário nas lagoas e nos recifes virados ao oceano com fundo de areia fina. Os juvenis podem se encontrar em estuários. Os adultos são raros a menos de 20 m. Mergulha na areia à noite para dormir ou quando se sente alarmado. Alimenta-se de moluscos e custáceos. Os juvenis imitam uma folha tanto em comportamento como em cores e forma.

Distribuição: Indo-Pacífico: Mar Vermelho e leste de África até às Ilhas da Sociedade. Desde o sul do Japão até ao Havaí e ilha Lord Howe. Pacífico Oriental: Golfo da Califórnia a Panamá e Ilhas Galápagos (Fishbase, 2000).

Ecology: Usually solitary in the lagoons and reefs face the ocean with bottom of thin sand. Juveniles may be found in estuaries. Adults are rare in less than 20 m. Dip in the sand at night to sleep or when you feel alarmed. It feeds on molluscs and shellfish. Juveniles mimic a leaf in behavior as in color and shape.

Distribution: Indo-Pacific: Red Sea and East Africa to the Society Islands, north to southern Japan and Hawaii, south to the Lord Howe Island. Eastern Pacific: Gulf of California to Panama and the Galapagos Islands (Fishbase, 2000).

(Juvenil)

21.19. *Labroides dimidiatus*

Nome Científico | Cientific Name • *Labroides dimidiatus* (Valenciennes, 1839)
Nome Inglês | English Name • Bluestreak cleaner wrasse
Nome Português | Portuguese Name • Bodião limpador
Nome Francês | French Name • Labre nettoyeur commun

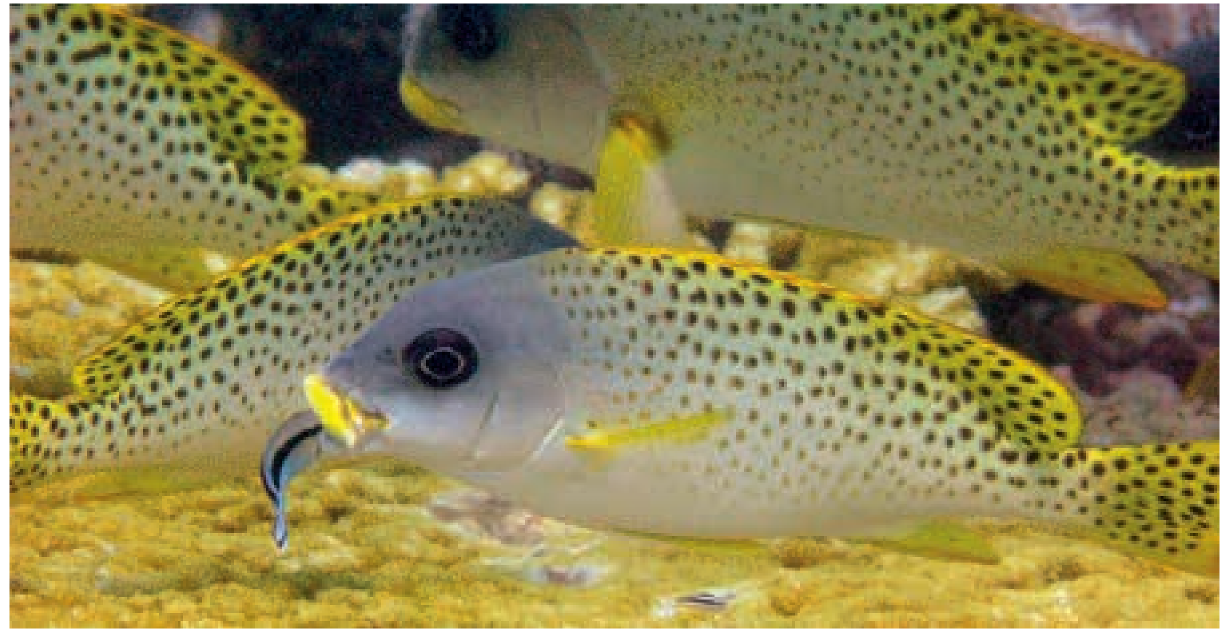
Ecologia: Em quase todos os habitats de recifes de coral: lagoas interiores e recifes rasos de interior até 40 m. O limpador mais comum em muitos recifes. Imitado pela comedora de barbatanas, o blenídeo *Aspidontus taeniatus* (Lieske, 1994).

Distribuição: Indo-Pacífico: Mar Vermelho e África Oriental até às ilhas Linha, Marquesas, e Ducie. Desde o sul do Japão até Lord Howe e Rapa (Fishbase, 2000).

Ecology: In almost every coral reef habitats: lagoons and reefs of shallow interiors inside until 40 m. the most common cleaner in many reefs. Imitated by the blenídeos fins eater Aspidontus taeniatus (Lieske, 1994).

Distribution: Indo-Pacific: Red Sea and East Africa to the Line, Marquesan, and Ducie islands, north to southern Japan, south to Lord Howe and Rapa islands (Fishbase, 2000).

Labroides dimidiatus (indivíduo adulto)



Labroides dimidiatus (a limpar Plectorhinchus gaterinus)

Labroides dimidiatus (a limpar Acanthurus sp.)

21.20. *Oxycheilinus mentalis*

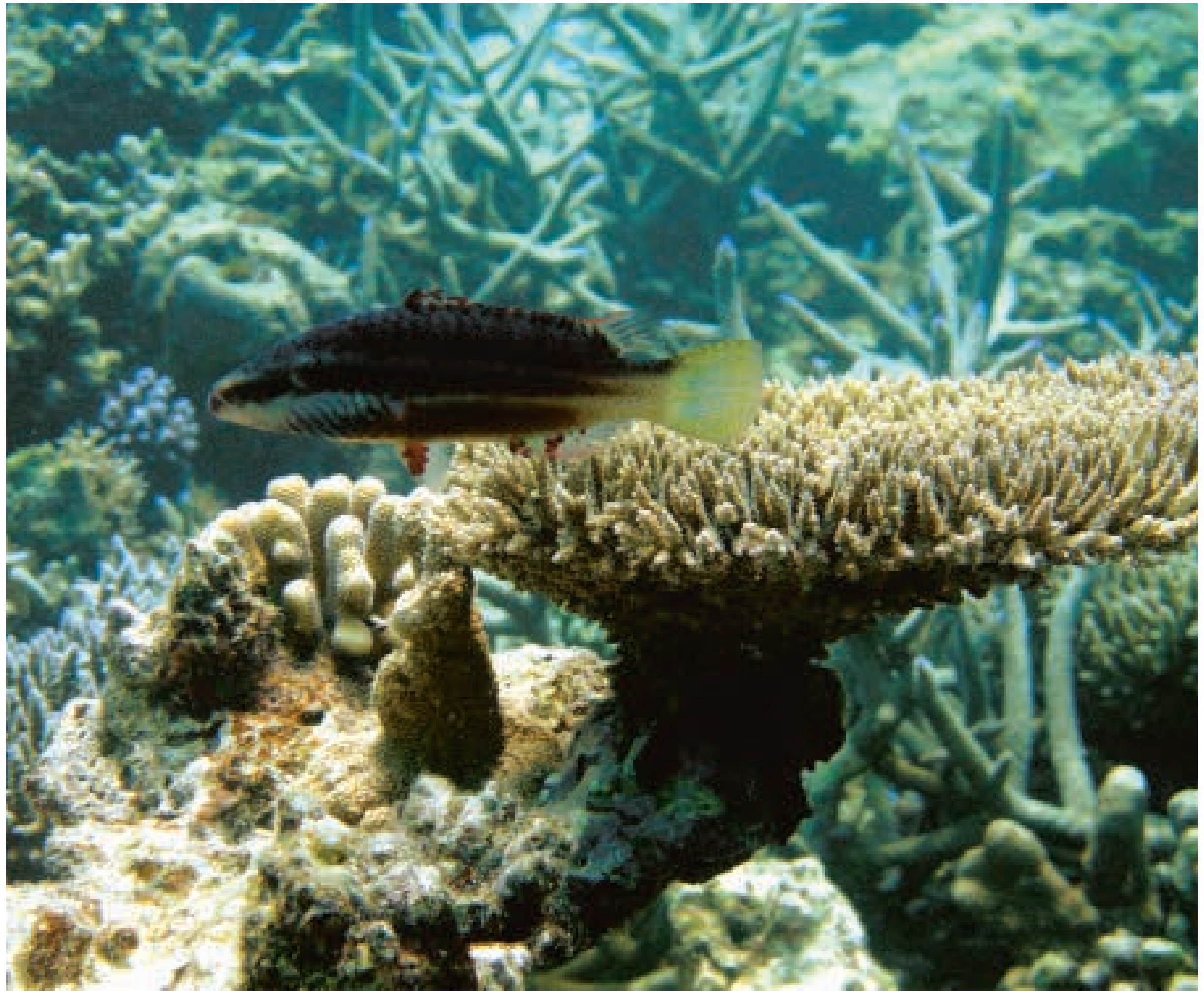
Nome Científico | Cientific Name • *Oxycheilinus mentalis* (Ruppell, 1828)
Nome Inglês | English Name • Mental wrasse
Nome Português | Portuguese Name • Bodião mental
Nome Francês | French Name • Labre mental

Ecologia: Recifes de franja perto de coral maciço de 1 a 20 m. Solitários. Comum no Mar Vermelho (Lieske, 1994).

Distribuição: Oeste do Oceano Índico: Mar Vermelho e Golfo de Aden (Fishbase, 2000).

Ecology: Fringe reefs near massif coral from 1 to 20 m. Solitaries. Common in the Red Sea (Lieske, 1994).

Distribution: Western Indian Ocean: Red Sea and Gulf of Aden (Fishbase, 2000).



21.21. *Thalassoma amblycephalum*

Nome Científico | Cientific Name • *Thalassoma amblycephalum* (Bleeker, 1856)
Nome Inglês | English Name • Bluntheaded wrasse
Nome Português | Portuguese Name • Bodião
Nome Francês | French Name • Labre ruban à tache rouge

Ecologia: As espécies de thalassoma são nadadores activos e rápidos. Machos terminais reproduzem-se individualmente com as fêmeas em seu harém, machos primários reproduzem-se em grupos de desova. Estas espécies habitam lagoas rasas e recifes interiores até 15 m, tipicamente perto dos topos de pináculos coralinos isolados e borda superior de encostas íngremes. Alimentam-se principalmente de crustáceos zooplanctonicos (Lieske, 1994).

Distribuição: Indo-Pacífico: SSomália e África do Sul até ilhas Linha, Marquesas e Tuamotu. Desde o sul do Japão até Rowley Shoals, norte da Nova Zelândia e Lord Howe e Rapa (Fishbase, 2000).

Ecology: Thalassoma species are active swimmers and fast. Terminal males mate individually with females in their harem, males to breed on primary spawning group. These species inhabit shallow lagoons and reefs interiors until 15 m, but typically near the tops of isolated reefs and pinnacles upper edge of steep hillsides. Feed mostly on crustaceans zooplanctonicos (Lieske, 1994).

Distribution: Indo-Pacific: Somalia and South Africa to the Line, Marquesan, and Tuamoto islands, north to southern Japan, south to Rowley Shoals, northern New Zealand and Lord Howe and Rapa islands (Fishbase, 2000

21.22. *Thalassoma hebraicum*

Nome Científico | Cientific Name • *Thalassoma hebraicum* (Lacepède, 1801)
Nome Inglês | English Name • Goldbar wrasse
Nome Português | Portuguese Name • Bodião de barras douradas
Nome Francês | French Name • Girelle-paon jaune

Ecologia: Lagoas e recifes interiores de 1 a 30 m. Geralmente espalhado em recifes de coral ou rochas (Lieske, 1994).

Distribuição: Oeste do Oceano Índico: até Baía de Algoa, África do Sul (Fishbase, 2000).

Ecology: Lagoons and seaward reefs from 1 to 30 m. Usually scattered on coral reefs or rocks (Lieske, 1994).

Distribution: Western Indian Ocean: south to Algoa Bay, South Africa (Fishbase, 2000).

21.23. *Thalassoma hardwicke*

Nome Científico | Cientific Name • *Thalassoma hardwicke* (Bennett, 1830)
Nome Inglês | English Name • Sixbar wrasse
Nome Português | Portuguese Name • Bodião de seis barras
Nome Francês | French Name • Girelle-paon à taches d'encre

Ecologia: Lagoas rasas e recifes interiores até 15 m, em áreas de águas claras. Alimentam-se de bentónicos e crustáceos planctónicos, pequenos peixes, e foraminifera (Lieske, 1994).

Distribuição: Indo-Pacífico: África Oriental até às ilhas Linha e Tuamotu. Desde o sul do Japão até Lord Howe e ilhas Austral (Fishbase, 2000).

Ecology: Shallow lagoons and seaward reefs to 15 m, in areas of clear water. They feed on benthic crustaceans and planctónicos, small fish, and foraminifera (Lieske, 1994).

Distribution: Indo-Pacific: East Africa to the Line and Tuamoto islands, north to southern Japan, south to the Lord Howe and Austral islands (Fishbase, 2000).

22. Papagaios | Parrotfishes

de bicos afiados para raspar as algas das rochas | sharp beaks to scratch algae from the rocks

O peixe papagaio tem uma forma oblonga que termina numa extremidade da cabeça arredondada e com uma boca terminal. As mandibulas são armadas cada uma de duas placas ósseas poderosas, fazendo um bico parecido ao do papagaio terrestre, origem do nome desta família. Os peixes papagaio têm normalmente três fase: Fase juvenil; fase inicial, maioritariamente constituída por fêmeas que se transformaram a partir dos juvenis; e a fase terminal maioritariamente constituída por machos provenientes de fêmeas. Podem no entanto existir dois sistemas sexuais: o aqui explicado e os machos que nascem machos e ficam sempre machos toda a vida. A maioria das espécies faz paradas reprodutoras: macho e fêmeas nadam juntos do fundo até à superfície, até libertarem os ovos e esperma, ao mesmo tempo na coluna de água. À noite algumas espécies dormem dentro de cocoons de muco, que produzem para se defenderem enquanto dormem. Estes peixes são herbívoros, raspando com os seus poderosos dentes as algas do substrato. Ocasionalmente comem corais. O seu trato digestivo está preparado com partículas de areia e rocha que podem ser arrancadas quando se está alimentar. A produção de areia por um grande papagaio pode chegar a duas toneladas por ano. O peixe papagaio também é importante para a manutenção da saúde dos recifes de corais, a sua atividade de limpeza das algas faz com que haja sempre substrato disponível para as larvas de coral e reduz a competição de algas com corais. É um dos peixes mais apreciados em Moçambique, sendo muito pescado pela pesca artesanal.

Parrotfish have an oblong shape that ends in a rounded hedge of the head and a terminal mouth. Each jaw has two powerful bony plates forming a beak similar to the one of the earth parrot, hence the name of the family. Parrot fishes usually evolve in three phases; Juvenile; initial phase mostly consisting in females that evolved from the juveniles; and terminal phase mostly consisting in males that evolved from females. However there may exist two sexual systems the one already explained and another where the males that are born males stay like that for the rest of their lives. Most of the species executes reproducing parades; male and female swim together from the bottom to the surface, until eggs and sperm are released at the same time in the water column. At night some species sleep in mucus cocoons, produced for self defense while sleeping. These fishes are herbivorous, scratching with their powerful beaks the algae from substratum. Occasionally they eat corals. It's digestive duct it's equipped with sand particles and rock uprooted when feeding. One single parrot fish can produce up to two tons of sand per year. Parrotfish also is very important for conservation of healthy reef corals, due to its activity in cleansing algae that provides substratum for the coral larvae and reduces competition from algae to corals. It's one of the most appreciated fishes in Mozambique, thus being heavily caught by artisanal fisheries.

22.1. *Cetoscarus ocellatus* (bicolor)

Nome Científico | Cientific Name | Cientific Name • *Cetoscarus ocellatus* (Valenciennes, 1840)
Nome Inglês | English Name • Bicolour parrotfish
Nome Português | Portuguese Name • Papagaio de duas cores
Nome Francês | French Name • Perroquet bicolore

Ecologia: Lagoas de águas claras e recifes interiores de 1 a 30 m. Juvenis geralmente solitários, adultos em haréns, geralmente ao longo da crista dos recifes de coral (Lieske, 1994).

Distribuição: Indo-Pacífico: Mar Vermelho até às ilhas Tuamoto. Desde a Ilha de Izu, até à Grande Barreira de Coral (Fishbase, 2000).

Ecology: Clear water lagoons and seaward reefs 1 to 30 m. Juveniles usually solitary, adults in harems, generally along the ridge of coral reefs (Lieske, 1994).

Distribution: Clear water lagoons and seaward reefs 1 to 30 m. Juveniles usually solitary, adults in harems, generally along the ridge of coral reefs (Lieske, 1994).

Cetoscarus bicolor (Adulto)

Cetoscarus bicolor (Juvenil)

22.2. *Bolbometopon muricatum*

Nome Científico | Cientific Name • *Bolbometopon muricatum* (Valenciennes, 1840)
Nome Inglês | English Name • Green humphead parrotfish
Nome Português | Portuguese Name • Papagaio de bossa ou gigante
Nome Francês | French Name • Perroquet bossu

Ecologia: Juvenis em lagoas, adultos em lagoas de águas claras e recifes interiores de 1 até 30 m. Tipicamente em cardumes. Alimentam-se de corais vivos bem como algas encrustantes. Podem chocar com a cabeça em corais para quebrá-los e assim facilitar a sua alimentação. Bastante cautelosos e vulneráveis á pesca excessiva.Considerado vulnerável pela IUCN (International Union for Conservation of Nature) (Lieske, 1994).

Ecology: Juvenile fish in lagoons, adults in clear water lagoons and interiors coral reefs, 1 until 30 m. Typically in shoals. They feed on living corals and encrusting algae. Can collide with the corals to break them and thus facilitate their food. Quite cautious and vulnerable to overfishing (Lieske, 1994).

Distribuição: Indo-Pacífico: Mar Vermelho e África Oriental até à Samoa e Ilhas Linha. Desde as Yaeyama e ilhas Wake até à Grande Barreira de Coral e Nova Caledônia (Fishbase, 2000).

Distribution: Indo-Pacific: Red Sea and East Africa to Samoa and the Line Islands, north to the Yaeyama and Wake islands, south to the Great Barrier Reef and New Caledonia (Fishbase, 2000).

22.3. *Chlorurus gibbus*

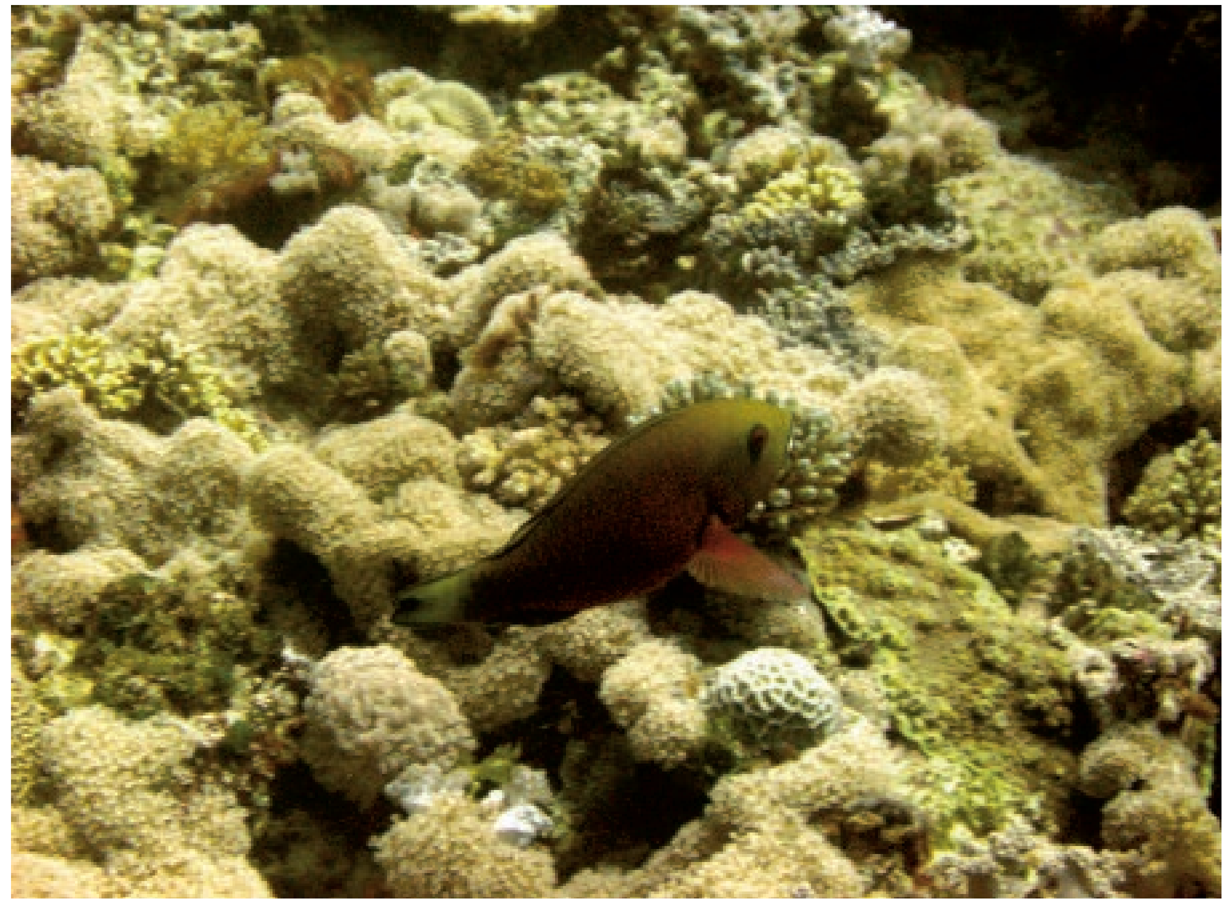
Nome Científico | Cientific Name • *Chlorurus gibbus* (Ruppell, 1829)
Nome Inglês | English Name • Heavybeak parrotfish
Nome Português | Portuguese Name • Papagaio de bico
Nome Francês | French Name • Perroquet machoîron

Ecologia: Lagoas e recifes interiores de 2 a 35 m. Juvenis geralmente solitários, adultos podem ocorrer em cardume. Comum (Lieske, 1994).

Ecology: Lagoons and seaward reefs from 2 to 35 m. Juveniles usually solitary, adults can occur in schools. Common (Lieske, 1994).

Distribuição: Oeste do Oceano Índico: Mar Vermelho. O complexo de espécies compreende *Chlorurus gibbus* no Mar Vermelho, *Chlorurus strongylocephalus* no Oceano Índico e *Chlorurus microrhinos* no Pacífico centro-oeste (Fishbase, 2000).

Distribution: Western Indian Ocean: Red Sea. The species complex comprise of Chlorurus gibbus in the Red Sea, *Chlorurus strongylocephalus* in the Indian Ocean and *Chlorurus microrhinos* in the west-central Pacific (Fishbase, 2000).



22.4. *Chlorurus sordidus*

Nome Científico | Cientific Name • *Chlorurus sordidus* (Forsskal, 1775)
Nome Inglês | English Name • Daisy parrotfish
Nome Português | Portuguese Name • Papagaio
Nome Francês | French Name • Perroquet marguerite

Ecologia: Recifes rasos, lagoas e recifes interiores acima de 25 m. Em coral rico bem como áreas abertas pavimentadas. Juvenis entre cascalho de coral de recifes rasos e lagoas. Juvenil e peixes em fase inicial, muitas vezes em grupos numerosos que podem migrar por grandes distâncias para se alimentar e para dormir (Lieske, 1994).

Distribuição: Indo-Pacífico: Mar Vermelho até Natal, África do Sul, Havai e ilhas Linha. Desde as ilhas Ryukyu até Perth, New South Wales, ilha Lord Howe e ilha de Rapa (Fishbase, 2000).

Ecology: The shallow reefs, lagoons and coral reefs above 25 m. interiors In rich coral areas as well as open areas paved. Juveniles between coral gravel reefs and shallow lagoons. Juvenile fish and in the initial stage, many times in numerous groups that can migrate great distances to feed and sleep (Lieske, 1994).

Distribution: Indo-Pacific: Red Sea south to Natal, South Africa and east to the Hawaiian, Line, and Ducie islands, north to the Ryukyu Islands, south to Perth, New South Wales, Lord Howe Island and Rapa Island (Fishbase, 2000).

Chlorurus sordidus (Macho)

Chlorurus sordidus (Variedade de fêmea)

22.5. *Hipposcarus harid*

Nome Científico | Cientific Name • *Hipposcarus harid* (Forsskal, 1775)
Nome Inglês | English Name • Candelamoa parrotfish
Nome Português | Portuguese Name • Papagaio amarelo de cabeça grande
Nome Francês | French Name • Perroquet jaune à longue tête

Ecologia: Lagoas e recifes interiores acima de 40 m. Normalmente em grupos em lagoas relativamente turvas sobre áreas arenosas perto dos recifes. Juvenis entre recifes de cascalho de coral e espalhados em lagoas (Lieske, 1994).

Distribuição: Oeste do Oceano Índico: Mar Vermelho até ao Canal de Moçambique, incluindo Madagáscar e Seychelles até Sri Lanka, Maldivas e o arquipélago de Chagos a leste (Fishbase, 2000).

Ecology: Lagoons and seaward reefs above 40 m. Usually in groups in relatively turbid water lagoons on sandy areas near the reef. Juveniles between coral gravel reefs scattered within lagoons (Lieske, 1994).

Distribution: Western Indian Ocean: Red Sea south to Mozambique Channel, including Madagascar and Seychelles and east to Sri Lanka, Maldives and the Chagos Archipelago. Occurrence in Java, Indonesia needs verification (Fishbase, 2000).

22.6. *Scarus caudofasciatus*

Nome Científico | Cientific Name • *Scarus caudofasciatus* (Gunther, 1862)
Nome Inglês | English Name • Redbarred parrotfish
Nome Português | Portuguese Name • Papagaio de listas vermelhas
Nome Francês | French Name • Perroquet à quele barrée

Ecologia: Canais de declives exteriores de recifes de 8 a 40 m. Solitários e desconfiados (Lieske, 1994).

Distribuição: Oeste do Oceano Índico: Mar Vermelho à África do Sul. Presença na Somália a ser confirmada (Fishbase, 2000).

Ecology: Outer reef slopes channels of 8 to 40 m. solitary and suspicious (Lieske, 1994).

Distribution: Western Indian Ocean: Red Sea to South Africa. Presence in Somalia to be confirmed (Fishbase, 2000).

Fêmea

22.7. *Scarus frenatus*

Nome Científico | Cientific Name • *Scarus frenatus* (Lacepède, 1802)
Nome Inglês | English Name • Bridled parrotfish
Nome Português | Portuguese Name • Papagaio de seis barras
Nome Francês | French Name • Perroquet à six bandes

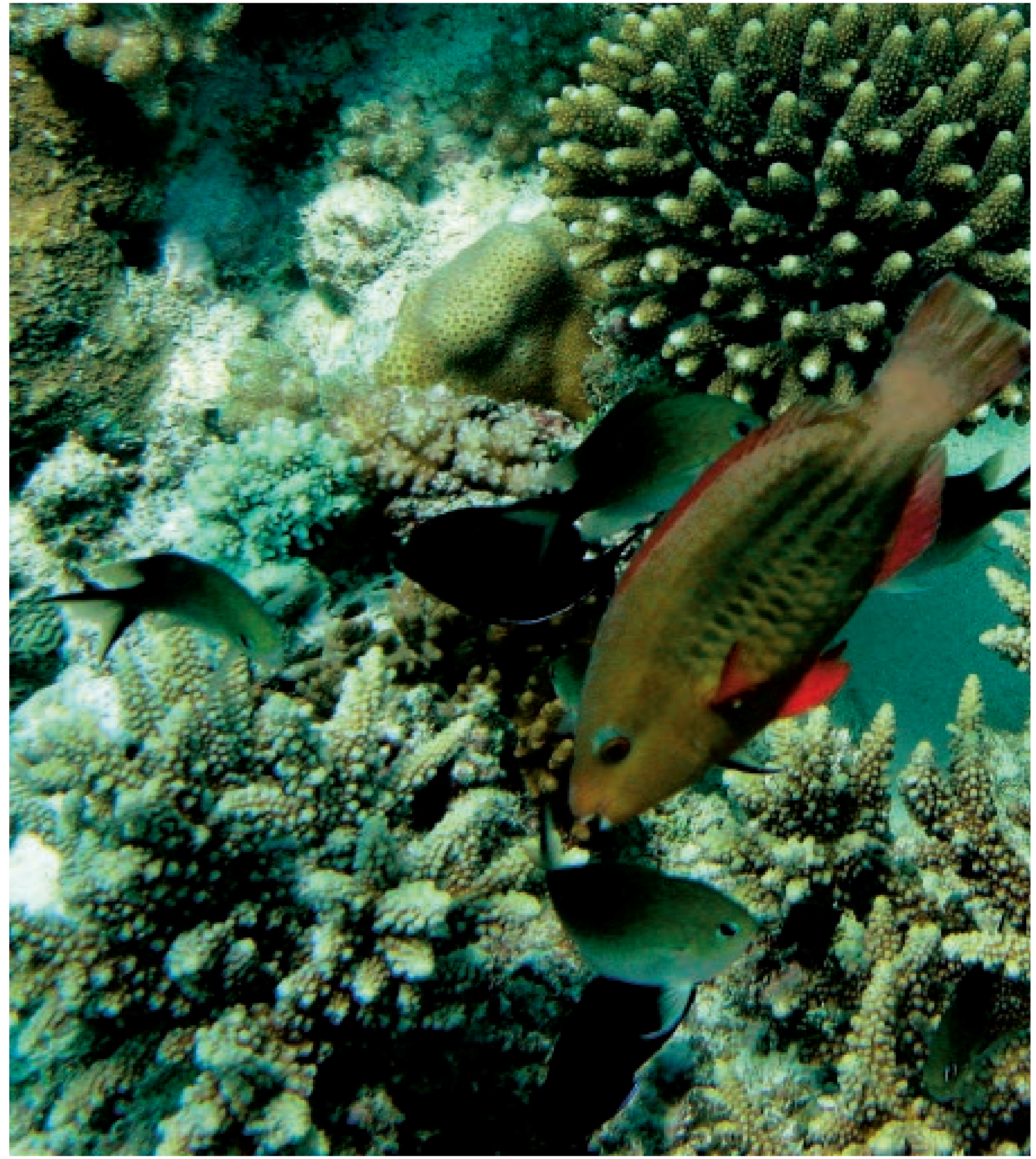
Ecologia: Recifes interiores e recifes de crista. Juvenis entre corais, recifes de cascalhos de coral e lagoas de águas claras. Geralmente solitários (Lieske, 1994).

Distribuição: Indo-Pacífico: Mar Vermelho até às ilhas Linha e Ducie. Desde o sul do Japão até Shark Bay, Austrália Ocidental e ilhas Lord Howe e Rapa. Ausente nas ilhas havaianas (Fishbase, 2000).

Ecology: Seaward reefs and coral Ridge reefs. Juveniles between corals and gravels of coral reefs in lagoons of clear water. Usually solitary (Lieske, 1994)

Distribution: Indo-Pacific: Red Sea to the Line and Ducie islands, north to southern Japan, south to Shark Bay, Western Australia and Lord Howe and Rapa islands. Absent from the Hawaiian Islands (Fishbase, 2000).

Macho



Fêmea

22.8. *Scarus niger*

Nome Científico | Cientific Name • *Scarus niger* (Forsskal, 1775)
Nome Inglês | English Name • Dusky parrotfish
Nome Português | Portuguese Name • Papagaio dourado
Nome Francês | French Name • Perroquet dorade

Ecologia: Lagoas de águas limpas e ricas em coral, canais e declives exteriores de recifes de 0.5 a 15 m. Geralmente solitários exceto durante o acasalamento (Lieske, 1994).

Distribuição: Indo-Pacífico: Mar Vermelho até Baia de Sodwana, África do Sul e ilhas Sociedade. Desde as ilhas Ryukyu até Shark Bay, Austrália Ocidental e Grande Barreira de Coral (Fishbase, 2000).

Ecology: Clean water lagoons and coral-rich channels and outer reef slopes 0.5 to 15 m. Usually solitary except during mating (Lieske, 1994).

Distribution: Indo-Pacific: Red Sea south to Sodwana Bay, South Africa and east to the Society Islands, north to the Ryukyu Islands, south to Shark Bay, Western Australia and the southern Great Barrier Reef (Fishbase, 2000).

Macho

Fêmea

22.9. *Scarus prasiognathos*

Nome Científico | Cientific Name • *Scarus prasiognathos* (Valenciennes, 1840)
Nome Inglês | English Name • Singapore parrotfish
Nome Português | Portuguese Name • Papagaio de singapura
Nome Francês | French Name • Parroquet de Singapour

Ecologia: Bordas superiores de paredes exteriores em areia plana adjacente a pelo menos 20 m. Geralmente em grandes cardumes (Lieske, 1994).

Distribuição: Indo-Pacífico Ocidental: Maldivas a Nova Irlanda, na Papua Nova Guiné, incluindo Cocos-Keeling. Desde as ilhas Ryukyu até às Filipinas, incluindo Palau. Esta espécie é o macho terminal de *Scarus singaporensis*. Possivelmente substituído por *Scarus falcipinnis* no Oceano Índico ocidental (Fishbase, 2000).

Ecology: Top edges of exterior walls on flat sand adjacent to at least 20 m. Usually in large shoals (Lieske, 1994).

Distribution: Indo-West Pacific: Maldives to New Ireland in Papua New Guinea, including Cocos-Keeling Islands, north to Ryukyu Islands and south to the Philippines, including Palau. This species is the terminal male of Scarus singaporensis. Possibly replaced by Scarus falcipinnis in the western Indian Ocean (Fishbase, 2000).

Macho

22.10. *Scarus rubroviolaceus*

Nome Científico | Cientific Name • *Scarus rubroviolaceus* (Bleeker, 1847)
Nome Inglês | English Name • Ember parrotfish
Nome Português | Portuguese Name • Papagaio
Nome Francês | French Name • Perroquet braisé

Ecologia: Recifes interiores de 1 a 30 m. Solitários ou em grandes cardumes (Lieske, 1994).

Distribuição: Indo-Pacífico: Leste de África até Durban, África do Sul e Ilhas Tuamoto. Desde as ilhas Ryukyu e Havai até Shark Bay, Austrália Ocidental e Grande Barreira de Recifes de Coral Pacífico Oriental: Golfo da Califórnia às Ilhas Galápagos (Fishbase, 2000).

Ecology: Seaward reefs from 1 to 30 m. Solitary or in large shoals (Lieske, 1994).

Distribution: Indo-Pacific: East Africa south to Durban, South Africa and east to the Tuamoto Islands, north to the Ryukyu and Hawaiian islands, south to Shark Bay, Western Australia and the southern Great Barrier Reef. Eastern Pacific: Gulf of California to the Galapagos Islands (Fishbase, 2000).

Macho

22.11. *Scarus scaber*

Nome Científico | Cientific Name • *Scarus scaber* (Valenciennes, 1840)
Nome Inglês | English Name • Fivesaddle parrotfish
Nome Português | Portuguese Name • Papagaio de cinco listas
Nome Francês | French Name • Perroquet à cinq selles

Ecologia: Recifes rasos e lagoas de recifes rasos com rico crescimento de coral de 1 a 20 m. Fase inicial geralmente em grupos (Lieske, 1994).

Distribuição: Oeste do Oceano Índico: Leste de África a Natal, África do Sul, também em torno das ilhas do Oceano Índico ocidental (Fishbase, 2000).

Ecology: Reef flats and shallow lagons with rich coral growth. Initial phase in groups (Lieske, 1994).

Distribution: Western Indian Ocean: East Africa south to Natal, South Africa; also around islands of the western Indian Ocean (Fishbase, 2000).

22.12 *Scarus tricolor*

Nome Científico | Cientific Name • *Scarus tricolor* (Bleeker, 1847)
Nome Inglês | English Name • Tricolour parrotfish
Nome Português | Portuguese Name • Papagaio
Nome Francês | French Name • Perroquet tricolore

Ecologia: Lagoas e recifes interiores ricos em coral. Geralmente solitários, ocasionalmente em grupos (Lieske, 1994).

Distribuição: Indo-Pacífico: difundido no Oceano Índico, desde a costa Leste de África até Natal, África do Sul, Madagáscar, Seychelles, Ilhas Maurícias, arquipélago de Chagos, e Maldivas através do Oceano Índico até Polinésia Francesa e Pitcairn. Substituído por *Scarus forsteni* na maior parte do Pacífico, com distribuições sobrepostas nas Filipinas, no leste da Indonésia e Palau. Recentemente, relatado a partir de Tonga.

Ecology: Areas of coral-rich lagoons and reefs. Usually solitary, occasionally in groups (Lieske, 1994).

Distribution: Indo-Pacific: widespread in the Indian Ocean, ranging from East Africa south to Natal, South Africa and east to Madagascar, Seychelles, Mauritius, Chagos Archipelago, and Maldives through the eastern Indian Ocean to French Polynesia and Pitcairn. Replaced by Scarus forsteni in most of the Pacific, with overlapping distributions in the Philippines, eastern Indonesia and Palau. Recently reported from Tonga (Fishbase, 2000).

23. Cabozes, marachombas e peixes flechas | Gobies, blennies and dartfishes

à espreita na entrada da porta | lurking in the doorway

Na família dos blenideos (marachombas) quase todos tem uma barbatana dorsal longa e única, contrariamente aos gobiídeos (cabozes) que tem duas barbatanas dorsais. A maioria dos peixes destes grupos são marinhos, mas também existem espécies de água doce e salobra. Normalmente vivem junto ao bentos em águas pouco profundas. Os blenideos alimentam-se de algas e invertebrados e os gobiídeos são maioritariamente predadores, mas também presas importantes. Os machos dos dois grupos atraem as fêmeas para pôr ovos que depois guardam até à eclosão.

Os gobiídeos são a família de peixes com mais espécies, muito delas não estão descritas e são de difícil deteção. Não são alvo de captura mas incluem-se nas capturas acessórias. Tanto os gobiídeos como os blenidios são importantes peixes de aquariofilia.

Nearly all the elements in the Blenniidae have a single long dorsal fin while those in the Gobiidae family have two dorsal fins. Most of these two groups are marine; nevertheless there are some species of fresh and brackish water. They usually are bottom-dwellers in shallow waters. Blennies feed on algae and invertebrate and Gobs are mainly predators and also important prey. In the 2 groups, male attract female to spawn and after they guard the eggs until hatching.

Gobiidae are the fish family comprising more species, a lot of them aren't described here and are very difficult to detect. They are not targeted for capture but are included in the catches. Both gobiidae as blenniidae are important fish aquarium.

23.1. *Cirripectes stigmaticus*

Nome Científico | Cientific Name • *Cirripectes stigmaticus* (Strasburg e Schultz, 1953)
Nome Inglês | English Name • Red-streaked blenny
Nome Português | Portuguese Name • Marachomba
Nome Francês | French Name • Gobie

Ecologia: Entre corais, algas e canais de ondas (Lieske, 1994).

Distribuição: Indo-Pacífico: Quénia, Sul de Moçambique e em todo o Oceano Índico e Pacífico ocidental central a Marshall e ilhas Samoa (Fishbase, 2000).

Ecology: Between the corals, algae and wave channels. (Lieske, 1994).

Distribution: Indo-Pacific: Kenya south to Mozambique and throughout the Indian Ocean and western central Pacific to the Marshall and Samoan islands (Fishbase, 2000).

23.2. *Ecsenius sp*

Nome Científico | Cientific Name • *Ecsenius sp*
Nome Inglês | English Name • Blenny
Nome Português | Portuguese Name • Bleniídeo
Nome Francês | French Name • blennies

Ecologia: Desconhecido.

Distribuição: desconhecida.

Ecology: Unknow.

Distribution: Unknow.

23.3. *Gnatholepis cauerensis*

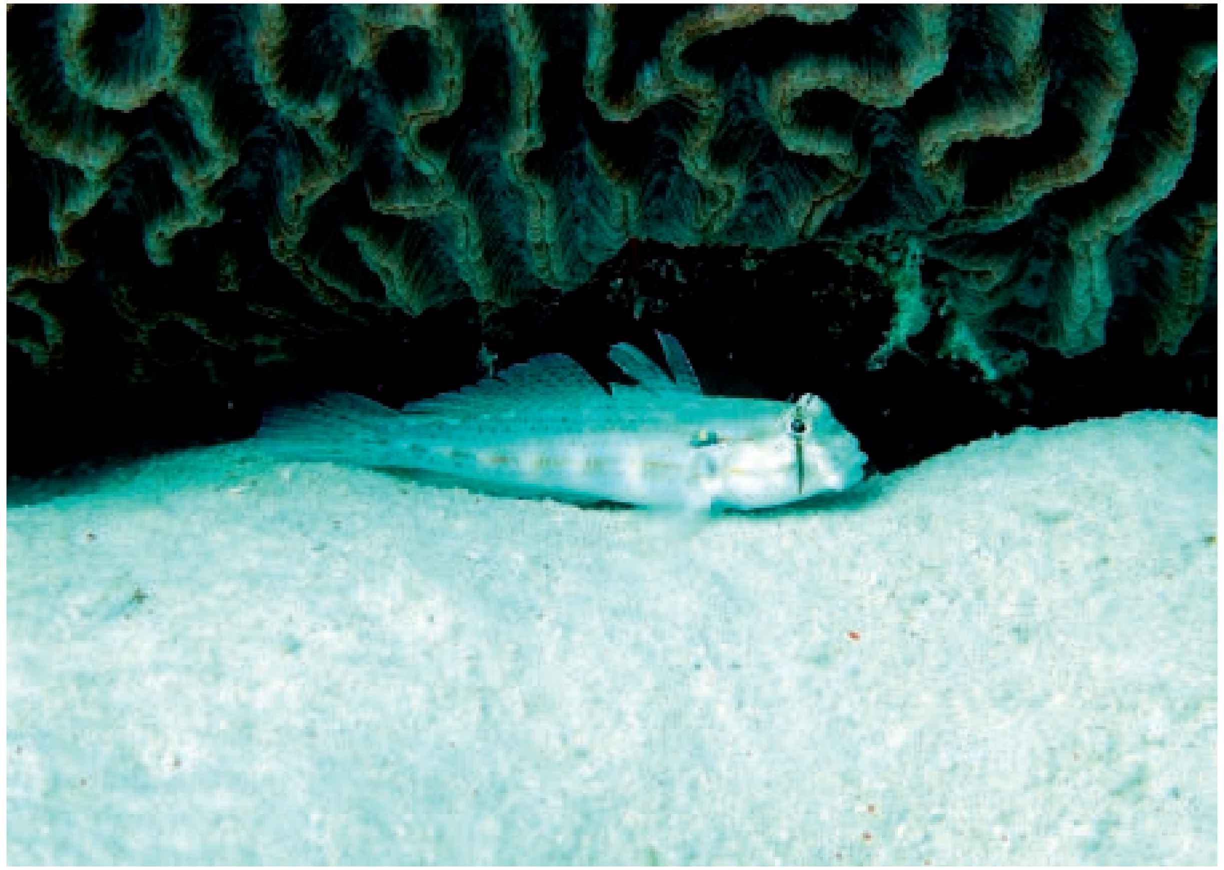
Nome Científico | Cientific Name • *Gnatholepis cauerensis* (Bleeker, 1853)
Nome Inglês | English Name • eyebar goby
Nome Português | Portuguese Name • Caboz
Nome Francês | French Name • Gobie

Ecologia: Em área de areia protegida, de recifes rasos a recifes virados ao oceano de 0-46m. Comum (Lieske, 1994).

Distribuição: Indo-Pacífico: generalizada desde a África do Sul até Pitcairn; no Pacífico desde Miyake-jima, Japão, até Sydney Harbour, na Austrália; no Oceano Índico desde Djibouti (Golfo do Tadjourah) até Aliwa Shoal, Kwa – Zulu Natal (Fishbase, 2000).

Ecology: Sheltered sandy areas from reef flats to seaward reefs, 0-46m. (Lieske, 1994).

Distribution: Indo-Pacific: widespread from South Africa to Pitcairn I.; in the Pacific north to Miyake-jima, Japan, south to Sydney Harbour, Australia; in the Indian Ocean north to Djibouti (Gulf of Tadjourah) and south to Aliwal Shoal, Kwa-Zulu Natal (Fishbase, 2000).



23.4. *Nemateleotris magrnifica*

Nome Científico | Cientific Name • *Nemateleotris magrnifica* (Fowler, 1938)
Nome Inglês | English Name • Fire goby
Nome Português | Portuguese Name • Peixe flecha de fogo
Nome Francês | French Name • Poisson-fléchette de feu

Ecologia: Recifes interiores de águas claras de 6 a 61 m. Parte superior de fundo duro exposta a declives exteriores de recife (raro no Havai). Frequentemente aos pares, mas também solitários ou em grupo (Lieske, 1994).

Distribuição: Indo-Pacífico: África Oriental ao Oriente havaiano, ilhas Marquesas e Pitcairn, ao norte das ilhas Ryukyu, ao sul de Nova Caledónia e Ilhas Austral; toda Micronésia (Fishbase, 2000).

Ecology: Seaward reefs of clear water from 6 to 61 m. Hard top funds exposed to outer reef slopes (rare in Hawaii). Often in pairs, but also solitary or in groups (Lieske, 1994).

Distribution: Indo-Pacific: East Africa to the Hawaiian, Marquesan and Pitcairn islands, north to the Ryukyu Islands, south to New Caledonia and the Austral Islands; throughout Micronesia (Fishbase, 2000).

23.5. *Ptereleotris evides*

Nome Científico | Cientific Name • *Ptereleotris evides* (Jordan & Hubbs, 1925)
Nome Inglês | English Name • Blackfin dartfish
Nome Português | Portuguese Name • Peixe flecha de barbatanas pretas
Nome Francês | French Name • Poisson flechette noir

Ecologia: Declives exteriores expostos do recife de 2 a 15 m. Juvenis em agregações, adultos geralmente aos pares. Normalmente gira em torno de buracos, 1-2m por cima, muitas vezes afasta-se quando perturbado (Lieske, 1994).

Ecology: Exposed outer reefs slopes, 2 to 15m. Juveniles in aggregations, adults paired. Typicaly hover above the hole, moves away when disturbed (Lieske, 1994).

Distribuição: Indo-Pacífico: Mar Vermelho e África Oriental até às Ilhas Linha e Sociedade. Desde as ilhas Ryukyu e Ogasawara até New South Wales, ilha Lord Howe, e Rapa (Fishbase, 2000).

Distribution: Indo-Pacific: Red Sea and East Africa to the Line and Society islands, north to the Ryukyu and Ogasawara islands, south to New South Wales, Lord Howe Island, and Rapa (Fishbase, 2000).

23.6. *Plagiotremus rhinorhynchos*

Nome Científico | Cientific Name • *Plagiotremus rhinorhynchos* (Bleeker, 1852)
Nome Inglês | English Name • Bluestriped fangblenny
Nome Português | Portuguese Name • ???????
Nome Francês | French Name • Blenne à rayures bleues

Ecologia: Todos os peixes deste género alimentam-se usando a sua mandibula para tirar escamas e pedaços de pele de outros peixes. Aproximam-se de outros peixes imitando o peixe limpador «verdadeiro» *Labroides dimidiatus* aproveitando-se da confiança destes para se alimentar da sua pele, e protegendo-se dos predadores. Os juvenis desta espécie são particularmente agressivos nesta técnica de mimetismo.

Ecology: All fish of this genus feed using its jaw to remove scales and bits of skin of other fishes. Approaches other fish by imitating the «true» cleaner fish Labroides dimidiatus taking advantage of their confidence on these to feed on their skin, and protecting themselves from predators. Juveniles of this species are particularly aggressive in this technique of mimicry.

Distribuição: Indo-Pacífico: Mar Vermelho até Knysna na África do Sul e a leste até às ilhas Linha, Marquesas e Sociedade. A norte desde o sul do Japão até Lord Howe. Substituído por *Plagiotremus ewaensis* nas ilhas havaianas.

Distribution: Indo-Pacific: Red Sea south to Knysna, South Africa and east to the Line, Marquesan and Society islands, north to southern Japan, south to Lord Howe Island. Replaced by *Plagiotremus ewaensis* in the Hawaiian Islands.

24. Peixes cirurgiões, barbeiros e rufias | Surgeonfishes, tangs and unicorne fishes

as algas que se cuidem | algae: take care

Estes peixes devem o seu nome a lâminas que possuem na cauda, parecidas com os instrumentos dos cirurgiões, e que são perigosas quer para as suas presas, quer para pescadores descuidados. Estas lâminas também servem para os dividir em três grandes famílias, das quais apenas duas existem no Oceano Índico: acanthuridae e a nasos. A primeira família, mais numerosa, apresenta os indivíduos de menor tamanho, a segunda apresenta peixes quase todos planctívoros (comem plâncton) e de maior tamanho podendo mesmo chegar a atingir 1 metro. Os juvenis são normalmente solitários, mas os adultos vivem em pequenos grupos. O *A.leucosternon*, *A.triostegus* e *A.guttatus* podem viver em grupos com mais de 100 indivíduos. Os seus ovos são postos a meia água e dispersos pelas correntes.

They owe their name to the blades they have in the tail, reminding the surgeon tools, which are very dangerous for their prey as well as for careless fishermen. Based on these blades they are divided in 3 families. Only two of them live in the Indian Ocean: acanthuridae and nasos. The former is the larger family with the smaller specimen, the latter one has bigger specimen, they may reach 1 m; nearly all are planctivorous (they eat plankton). Juveniles are usually solitary, but adults live in small groups. *A.leucosternon*, *A.triostegus* and *A.guttatus* may live in groups with more than 100 elements. Their eggs are laid half water and dispersed by currents.

24.1. *Acanthurus leucosternon*

Nome Científico | Cientific Name • *Acanthurus leucosternon* (Bennett, 1833)
Nome Inglês | English Name • Powderblue surgeonfish
Nome Português | Portuguese Name • Peixe cirurgião azul
Nome Francês | French Name • Chirurgien bleu

Ecologia: Recifes rasos, costeiros e claros de 0.5 a 25 m. Geralmente em recifes rasos ao longo de declives superiores, às vezes em grandes agregações (Lieske, 1994).

Distribuição: Oceano Índico: Leste de África até ao Mar de Andaman, sudoeste da Indonésia e Ilhas Natal, com alcance até Bali, Indonésia, no Pacífico Ocidental (Fishbase, 2000).

Ecology: Flat reefs, coastal and clear from 0.5 to 25 m. Usually in shallow reefs along upper slopes, sometimes in huge aggregations (Lieske, 1994).

Distribution: Indian Ocean: eastern Africa to the Andaman Sea, southwest Indonesia and Christmas Island; with range extended to Bali, Indonesia in Western Pacific (Fishbase, 2000).

24.2. *Acanthurus lineatus*

Nome Científico | Cientific Name • *Acanthurus lineatus* (Linnaeus, 1758)
Nome Inglês | English Name • Lined surgeonfish
Nome Português | Portuguese Name • Peixe cirurgião zebra
Nome Francês | French Name • Chirurgien zèbre

Ecologia: Recifes exteriores e zonas de ondas de recifes rasos expostos e topos de pequenos recifes, geralmente a 4 m. Territoriais e agressivos. Comuns (Lieske, 1994).

Distribuição: Indo-Pacífico: África Oriental, incluindo as ilhas Mascarenhas, as Havaianas, ilhas Marquesas e Tuamotu. Desde o sul do Japão até à Grande Barreira de Coral e Nova Caledónia. Substituído no Mar Vermelho pelo intimamente relacionado *Acanthurus sohal* (Fishbase, 2000).

Ecology: Outer reefs and shallow reef wave zones exposed and tops of small reefs, usually 4 m. Territorial and aggressive. Common (Lieske, 1994).

Distribution: Indo-Pacific: East Africa, including the Mascarene Islands to the Hawaiian, Marquesan and Tuamoto islands, north to southern Japan, south to the Great Barrier Reef and New Caledonia. Replaced by the closely related *Acanthurus sohal* in the Red Sea (Fishbase, 2000).

24.3. *Acanthurus triostegus*

Nome Científico | Cientific Name • *Acanthurus triostegus* (Linnaeus, 1758)
Nome Inglês | English Name • Convict surgeonfish
Nome Português | Portuguese Name • Peixe cirurgião
Nome Francês | French Name • Chirurgien bagnard

Ecologia: Lagoas e recifes interiores em áreas de substrato duro de 0 a 90 m. Juvenis nas poças de maré. Alimentam-se de algas filamentosas. Individuais ou em grandes grupos. Ganha acesso a alimentação de territórios de outros herbívoros por ir em grupos grandes. Comum em muitas áreas (Lieske, 1994).

Distribuição: Indo-Pacífico: em toda a região, exceto nos mares em redor da Península Arábica. Pacífico Oriental: parte inferior do Golfo da Califórnia até ao Panamá, incluindo as Revillagigedo, Cocos, Clipperton, e as ilhas Galápagos (Fishbase, 2000).

Ecology: Lagoons and interior reefs of hard substrate, 0 to 90 m. Juveniles in tidal pools. They feed on filamentous algae. Individually or in large groups. Gain access to territories of other herbivores feed on go in large groups. Common in many areas (Lieske, 1994).

Distribution: Indo-Pacific: throughout the region except for the seas around the Arabian Peninsula. Eastern Pacific: lower Gulf of California to Panama, including the Revillagigedo, Cocos, Clipperton, and Galapagos islands (Fishbase, 2000).

24.4. *Acanthurus nigricauda*

Nome Científico | Cientific Name • *Acanthurus nigricauda* (Duncker & Mohr, 1929)
Nome Inglês | English Name • Epaulette surgeonfish
Nome Português | Portuguese Name • Peixe cirurgião de cauda negra
Nome Francês | French Name • Chirurgien à épaulette

Ecologia: Lagoas de águas claras e recifes virados ao oceano de 1-30m. Prefere áreas abertas de fundo de areia perto de recifes pequenos. Ocorre frequentemente em grupos grandes com A. Olivaceus.

Distribuição: Indo-Pacífico: África Oriental, incluindo as ilhas Mascarenhas até às Ilhas Tuamoto. Desde as Ilhas Ryukyu até ao sul da Grande Barreira de Coral. Não ocorrendo no Mar Vermelho.

Ecology: Clear water lagoons and reefs of ocean-facing 1-30 m. Prefers open areas of sand bottom near reefs. Often occurs in large groups with *A. Olivaceus.*

Distribution: Indo-Pacific: East Africa, including the Mascarene Islands to the Tuamoto Islands, north to Ryukyu Islands, south to southern Great Barrier Reef. Not occurring in the Red Sea (Fishbase, 2000).

24.5. *Acanthurus blochii*

Nome Científico | Cientific Name • *Acanthurus blochii* (Valenciennes, 1835)
Nome Inglês | English Name • Ringtail surgeonfish
Nome Português | Portuguese Name • Peixe cirurgião de Blooch
Nome Francês | French Name • Chirurgien de blochi

Ecologia: Lagoas exteriores e recifes interiores de 1 a 12 m. Frequentemente em grupos em áreas de pastagem aberta aliemtando-se de filme de algas que crescem em areia compacta (Lieske, 1994).

Ecology: Exterior and interior of reefs lagoons 1 to 12 m. Often in groups in open grazing areas feeding on algae film growing on sand compacts (Lieske, 1994).

Distribuição: Indo-Pacífico: África Oriental, incluindo as ilhas Mascarenhas até ao Havai e Sociedade. Desde as Ilhas Ryukyu até ilha Lord Howe (Fishbase, 2000).

Distribution: Indo-Pacific: East Africa, including the Mascarene Islands to the Hawaiian and Society islands, north to Ryukyu Islands, south to Lord Howe Island (Fishbase, 2000).

24.6. *Acanthurus dussumieri*

Nome Científico | Cientific Name • *Acanthurus dussumieri* (Valenciennes, 1835)
Nome Inglês | English Name • Eyestripe surgeonfish
Nome Português | Portuguese Name • Peixe cirurgião de risca no olho
Nome Francês | French Name • Chirurgien couronné

Ecologia: Recifes interiores de 4 a 131 m, geralmente mais profundo que 10 m. Alimentam-se principalmente de algas na superfície que cobre a areia, mas ocasionalmente navega sobre uma superfície dura (Lieske, 1994).

Ecology: Seaward reefs from 4 to 131 m, usually deeper than 10 m. Feeds mainly of algae on the surface that covers the sand, but occasionally sails on a hard surface (Lieske, 1994).

Distribuição: Indo-Pacífico: Leste da África (incluindo as ilhas Mascarenhas) até ao Havai e ilhas Linha. Desde o sul do Japão até Rowley Shoals e o sul da Grande Barreira de Coral e ilha de Lord Howe. Ausente da maior parte do Pacífico central (Fishbase, 2000).

Distribution: Indo-Pacific: East Africa (including the Mascarene Islands) to the Hawaiian and Line islands, north to southern Japan, south to Rowley Shoals, southern Great Barrier Reef and Lord Howe Island. Absent from most of central Pacific (Fishbase, 2000).

24.7. *Acanthurus nigrofuscus*

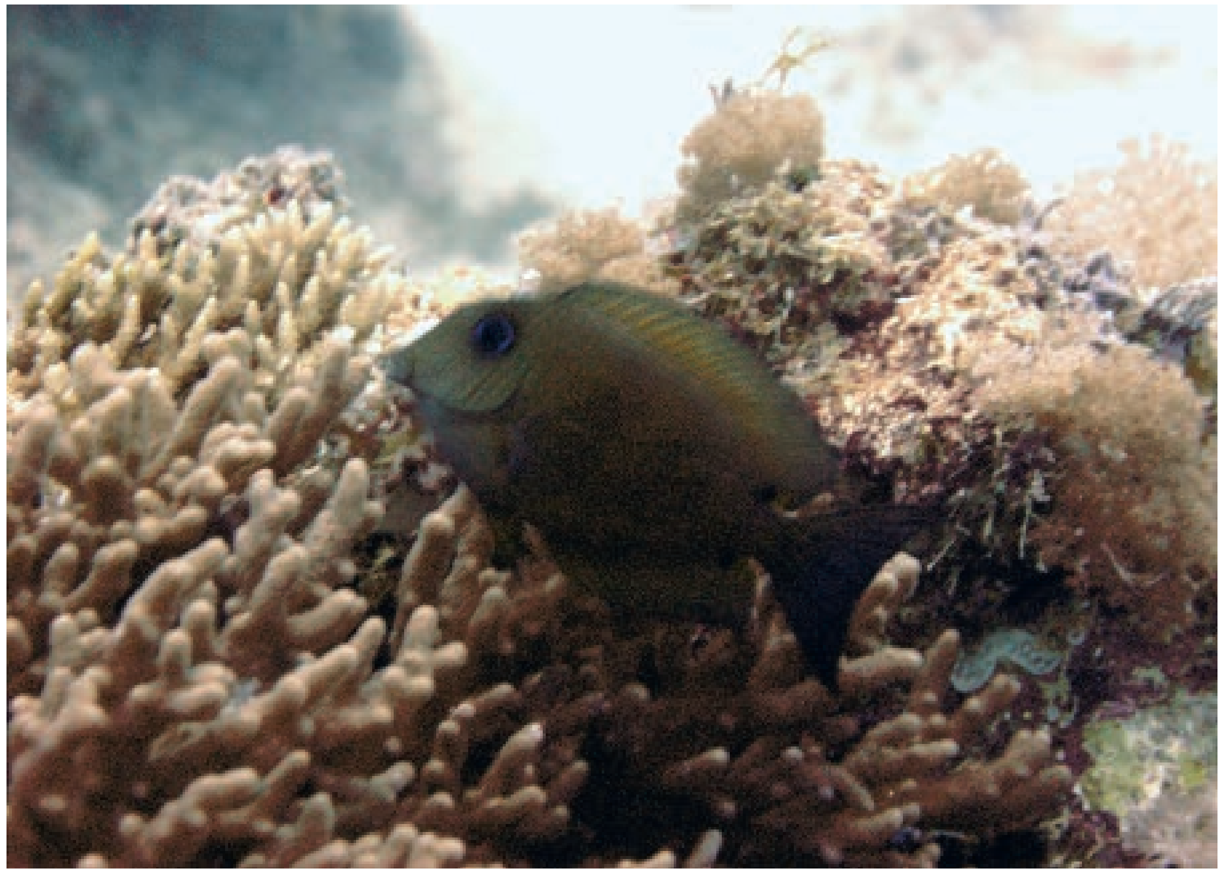
Nome Científico | Cientific Name • *Acanthurus nigrofuscus* (Forsskal, 1775)
Nome Inglês | English Name • Brown surgeonfish
Nome Português | Portuguese Name • Peixe cirurgião castanho
Nome Francês | French Name • Chirurgien brun

Ecologia: Lagoas e recifes interiores de 1 a 15 m. Frequentemente em grandes cardumes, por vezes com *Acanthurus triostegus.* Em cardumes nos territórios de outros peixes cirurgiões para se alimentar de algas filamentosas (Lieske, 1994).

Ecology: Lagoons and coral reefs 1 interiors to 15 m. often found in large schools, sometimes with Acanthurus triostegus. In schools in the territories of other surgeons fish to feed on filamentous algae (Lieske, 1994).

Distribuição: Indo-Pacífico: Mar Vermelho até ao Transkei, África do Sul, Havai e ilhas Tuamotu. Desde o sul do Japão até ao sul da Grande Barreira de Coral, Nova Caledónia, e Rapa (ilha Austral) (Fishbase, 2000).

Distribution: Indo-Pacific: Red Sea south to Transkei, South Africa and east to the Hawaiian and Tuamoto islands, north to southern Japan, south to the southern Great Barrier Reef, New Caledonia, and Rapa (Austral Islands) (Fishbase, 2000).



24.8. *Ctenochaetus binotatus*

Nome Científico | Cientific Name • *Ctenochaetus binotatus* (Randall, 1955)
Nome Inglês | English Name • Twospot surgeonfish
Nome Português | Portuguese Name • Peixe cirurgião de duas manchas
Nome Francês | French Name • Chirurgien à deux points

Ecologia: Corais e áreas de cascalho de lagoas profundas e recifes interiores de 12 a 53 m. As espécies de *Ctenochaetus* alimentam-se de detritos e películas de algas unicelulares da superfície do recife incluindo superfície de algas e ervas marinhas. São importantes vetores de ciguatera (Lieske, 1994).

Ecology: Corals and gravel areas of deep lagoons and seaward reefs from 12 to 53 m . Ctenochaetus species feed on detritus and algae films of the reef surface including surface of algae and seagrass. Are important vectors of ciguatera (Lieske, 1994).

Distribuição: Indo-Pacífico: Leste de África até às Ilhas Tuamotu. Desde o sul do Japão até New South Wales (Austrália) e Nova Caledónia. Não conhecido no Mar Vermelho, Golfo de Omã, nas ilhas havaianas, Marquesas, Rapa, Ilhas Pitcairn, e Ilha de Páscoa (Fishbase, 2000).

Distribution: Indo-Pacific: East Africa to the Tuamoto Islands, north to southern Japan, south to central New South Wales (Australia) and New Caledonia. Not known from the Red Sea, Gulf of Oman, the Gulf, the Hawaiian Islands, Marquesas, Rapa, Pitcairn Islands, and Easter Island (Fishbase, 2000).

24.9. *Naso brevirostris*

Nome Científico | Cientific Name • *Naso brevirostris* (Cuvier, 1829)
Nome Inglês | English Name • Spotted unicornfish
Nome Português | Portuguese Name • Unicornio malhado
Nome Francês | French Name • Licorne pointue

Ecologia: Paredes íngremes de lagoa exteriores e declives de recifes interiores de 4 a 46 m. Juvenis alimentam-se de algas bentónicas, adultos de zooplâncton (Lieske, 1994).

Distribuição: Indo-Pacífico: Mar Vermelho e África Oriental até ao Havai, ilhas Marquesas e Ducie. Desde o sul do Japão até ilha de Lord Howe (Fishbase, 2000).

Ecology: Steep walls of outer lagoon and reef slopes of seaward reefs from 4 to 46 m. Juveniles feed on benthic algae; adults of zooplankton (Lieske, 1994).

Distribution: Indo-Pacific: Red Sea and East Africa to the Hawaiian, Marquesan and Ducie islands, north to southern Japan, south to Lord Howe Island (Fishbase, 2000).

Juvenil

Adulto

24.10. *Naso hexacanthus*

Nome Científico | Cientific Name • *Naso hexacanthus* (Bleeker, 1855)
Nome Inglês | English Name • Sleek unicornfish
Nome Português | Portuguese Name • Unicornio cinzento
Nome Francês | French Name • Licorne grise

Ecologia: Lagoas águas limpas e declives de recifes interiores de 6 a 137 m. Alimentam-se de grandes animais zooplanctonicos. Por vezes com cardumes de *Naso caesius* (Lieske, 1994).

Distribuição: Indo-Pacífico: Mar Vermelho e África Oriental, incluindo as ilhas Mascarenhas até ao Havai, Marquesas e Ducie. Desde o sul do Japão até ilha de Lord Howe (Fishbase, 2000).

Ecology: Clean water lagoons and seaward reef slopes from 6 the 137 m. Feeds on large animals zooplanktonics. Sometimes with shoals of Naso caesius (Lieske, 1994).

Distribution: Indo-Pacific: Red Sea and East Africa, including the Mascarene Islands to the Hawaiian, Marquesan and Ducie islands, north to southern Japan, south to Lord Howe Island.

24.11. *Naso lituratus*

Nome Científico | Cientific Name • *Naso lituratus* (Forster, 1801)
Nome Inglês | English Name • Orangespine unicornfish
Nome Português | Portuguese Name • Unicornio de espinha laranja
Nome Francês | French Name • Licorne de spine orange

Ecologia: Lagoas e recifes interiores de 0 a 90 m. Em areias abertas e cascalhos de areia bem como áreas ricas em coral. Alimentam-se de algas frondosas. Comum (Lieske, 1994).

Distribuição: Oceano Pacífico: Honshu, Japão até à Grande Barreira de Coral e Nova Caledónia e ilhas Havaianas, Polinésia Francesa, e Pitcairn. Pacífico Oriental: Clipperton. Em tempos considerada uma espécie de grande alcance no Indo-Pacífico, a população do Oceano Índico é agora reconhecida como uma espécie separada, *Naso elegans* (Fishbase, 2000).

Ecology: Lagoons and seawards reefs from 0 to 90 m. In open sands and gravels of sand and coral-rich areas. They feed on leafy algae. Common (Lieske, 1994).

Distribution: Pacific Ocean: Honshu, Japan south to the Great Barrier Reef and New Caledonia and east to the Hawaiian Islands, French Polynesia, and Pitcairn. Eastern Pacific: Clipperton Island. Once regarded a wide-ranging Indo-Pacific species, the Indian Ocean population is now recognized as a separate species, *Naso elegans* (Fishbase, 2000).

24.12. *Naso vlamingii*

Nome Científico | Cientific Name • *Naso vlamingii* (Valencienne, 1835)
Nome Inglês | English Name • Bignose unicornfish
Nome Português | Portuguese Name • Unicornio narigudo
Nome Francês | French Name • Licorne à gros nez

Ecologia: Lagoas profundas e recifes interiores de 4 a 40 m. Geralmente agregam-se em águas médias perto de declives de recifes quando se alimentam de zooplâncton. Comum em volta de destroços. Podem transformar-se instantaneamente mostrando marcas brilhantes azuis. Machos são particularmente coloridos durante o namoro (Lieske, 1994).

Distribuição: Indo-Pacifico: Leste de Africa até às Galápagos. Desde o sul do Japão até ao sul da Grande Barreira de Coral, Nova Caledónia, Tuamotu, ao longo da Micronésia (Fishbase, 2000).

Ecology: Deep lagoons and seaward reefs from 4 to 40 m. Generally aggregate average water near reef slopes when they feed on zooplankton. Common around the wreckage. Can transform instantly showing bright blue markings. Males are particularly colourful during the courtship (Lieske, 1994).

Distribution: Indo-pan-Pacific: East Africa to the Galapagos Is. north to southern Japan, south to the southern Great Barrier Reef and New Caledonia, Tuamotus, throughout Micronesia (Fishbase, 2000).

24.13. *Paracanthurus hepatus*

Nome Científico | Cientific Name • *Paracanthurus hepatus* (Linnaeus, 1766)
Nome Inglês | English Name • Palette surgeonfish
Nome Português | Portuguese Name • Cirurgião palete
Nome Francês | French Name • Chirurgien palette

Ecologia: Recifes interiores claros de 2 a 40 m, geralmente em áreas com movimentação de correntes. Em agregações soltas 1 a 3 m acima do substrato. Alimentam-se de zooplâncton. Abrigam-se em grupos entre as ramificações de corais de pocilopora ou em fendas de rochas. Frequentemente encontrado no mesmo grupo de corais (Lieske, 1994).

Distribuição: Indo-Pacífico: África Oriental, incluindo as ilhas Mascarenhas até Kiribati. Desde o sul do Japão até ao sul da Grande Barreira de Coral, Nova Caledónia e Samoa (Fishbase, 2000).

Ecology: Seaward reefs from 2 to 40 m, generally in areas with chain drive. In loose aggregations 1 to 3 m above the substrate. They feed on zooplankton. Shelter in groups among the branches of corals of the genus pocilopora or in crevices of rocks. Often found in the same group of corals (Lieske, 1994).

Distribution: Indo-Pacific: East Africa, including the Mascarene Islands to Kiribati, north to southern Japan, south to the southern Great Barrier Reef, New Caledonia, and Samoa (Fishbase, 2000).

24.14. *Zanclus cornutus*

Nome Científico | Cientific Name • *Zanclus cornutus* (Linnaeus, 1758)
Nome Inglês | English Name • Moorish idol
Nome Português | Portuguese Name • Ídolo Mourisco
Nome Francês | French Name • Idole maure

Ecologia: Presente em quase todos os habitats até 182m. Normalmente em pequenos grupos algumas vezes em grupos grandes. Alimenta-se principalmente de esponjas. Dificil de manter em aquário (Lieske, 1994).

Distribuição: Indo-Pacífico: Leste de Africa até Rapa e ilhas Ducie. Desde o sul do Japão e ilhas Havaianas até ilha de Lord Howe. Pacífico Oriental: sul do Golfo da Califórnia ao Peru.

Ecology: Present in almost every habitat up to 182 m. Usually in small groups, sometimes in large groups. It feeds mainly on sponges. Hard to keep in an Aquarium (Lieske, 1994).

Distribution: Indo-Pacific: East Africa to Rapa and Ducie islands, north to southern Japan and the Hawaiian Islands, south to the Lord Howe Island. Eastern Pacific: southern Gulf of California to Peru (Fishbase, 2000).

24.15. *Zebrassoma scopas*

Nome Científico | Cientific Name • *Zebrassoma scopas* (Cuvier, 1829)
Nome Inglês | English Name • Twotone tang
Nome Português | Portuguese Name • Cirugião acastanhado
Nome Francês | French Name • Chirurgien voile brun

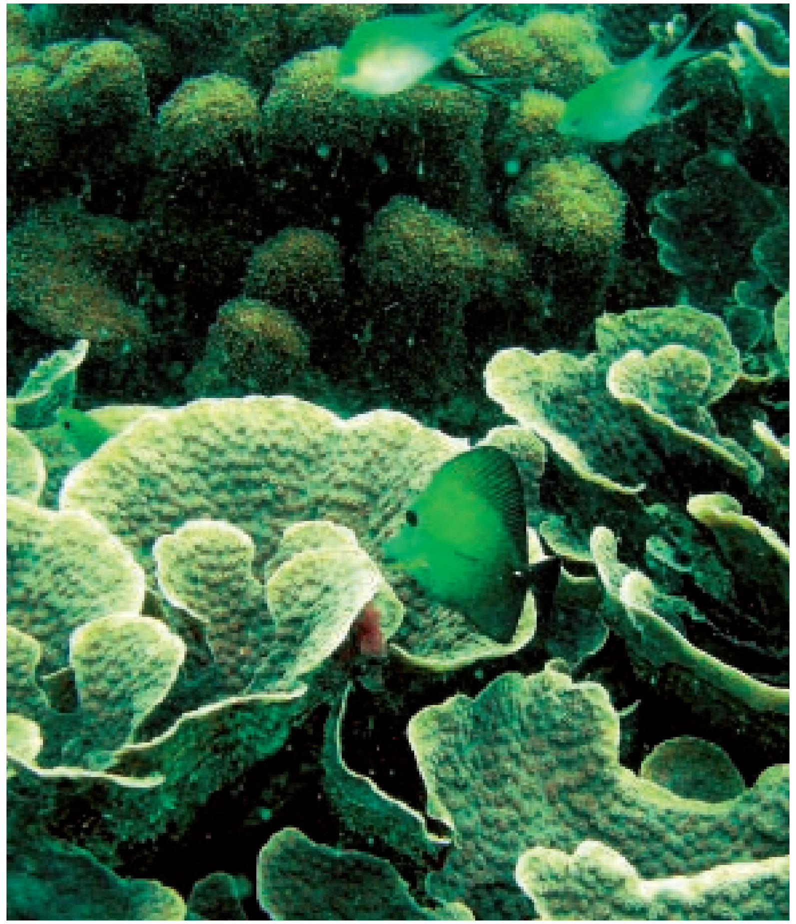
Ecologia: Áreas de lagoa ricas em coral e recifes interiores de 1 a 60 m. Sós ou em pequenos grupos. Hibridizado com *Zebrassoma flavescens* (Lieske, 1994).

Ecology: Lagoon areas rich in coral and seaward reefs from 1 to 60 m. Alone or in small groups. Hybridized with *Zebrassoma flavescens* (Lieske, 1994).

Distribuição: Indo-Pacífico: África Oriental, incluindo as ilhas Mascarenhas, até às Ilhas Tuamotu. Desde o sul do Japão até ilha de Lord Howe e ilhas Rapa (Fishbase, 2000).

Distribution: Indo-Pacific: East Africa, including the Mascarene Islands to the Tuamoto Islands, north to southern Japan, south to Lord Howe and Rapa islands (Fishbase, 2000).

Adulto



Juvenil

24.16. *Zebrassoma desjardinii*

Nome Científico | Cientific Name • *Zebrassoma desjardinii* (Bennett, 1836)
Nome Inglês | English Name • Indian Sail-fin tang
Nome Português | Portuguese Name • Canivete veleiro do Índico
Nome Francês | French Name • Chirurgien voile indien

Ecologia: Lagoas e recifes interiores a mais de 30 m. Juvenis em abrigos em áreas do interior do recife (Lieske, 1994).

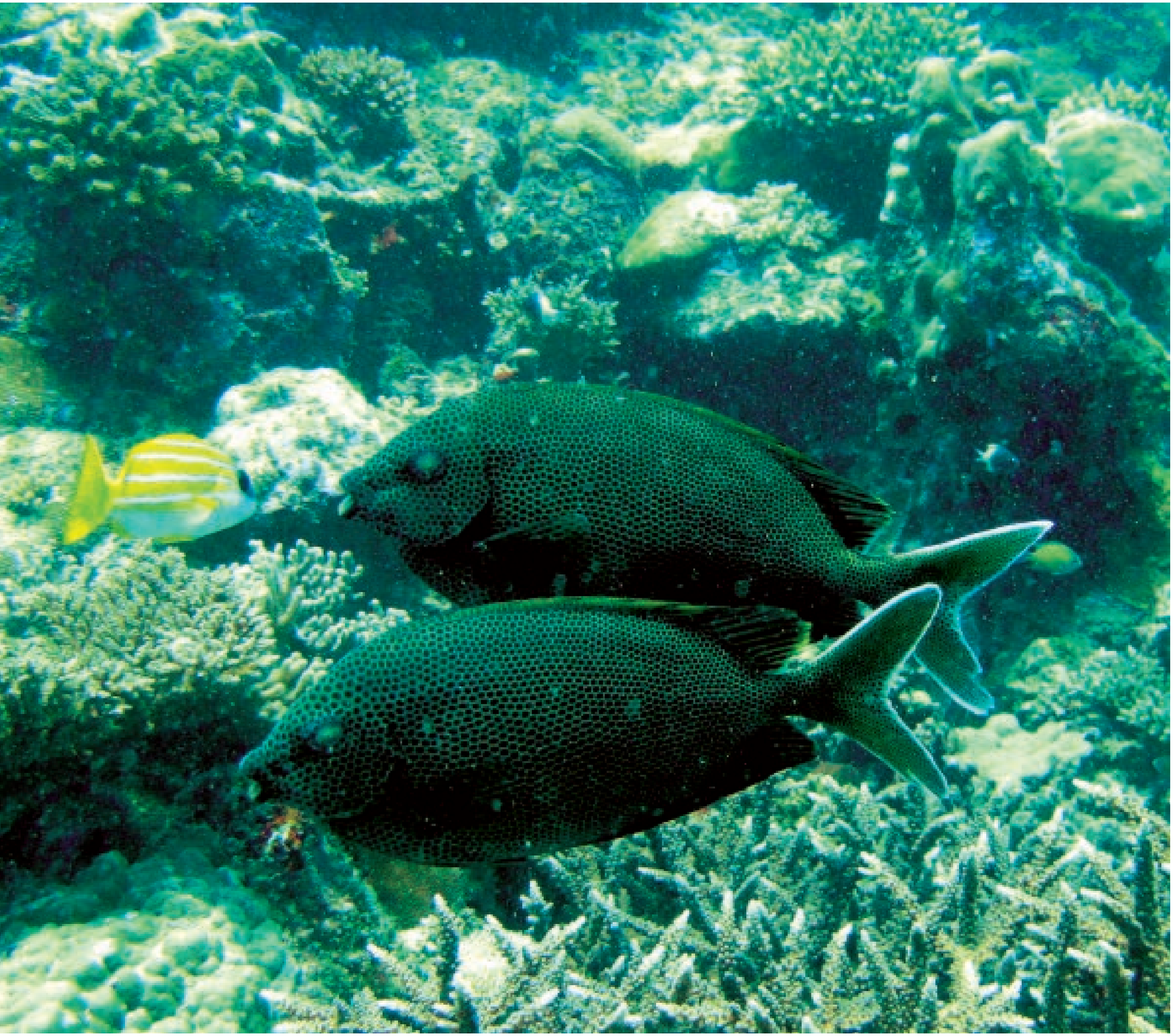
Ecology: Lagoons and seaward reefs more than 30 m. Juveniles in shelters in the interior areas of the reef (Lieske, 1994).

Distribuição: Oceano Índico: Mar Vermelho até Natal na África do Sul e a leste até Índia, Java, e Ilhas Cocos-Keeling, não é encontrado nas ilhas Christmas (Fishbase, 2000).

Distribution: Indian Ocean: Red Sea south to Natal, South Africa and east to India, Java, and Cocos-Keeling Islands, but not Christmas Island (Fishbase, 2000).

25. Peixes coelho | Rabbitfish

de nariz arrebitado | upturned nose



Estes peixes devem o seu nome ao formato afilado da boca que parece um focinho de coelho. No entanto os espinhos das suas barbatanas pélvicas são venenosos. A cor dos peixes coelhos varia muito, sendo mais colorida a das espécies de corais e mais neutra a das espécies de ervas marinhas. São peixes de águas marinhas que podem penetrar nos mangais e rios. Possuem um tamanho médio entre 25 e 50cm na idade adulta. São herbívoros, activos de dia, nas pradarias de ervas marinhas ou nas zonas de algas dos recifes de corais mistos. Os machos e a fêmeas são distintos sem hermafroditismos conhecidos. Reproduzem-se a meia água, algumas espécies agregam-se em grandes quantidades ao longo de 1 ou dois dias para reproduzir-se em determinado local. Esta família é um importante recurso pesqueiro, sendo o Siganus sutor a principal espécie pescada.

These fish owe their name to the tapered shape of the mouth that looks like a rabbit snout. However the spines of their pelvic fins are poisonous. The color of rabbitfish varies widely. The species living in corals are more colorful than the ones living in the sea grass. They are marine water fish but they can penetrate the mangroves and rivers. Their average size is between 25 and 50cm in adulthood. They are herbivores, active during the day, in the beds of seagrass or algae or in mixed coral in half water. Some species gather in large numbers over one or two days to reproduce on a particular site. This family is an important fishing resource, Siganus sutor being the main species caught.

25.1. *Siganus sutor*

Nome Científico | Cientific Name • *Siganus sutor* (Valenciennes, 1835)
Nome Inglês | English Name • Shoemaker spinefoot
Nome Português | Portuguese Name • Peixe coelho
Nome Francês | French Name • Cordonnier

Ecologia: Áreas costeiras e recifes internos, particularmente em pradarias de ervas marinhas (Lieske, 1994).

Distribuição: Atlântico e Oceano Indo-Pacífico (Fishbase, 2000).

Ecology: Coastal areas and coral reefs, particularly in seagrass meadows (Lieske, 1994).

Distribution: Atlantic and Indo-Pacific Ocean (Fishbase, 2000).

25.2. *Siganus stellatus*

Nome Científico | Cientific Name • *Siganus stellatus* (Forsskal, 1775)
Nome Inglês | English Name • Brown-spotted spinefoot
Nome Português | Portuguese Name • Peixe coelho
Nome Francês | French Name • Cordonnier marguerite

Ecologia: Lagoas de água claras e recifes interiores de 1 a 27 m. Geralmente aos pares (Lieske, 1994).

Distribuição: Oceano Índico: Mar Vermelho e África Oriental até o Mar de Andaman (Fishbase, 2000).

Ecology: Clear water lagoons and seaward reefs from 1 the 27 m. Usually in pairs (Lieske, 1994).

Distribution: Indian Ocean: Red Sea and East Africa to the Andaman Sea (Fishbase, 2000).

26. Peixes porcos | Triggerfish

com dentes poderosos | powerful teeth

Os peixes porco possuem dentes poderosos, que podem infligir graves lesões, e a esses devem o seu nome em português. O nome em inglês, Trigerfish, deve-se a sua barbatana dorsal original, dividida em duas. A primeira parte é de tal maneira robusta que, quando erguida, serve para prender o animal aos buracos onde se pode esconder. A sua pele também é muito mais espessa do que a maioria dos peixes. Os seus olhos podem rodar em várias direções e independentemente um do outro, dando-lhe uma visão apurada. A sua natação é muito característica, pois usa a barbatana dorsal e a anal. Na maioria das espécies a fêmea põe um ninho no fundo e fica a cuidar dos ovos, podendo em algumas espécies ser ajudada pelo macho. O mergulhador tem que estar atento as estes ninhos pois os pais defendem-nos com os seus dentes poderosos. Os peixes porcos podem variar de poucos centímetros a cerca de 80cm (Peixe Porco Titan). Têm uma alimentação variada. Graças aos seus dentes podem comer ouriços-do-mar, moluscos com concha e caranguejos. São bastante importantes nos recifes de corais por controlarem as populações de ouriços-do-mar que proliferam exageradamente quando existem muitas algas. A sua carne é muito apreciada em Moçambique, no entanto não é considerado uma espécie importante para a pesca pela FAO(Food and Agriculture Organization).

Triggerfish have very powerful teeth that may inflict serious damage. This inspired the Portuguese name. The English name is due to the fact that they have an original dorsal fin divided in two. The first part of which is so strong that when raised it can hold the animal to the holes where it hides. Its skin is much thicker than in most of the fishes. Its eyes are able to roll in several directions and independently from one another, providing a very acute vision. They have a characteristic swim caused by the undulating movement of the dorsal and anal fin. In most species the female nests in the bottom and stays there guarding the eggs, sometimes the male also helps. Divers must be very attentive to these nests because parents defend them with their powerful teeth. They measure from a few centimeters up to at least 80 cm (Titan Triggerfish). They have a varied diet. Thanks to their teeth they can eat sea urchins, crabs and clams with shell. They are quite important in coral reefs because they control the excessive proliferation of sea urchins when there are many algae. Its meat is highly prized in Mozambique; however it is not considered an important species for fisheries by FAO (Food and Agricultural Organization).

26.1. *Balistapus undulatus*

Nome Científico | Cientific Name • *Balistapus undulatus* (Park, 1797)
Nome Inglês | English Name • Orange-lined triggerfish
Nome Português | Portuguese Name • Peixe-porco de linhas laranjas
Nome Francês | French Name • Baliste strié

Ecologia: Áreas de lagoas ricas em coral e recifes interiores de 2 a 50 m. Alimentam-se de grande variedade de animais incluindo corais, esponjas, vermes, equinodermes, crustáceos e peixes (Lieske, 1994).

Distribuição: Indo-Pacífico: Mar Vermelho até Natal, África do Sul e ilhas Linhas, Marquesas e Tuamotu. Desde o sul do Japão até ao sul da Grande Barreira de Coral e Nova Caledónia (Fishbase, 2000).

Ecology: Areas of coral-rich lagoons and seaward reefs from 2 to 50 m. Feeds on a wide variety of animals including corals, sponges, worms, echinoderms, crustaceans and fishes (Lieske, 1994).

Distribution: Indo-Pacific: Red Sea south to Natal, South Africa and east to the Line, Marquesan and Tuamoto islands, north to southern Japan, south to the southern Great Barrier Reef and New Caledonia (Fishbase, 2000).

26.2. *Balistoides conspicillum*

Nome Científico | Cientific Name • *Balistoides conspicillum* (Bloch & Schneider, 1801)
Nome Inglês | English Name • Clown triggerfish
Nome Português | Portuguese Name • Peixe-porco palhaço
Nome Francês | French Name • Baliste-clown

Ecologia: Recifes interiores claros de 1 a 75 m. Juvenis em grutas abaixo de 20 m ao longo de declives íngremes. Adultos, frequentemente em terraços ricos em coral perto de encostas íngremes (Lieske, 1994).

Distribuição: Indo-Pacífico: Leste de África até Durban, África do Sul e a leste ao longo da Indonésia até Samoa. Desde o sul do Japão até à Nova Caledónia (Fishbase, 2000).

Ecology: Seaward reef 1 to 75 m. Juveniles in caves below 20 m along steep inclines. Adults, often in coral-rich terraces near steep slopes (Lieske, 1994).

Distribution: Indo-Pacific: East Africa south to Durban, South Africa and east through Indonesia to Samoa, north to southern Japan and south to New Caledonia (Fishbase, 2000).

26.3. *Balistoides viridescens*

Nome Científico | Cientific Name • *Balistoides viridescens* (Bloch & Schneider, 1801)
Nome Inglês | English Name • Titan triggerfish
Nome Português | Portuguese Name • Peixe-porco Titan
Nome Francês | French Name • Baliste titan

Ecologia: Lagoas e recifes interiores de 1 a aproximadamente 40 m. Juvenis geralmente em áreas arenosas baixas e protegidas. Adultos solitários ou aos pares. Alimentam-se de corais, invertebrados bentónicos, particularmente formas com corpo duro, e algas. Normalmente cautelosos, mas podem atacar mergulhadores quando guardam o ninho. Mordidas graves podem requerer atenção médica. Ocasionalmente ciguatoxicos (Lieske, 1994).

Distribuição: Indo-Pacífico: Mar Vermelho até à Baía de Maputo, Moçambique e ilhas Linha e Tuamoto. Desde o sul do Japão até Nova Caledónia (Fishbase, 2000).

Ecology: Lagoons and reefs singlets 1 approximately 40 m. juvenile fish, usually in sandy areas and protected. Adults are solitary or in pairs. They feed on benthic invertebrates, corals, particularly with hard body shapes, and algae. Normally cautious, but can attack divers when guarding the nest. Serious bites may require medical attention. Occasionally ciguatoxics (Lieske, 1994).

Distribution: Indo-Pacific: Red Sea south to Delagoa Bay, Mozambique and east to the Line and Tuamoto islands, north to southern Japan, south to New Caledonia (Fishbase, 2000).

26.4. *Melichtys indicus*

Nome Científico | Cientific Name • *Melichtys indicus* (Randall & Klausewitz, 1973)
Nome Inglês | English Name • Indian triggerfish
Nome Português | Portuguese Name • Peixe-porco do índico
Nome Francês | French Name • Baliste indien

Ecologia: Declives de recifes interiores ricos em coral de 2 a 30 m. Solitários (Lieske, 1994).

Distribuição: Oceano Índico: Mar Vermelho e África Oriental até à Tailândia ocidental e Sumatra, na Indonésia (Fishbase, 2000).

Ecology: Inner reef slopes rich in coral of the 2 m 30. Solitaries (Lieske, 1994).

Distribution: Indian Ocean: Red Sea and East Africa eastward to western Thailand and Sumatra, Indonesia (Fishbase, 2000).

26.5. *Odonus niger*

Nome Científico | Cientific Name • *Odonus niger* (Ruppell, 1836)
Nome Inglês | English Name • Red-tooth triggerfish
Nome Português | Portuguese Name • Peixe-porco de dente vermelho
Nome Francês | French Name • Baliste bleu

Ecologia: Recifes interiores com movimentação de ondas de 2 a 35 m. Geralmente em enormes agregações na água. Alimentam-se principalmente de plâncton, ocasionalmente de esponjas. Quando assustados escondem-se em buracos deixando apenas o filamento da cauda visível (Lieske, 1994).

Distribuição: Indo-Pacífico: Mar Vermelho até Durban, África do Sul e ilhas Marquesas e Sociedade. Desde o sul do Japão até ao sul da Grande Barreira de Coral na Austrália e na Nova Caledónia (Fishbase, 2000).

Ecology: Seaward reefs with moving waves, from 2 to 35 m. Generally into huge aggregates in water. Feed mostly on plankton, occasionally of sponges. When frightened they hide in holes leaving only the visible tail filament (Lieske, 1994).

Distribution: Indo-Pacific: Red Sea south to Durban, South Africa and east to the Marquesas and Society islands, north to southern Japan, south to the southern Great Barrier Reef in Australia and New Caledonia (Fishbase, 2000).

26.6. *Rhinecanthus aculeatus*

Nome Científico | Cientific Name • *Rhinecanthus aculeatus* (Linnaeus, 1758)
Nome Inglês | English Name • White-banded triggerfish
Nome Português | Portuguese Name • Peixe-porco Picasso
Nome Francês | French Name • Baliste picasso clair

Ecologia: Recifes e lagoas rasas até 4 m. Abundante em áreas arenosas com cascalho. Todas espécies do género alimentam-se de vários invertebrados bentónicos, peixes e algas (Lieske, 1994).

Distribuição: Indo-Pacífico: Mar Vermelho até à África do sul e Havai, ilhas Marquesas e Tuamotu. Desde o sul do Japão até ilha de Lord Howe. Atlântico Leste: Senegal à África do Sul (Fishbase, 2000).

Ecology: Reefs flats and shallow lagoons up to 4 m. Abundant in sandy areas with gravel. All species of the genus feed on a variety of benthic invertebrates, fish and algae (Lieske, 1994).

Distribution: Indo-Pacific: Red Sea south to South Africa and east to the Hawaiian, Marquesan, and Tuamoto islands, north to southern Japan, south to Lord Howe Island. Eastern Atlantic: Senegal to South Africa (Fishbase, 2000).

26.7. *Sufflamen bursa*

Nome Científico | Cientific Name • *Sufflamen bursa* (Bloch & Schneider, 1801)
Nome Inglês | English Name • Boomerang triggerfish
Nome Português | Portuguese Name • Peixe-porco
Nome Francês | French Name • Baliste carène

Ecologia: Declives de recifes exteriores abaixo da zona de ondas de 3 a 90 m. Preferem áreas com abundância de abrigos. Alimentam-se de uma grande variedade de invertebrados bentónicos e algas (Lieske, 1994).

Distribuição: Indo-Pacífico: África Oriental até ao Havai, ilhas Marquesas e Ducie. Desde o sul do Japão até ao sul da Grande Barreira de Coral na Austrália, Nova Caledónia, e Rapa (Fishbase, 2000).

Ecology : Outer reef slopes, below the waves, of 3 to 90 m. Prefer areas with plenty of shelter. They feed on a wide variety of benthic invertebrates and algae (Lieske, 1994).

Distribution: Indo-Pacific: East Africa to the Hawaiian, Marquesan and Ducie islands, north to southern Japan, south to the southern Great Barrier Reef in Australia, New Caledonia, and Rapa (Fishbase, 2000).

26.8. *Sufflamen chrysopterum*

Nome Científico | Cientific Name • *Sufflamen chrysopterum* (Bloch & Schneider, 1801)
Nome Inglês | English Name • Halfmoon triggerfish
Nome Português | Portuguese Name • Peixe-porco
Nome Francês | French Name • Baliste à gorge bleue

Ecologia: Lagoas rasas e recifes interiores até 30 m. Comum sobre fundos abertos com corais baixos (Lieske, 1994).

Distribuição: Indo-Pacífico Ocidental: Leste de África até ao rio Chalumna, África do Sul e Samoa. Desde o sul do Japão até ilha de Lord Howe. Substituído no Mar Vermelho por *Sufflamen albicaudatus* estreitamente relacionados (Fishbase, 2000).

Ecology: Shallow lagoons and reefs interiors until 30 m. Common in funds opened with low coral (Lieske, 1994).

Distribution: Indo-West Pacific: East Africa south to the Chalumna River, South Africa and east to Samoa, north to southern Japan, south to Lord Howe Island. Replaced by closely related Sufflamen albicaudatus in the Red Sea (Fishbase, 2000).

Sufflamen chrysopterum (Forma de transição entre o *S. crysopterus ec. Albicaudatus*)

Sufflamen chrysopterum (Juvenil)

26.9. *Oxymonacanthus longirostris*

Nome Científico | Cientific Name • *Oxymonacanthus longirostris* (Bloch & Schneider, 1801)
Nome Inglês | English Name • Harlequin filefish
Nome Português | Portuguese Name • Peixe porco laranja
Nome Francês | French Name • Poisson-lime à taches orange

Ecologia: Lagoas de águas claras e recifes interiores de 1 a 3 m, onde corais de acropora são comuns. Alimentam-se exclusivamente de pólipos de acropora. Frequentemente aos pares ou em pequenos grupos (Lieske, 1994).

Distribuição: Indo-Pacífico: Leste de África do Sul a Moçambique e no leste de Samoa, no norte de Ryukyu, ao sul do sudoeste da Grande Barreira de Corais, Nova Caledónia, e Tonga. Substituído por *Oxymonacanthus halli* no Mar Vermelho (Fishbase, 2000).

Ecology: Clear water lagoons and seaward reefs from 1 to 3 m, where the genus acropora corals are common. They feed exclusively on acropora polyps. Often in pairs or in small groups (Lieske, 1994).

Distribution: Indo-Pacific: East Africa south to Maputo, Mozambique and east to Samoa, north to Ryukyu Islands, south to the southern Great Barrier Reef, New Caledonia, and Tonga. Replaced by *Oxymonacanthus halli* in the Red Sea (Fishbase, 2000).

26.10. *Xanthichthys auromarginatus*

Nome Científico | Cientific Name • *Xanthichthys auromarginatus* (Bennett, 1832)
Nome Inglês | English Name • Gilded triggerfish
Nome Português | Portuguese Name • Peixe porco
Nome Francês | French Name • Baliste à bord jaune

Ecologia: Paredes íngreme de recifes interiores de 8 a 147 m. Preferem bordas superiores de declives, raramente em menos do que 20 m. Pequenas agregações. Alimentam-se de zooplanctons (Lieske, 1994).

Distribuição: Indo-Pacífico: Leste de África até às ilhas Havaianas. Desde as ilhas Ryukyu até ao Atoll de Cocos--Keeling e Nova Caledónia (Fishbase, 2000).

Ecology: Steep walls of seaward reefs from 8 to 147 m. Prefer top edges of slopes, seldom in less than 20 m. Small aggregations. They feed on zooplanctons (Lieske, 1994).

Distribution: Indo-Pacific: East Africa to the Hawaiian Islands, north to the Ryukyus, south to Cocos-Keeling Atoll and New Caledonia (Fishbase, 2000).

27. Peixes cofres e outros | Boxfishes and others

tão quadrados como um cofre | square like a box

Os peixes cofre devem o seu nome à forma cúbica que apresentam. O corpo está inteiramente coberto por placas ósseas não possuindo escamas. As espécies do género Lactoria desenvolveram duas espinhas na cabeça que parecem uns cornos às quais devem o nome vulgar de peixes vaca. O pedúnculo caudal que sai da carapaça óssea pode ser muito alongado e proporciona uma boa velocidade de escape. A pequena boca está orientada obliquamente para baixo o que lhes dá acesso aos alimentos, que são pequenos invertebrados, esponjas, algas e tunicados. Vivem em haréns de várias fêmeas. A fecundação é a meia água, ovos e larvas são pelágicos. Os peixes cofres são normalmente muito pequenos, raras vezes chegando a 40 cm. No entanto quando estão em stress produzem uma toxina, a ostracitoxina, que pode ser fatal para os peixes que os comam pelo que são impróprios para os aquários.

Boxfishes owe their names to their cubic shape. The body is fully covered with bony plates with no scales at all. Species of the genus Lactoria developed two spines in the head that look like horns and because of that they are commonly called cowfish. The caudal peduncle exiting the bony carapace can be very elongated and provides a good escape velocity. The small mouth is directed obliquely downward which gives them access to food, which is small invertebrates, sponges, tunicates and algae. They live in harems of several females. Fertilization is half water, eggs and larvae are pelagic. Boxfishes are usually very small, seldom reaching 40cm. However when in stress they produce a toxin, the ostracitoxin, which can be fatal to the fish that eats them, therefore they are unsuitable for aquariums.

27.1. *Ostracion meleagris*

Nome Científico | Cientific Name • *Ostracion meleagris* (Shaw, 1796)
Nome Inglês | English Name • Whitespotted boxfish
Nome Português | Portuguese Name • Peixe caixa
Nome Francês | French Name • Poisson-coffre pintade

Ecologia: Lagoas de águas claras e recifes interiores de 1 a 30 m. Alimentam-se de esponjas e invertebrados bentónicos (Lieske, 1994).

Distribuição: Indo-Pacífico e Pacífico Oriental: África Oriental ao México, norte a sul do Japão e as ilhas Havaianas, ao sul de Nova Caledónia e Ilhas Tuamotu. A subespécie *Ostracion meleagris camurum* é encontrada nas ilhas Havaianas e *Ostracion meleagris clippertonense* no Pacífico Oriental. Espécies substituído por *Ostracion cyanurus* no Mar Vermelho e no Golfo de Aden (Fishbase, 2000).

Ecology: Clear water lagoons and seaward reefs from 1 to 30 m. Feed on sponges and benthic invertebrates (Lieske, 1994).

Distribution: Indo-Pacific and Eastern Pacific: East Africa to the Mexico, north to southern Japan and the Hawaiian Islands, south to New Caledonia and the Tuamoto Islands. The subspecies *Ostracion meleagris camurum* is found in the Hawaiian Islands and *Ostracion meleagris clippertonense* in the Eastern Pacific. Species replaced by *Ostracion cyanurus* in Red Sea and Gulf of Aden (Fishbase, 2000).

Fêmea

Macho

28. Peixes balão | Pufferfish

ninguém os consegue engolir | No way to be swallowed

Os peixes balão devem o seu nome à capacidade de se insuflar e ficarem com a forma de bola. Assim ficam maiores e assustam o inimigo ou este não os consegue engolir. Este dispositivo é reforçado em algumas espécies pela presença de numerosos espinhos na pele que não tem escamas. Em contrapartida a sua capacidade de natação é muito reduzida enquanto estão inchados, não sendo também muito grande no seu estado normal. A natação é feita normalmente pelas barbatanas dorsais e anais e, quando em fuga, pela caudal. Os peixes balão tem poderosos dentes muito parecidos com os dos peixes porco e igualmente perigosos, no entanto devido ao seu carácter menos agressivo são menos perigosos. Uma das famílias, Diodontidae, é completamente marinha com reprodução a meia água e ovos e larvas pelágicas. A outra família mais numerosa, Tetradontidae, é fundamentalmente marinha mas com espécies de água salobra e doce. A fêmea põe os ovos num ninho, no substrato, defendido por um ou dois pais. Todas as espécies se alimentam de crustáceos, invertebra-

Pufferfish can self insufflate and look like a ball. This way they get much bigger and either they scare their enemies or they get to big to be eaten. This mechanism is, in some species, reinforced by the presence of numerous thorns in the skin that has no scales. On the other hand, while they are swollen, their ability to swim is extremely reduced compared to their normal speed which anyway it's not fast. The swimming movement is normally done by its dorsal and anal fins, while on the run it's done by the caudal fin. Pufferfish have powerful teeth similar to triggerfish and equally dangerous, however due to their less aggressive character they are not as dangerous. One of the families, Didontidae, is totally marine; reproduces in midwater; the eggs and larvae are pelagic. The other family, Tetradontidae, more numerous, is mostly marine with just some species of brackish and freshwater. The female lays the eggs in a nest on the substrate, defended by one or both parents. All the species feed on crustaceans, invertebrates and mollusks with shell that they dos e moluscos com concha que podem quebrar com os seus dentes poderosos. No estado adulto estas espécies são solitárias mas alguns juvenis agregam-se em grupos numerosos. Os peixes balões não tem nenhum interesse para a pesca, pois a maioria das espécies são tóxicas e em muitos países a sua venda está interdita. A sua toxicidade vem da produção de uma toxina poderosa, a tetradoxina, que se concentra nos intestinos, gónadas e no muco. As espécies do género Fugu são particularmente tóxicas, mas particularmente procuradas no Japão onde uma tradição especifica desenvolveu o consumo deste produto muito arriscado para o consumo. Os cozinheiros habilitados a cozinhar o Fugu devem preparar-se durante muitos anos antes de ser autorizados a exercer a sua arte. Algumas vezes morrem pessoas, e o risco faz parte do atrativo desta estranha tradição culinária.

can break with its powerful teeth. In adulthood these species are solitary however while juvenile they aggregate in large numbers. Pufferfish have no interest for commercial fishery, because most of them are toxic; in many countries its sale is forbidden. Its toxicity is the outcome of producing a powerful toxin, the tetradoxin, which concentrates in the intestines, gonads and mucus. Species of the genus Fugu are particularly toxic, but also particularly sought after in Japan where a specific tradition developed the use of this fish with a high risk for the consumer. Skilled cooks specialized on how to cook Fugu, have to train for many years before being allowed to practice their art. Sometimes people die, but the risk is part of the allure in this strange culinary tradition.

28.1. *Arothron mappa*

Nome Científico | Cientific Name • *Arothron mappa* (Lesson, 1831)
Nome Inglês | English Name • Map puffer
Nome Português | Portuguese Name • Peixe balão mapa
Nome Francês | French Name • Poisson-ballon griffonné

Ecologia: Lagoas de águas claras e recifes interiores escondidos até 30 m. Alimentam-se de algas, esponjas e invertebrados bentónicos. Geralmente encontram-se escondidos nos abrigos (Lieske, 1994).

Ecology: Clear water lagoons and seaward reefs hidden until 30 m. Feed on benthic invertebrates, sponges and algae. Usually are hidden in shelters (Lieske, 1994).

Distribuição: Indo-Pacífico: Leste de África até Natal, África do Sul e Samoa. Desde as Ryukyu e o mar ocidental do Japão até Nova Caledónia e Queensland, na Austrália (Fishbase, 2000).

Distribution: Indo-Pacific: East Africa south to Natal, South Africa and east to Samoa, northward to the Ryukyus and western sea of Japan, southward to New Caledonia and Queensland, Australia (Fishbase, 2000).

28.2. *Arothron nigropunctatus*

Nome Científico | Cientific Name • *Arothron nigropunctatus* (Bloch & Schneider, 1801)
Nome Inglês | English Name • Blackspotted puffer
Nome Português | Portuguese Name • Peixe balão
Nome Francês | French Name • Poisson-ballon jaune

Arothron nigropunctatus (Variedade castanha)

Ecologia: Alimentam-se de corais, esponjas, tunicados e algas. Geralmente comum (Lieske, 1994).

Distribuição: Indo-Pacífico: Leste de Africa até Micronésia e Samoa. Desde o sul do Japão até New South Wales. Substituído por *Arothron diadematus* no Mar Vermelho (Fishbase, 2000).

Ecology: They feed on coral, sponges, tunicates and algae. Generally common (Lieske, 1994).

Distribution: Indo-Pacific: East Africa to Micronesia and Samoa, north to southern Japan, south to New South Wales. Replaced by Arothron diadematus in the Red Sea (Fishbase, 2000).

Arothron nigropunctatus (Variedade creme)

Arothron nigropunctatus (Variedade azul)

Um par de *Arothron* a meia água algo muito difícil de ver

28.3. *Arothron hispidus*

Nome Científico | Cientific Name • *Arothron hispidus* (Linnaeus, 1758)
Nome Inglês | English Name • White-spotted puffer
Nome Português | Portuguese Name • Peixe balão de manchas brancas
Nome Francês | French Name • Poisson-ballon à taches blanches

Ecologia: Areia e áreas costeiras de cascalho, lagoas, e recifes interiores de 1 a 50 m. Alimentam-se de grande variedade de plantas e animais (Lieske, 1994).

Distribuição: Indo-Pacífico: Mar Vermelho e África Oriental até ao Panamá. Desde o sul do Japão e as ilhas Havaianas até ilha de Lord Howe e ilhas Rapa. Pacífico Oriental: Baja Califórnia e do Golfo da Califórnia ao Panamá (Fishbase, 2000).

Ecology: Sand and gravel, coastal areas, lakes and seaward reefs 1 to 50 m. Feed on a wide variety of plants and animals (Lieske, 1994).

Distribution: Indo-Pacific: Red Sea and East Africa to Panama, north to southern Japan and the Hawaiian Islands, south to Lord Howe and Rapa islands. Eastern Pacific: Baja California and the Gulf of California to Panama (Fishbase, 2000).

28.4. *Canthigaster valentine*

Nome Científico | Cientific Name • *Canthigaster valentini* (Bleeker, 1853)
Nome Inglês | English Name • Valentini's sharpnose puffer
Nome Português | Portuguese Name • Balão valentino
Nome Francês | French Name • Canthigaster à selles

Ecologia: Lagoas e recifes interiores, maior ou igual a 55 m. Comum em áreas de mistura de coral, rochas e cascalho. Alimentam-se de algas e invertebrados sesseis e moveis. Territoriais e haremicos, machos desovam com uma fémea diferente por dia. Depositam ovos nas algas (Lieske, 1994).

Distribuição: Indo-Pacífico: Mar Vermelho até Durban, África do Sul e Ilhas Tuamotu. Desde o sul do Japão até ilha de Lord Howe (Fishbase, 2000).

Ecology: Lagoons and reefs, greater than or equal to 55 m. common in areas of mixed coral, rocks and gravel. They feed on algae and invertebrates sesseis and furniture. Males are terrotoriais and have a harem, spawn with a different female per day. Lay eggs in a turf of algae (Lieske, 1994).

Distribution: Indo-Pacific: Red Sea south to Durban, South Africa and east to the Tuamoto Islands, north to southern Japan, south to Lord Howe Island (Fishbase, 2000).

28.5. *Canthigaster bennetti*

Nome Científico | Cientific Name • *Canthigaster bennetti* (Bleeker, 1854)
Nome Inglês | English Name • Bennett's sharpnose puffer
Nome Português | Portuguese Name • Balão de Bennett
Nome Francês | French Name • Canthigaster de Bennett

Ecologia: Areia e áreas de cascalho de recifes interiores rasos e lagoas escondidas até 10 m. (Lieske, 1994).

Distribuição: Indo-Pacífico: Leste de África até Porto Alfredo, África do Sul e ilhas Tuamotu. Desde o sul de Taiwan até New South Wales. Relatos na Baia de Tanabe, Japão e Atlântico Sudeste (Fishbase, 2000).

Ecology: Sand and gravel areas of reefs and shallow lagoons hidden interiors up to 10 m. (Lieske, 1994).

Distribution: Indo-Pacific: East Africa south to Port Alfred, South Africa and east to Tuamoto Islands, north to southern Taiwan, south to New South Wales. Reported from Tanabe Bay, Japan and Southeast Atlantic (Fishbase, 2000).

28.6. *Canthigaster smithae*

Nome Científico | Cientific Name • *Canthigaster smithae* (Allen & Randall, 1977)
Nome Inglês | English Name • Bicolored toby
Nome Português | Portuguese Name • Balão de duas cores
Nome Francês | French Name • Canthigaster bicolore

Ecologia: Declives externos de recifes de 20 m a pelo menos 37 m. (Lieske, 1994).

Distribuição: Oeste do Oceano Índico: Ilhas Agalegae, Maurícias até Durban, África do Sul. Também Maldivas (Fishbase, 2000).

Ecology: External slopes of coral reefs 20 m to at least 37 m. (Lieske, 1994).

Distribution: Western Indian Ocean: Agalega Islands, Mauritius to Durban, South Africa. Also Maldives (Fishbase, 2000).

28.7. *Canthigaster solandri*

Nome Científico | Cientific Name • *Canthigaster solandre* (Richardson, 1845)
Nome Inglês | English Name • Spotted sharpnose
Nome Português | Portuguese Name • Balão manchado
Nome Francês | French Name • Canthigaster tacheté

Ecologia: Recifes rasos, lagoas e recifes interiores até 36 m. Alimentam-se principalmente de filamentos e algas coralinas, em menor quantidade de corais, e invertebrados bentónicos (Lieske, 1994).

Distribuição: Indo-Pacífico: África Oriental até ilhas Linha e Tuamotu. Desde as Ilhas Ryukyu até Nova Caledónia e Tonga; desvia para as ilhas Havaianas. População das Filipinas, Indonésia, Nova Guiné, Queensland, e Belau difere em coloração (anteriormente *Canthigaster papua*), substituído por *Canthigaster margaritata* no Mar Vermelho (Fishbase, 2000).

Ecology: Reefs flats, lagoons and reefs interiors until 36 m. Feeds mainly on filaments and coralline algae, a lesser amount of corals, and benthic invertebrates (Lieske, 1994).

Distribution: Indo-Pacific: East Africa to the Line and Tuamoto Islands, north to Ryukyu Islands, south to New Caledonia and Tonga; strays to the Hawaiian Islands. Population from the Philippines, Indonesia, New Guinea, Queensland, and Belau differs in coloration (formerly Canthigaster papua); replaced by Canthigaster margaritata in the Red Sea.

28.8. *Diodon liturosus*

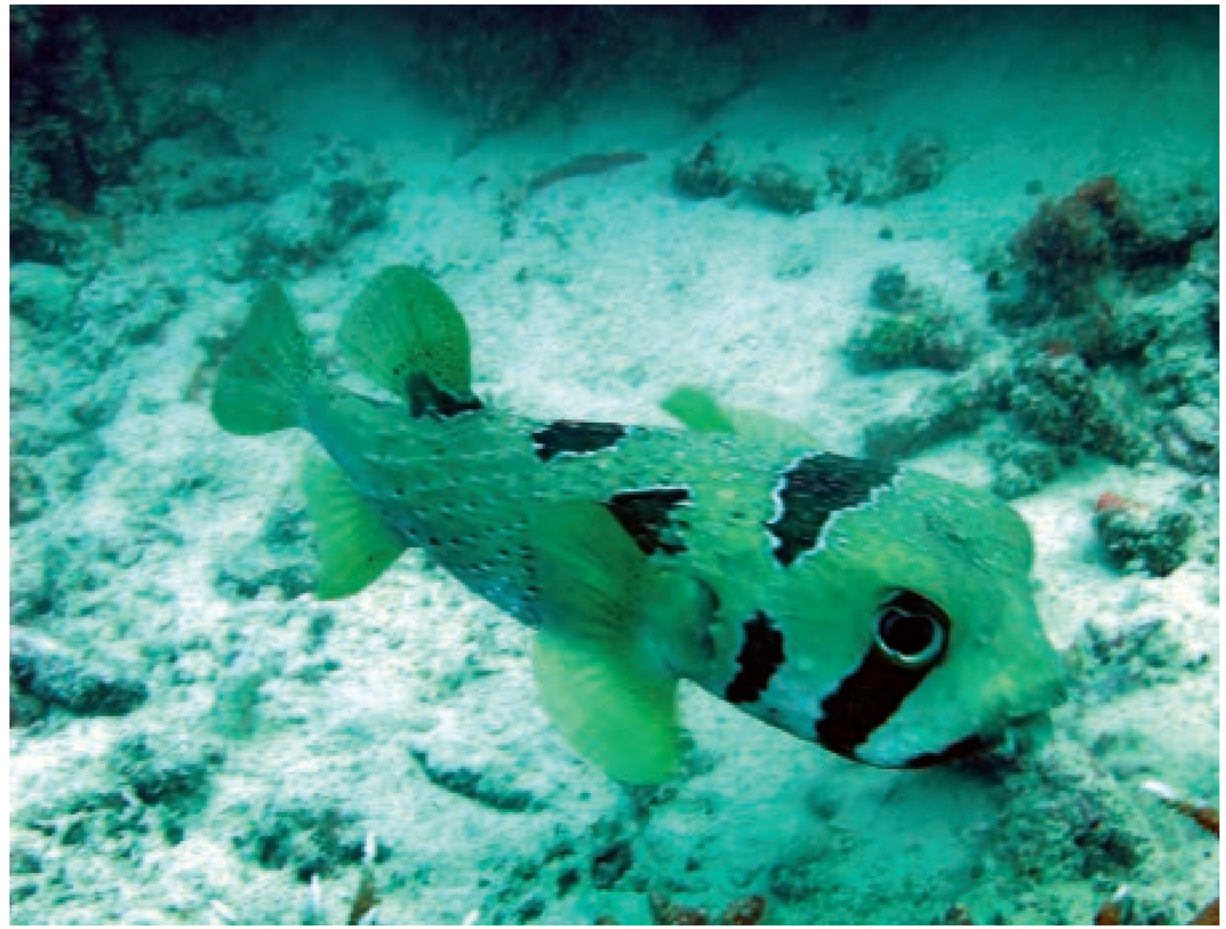
Nome Científico | Cientific Name • *Diodon liturosus* (Shaw, 1804)
Nome Inglês | English Name • Black-blotched porcupinefish
Nome Português | Portuguese Name • Peixe-porco com espinhos
Nome Francês | French Name • Diodon à longues épines

Ecologia: Recifes costeiros e interiores. Frequentemente repousam em saliências durante o dia, e alimentam-se durante a noite (Lieske, 1994).

Distribuição: Indo-Pacífico: Leste de Africa às Ilhas Sociedade, norte a sul do Japão, ao sul de New South Wales, Austrália. Não encontrado no Havaí. Atlântico Sudeste: costa sudeste da África do Sul (Fishbase, 2000).

Ecology: Coastal reefs and interiors. Often rest on ledges during the day and feed at night (Lieske, 1994).

Distribution: Indo-Pacific: East Africa to the Society Islands, north to southern Japan, south to New South Wales. Not present in Hawaii. Southeast Atlantic: southeast coast of South Africa (Fishbase, 2000).



Agradecimentos | Acknowledgments

À Universidade do Lúrio, especialmente ao Reitor por me convidar para ensinar no curso de Ciências biológicas.

Ao departamento de biologia da Universidade de Aveiro e à pessoa do Prof. Amadeu Soares, por ter apoiado o meu doutoramento, o projecto PPemba e a realização deste livro.

À Gulbenkian e ao Oceanário de Lisboa por terem acreditado no projecto PPemba, que apoiou este livro.

Gostaria de agradecer ao Dr. Oscar Monteiro que me apoiou quando cheguei a Moçambique em 2006 na «perdida» ilha de Vamizi fazendo-me sentir menos perdida. E ao Professor Jorge Ferrão por ter acreditado na rapariga de capulana e chinelo da ilha de Vamizi para professora da Unilúrio, tendo eu no processo descoberto uma vocação que julgava não ter: o ensino. À minha irmã Helena pela paciência infindável de rever este livro, e de me aturar nas minhas crises existenciais. À minha aluna, agora colega Bibiana Nassongole por me ter ajudado nas distribuições e na ecologia das espécies. Ao Professor Fernando Morgado por se ter lembrado deste livro quando viu as minhas fotografias, e por tão bem ter tratado da ligação Portugal/Moçambique para a sua publicação, sem ele não teria sido possível o livro. À minha família por aturar as minhas loucuras. Ao Fernando Carvalho por estar ao meu lado apesar dos 2000 e tantos quilómetros que nos separam.

Aos meus alunos a quem dedico este livro, para que não resmunguem tanto quando dou material de estudo em Inglês, pois agora já tem um livro de peixes em Português.

University of Lurio, especially to the Rector for inviting me to teach in the course of Biological Sciences.

The Department of Biology of the University of Aveiro in particular to Prof. Amadeu Soares for supporting my PhD, PPemba project and the realization of this book.

Gulbenkian Foundation and the Lisbon Oceanarium for believing in PPemba project, which supported this book.

I would like to thank Dr. Oscar Monteiro who supported me when I came to Mozambique in 2006 «lost» Island Vamizi making me feel less lost. And to Professor Jorge Ferrão because he believed the «capulana» and slipper girl in the island of Vamizi for teacher in the Unilúrio, following the process i discovered a vocation that I never though that could had: teaching. My sister Helena, by endless patience to review this book and put up in my existential crises. My student, now colleague, Bibiana Nassongole, for helping me in the distribution and ecology of the species. Professor Fernando Morgado for having remembered this book for publication when he saw my photos, and treated so well the connection Portugal/Mozambique, without him it would not have been possible. My family, for putting up with my craziness. Fernando Carvalho for being by my side despite the 2000 miles that separate us.

My students, to whom I dedicate this book, so do not grumble so much when I give study material in English, because now I have a book of fish in Portuguese.

Ficha Técnica | Technical Data

Título | Title: Um mergulho num outro mundo: Os peixes dos recifes de coral da Baía de Pemba
Autor | Author: Isabel Marques da Silva

Fotografias | Photography: Isabel Marques da Silva,
excepto *Rhimuraena quasesita, Gymnothorax flavimarginatus, hippocampus kuda, Aeliscus punctatus, Solenostomus cyanopterus, Antennarius commerson, Bristletooth spot juvenile*, de Robert Koch
Edição | Publisher: Edições Afrontamento | Rua de Costa Cabral, 859 | 4200-225 Porto
www.edicoesafrontamento.pt | comercial@edicoesafrontamento.pt
Editores da colecção | Series Editors: Fernando Morgado e Amadeu Soares
Concepção Gráfica | Graphic Design: Edições Afrontamento
Colecção: Biologicando [série especial PPEMBA, UNILÚRIO] 3
N.º edição: 1602
ISBN: 978-972-36-1381-0
Depósito Legal: 380843/14
Impressão e acabamento | Printer and Binding: Rainho & Neves, Lda. | Santa Maria da Feira
geral@rainhoeneves.pt
Distribuição: Companhia das Artes – livros e Distribuição, Lda.
comercial@companhiadasartes.pt

Setembro de 2014