Chapter 36

Rare and endemic fishes, little-known players that must be preserved

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This angelfish *(Pygoplites diacanthus)* is rare in New Caledonia except in the lagoon of Ouvéa. Its rarity may be explained by its diet, largely made of sponges, which are toxic to most other fish. © S. Floeter

Endemic and rare species are often a source of curiosity for both neophytes and specialists (scientists or environmental managers). Is this the case for our reef fish species?

First, how do we define endemism and rarity? Endemism refers to species which occur in only one locality. Depending on the definition of locality, there may be many different scales of endemism. In this chapter, we will talk about local endemism, for species with a geographical distribution restricted to an area of about 500 km in radius, and regional endemism, for species with a distribution range of 1,500 km in radius. These scales may seem relatively large compared to terrestrial endemism, which often has very small distribution ranges. This difference in scale is due to the dispersal capacities of reef fish species, which, during their larval stage, can drift with ocean currents over hundreds of kilometers. There are also several ways to be rare:

– rarity of abundance, for which there are very few individuals of the species throughout its entire distribution range;

– rarity of frequency, where the species rarely occurs, but can be locally abundant.

This means that there is a link between rarity and endemism, since one of the definitions of rarity relates to geographical frequency and, consequently, to distribution range.

On the importance of these species

For species to be endemic or rare, it is likely that they have unique biological, genetic or ecological characteristics, which makes them particularly important to diversity. For instance, an endemic species can be expected to be better adapted to local conditions than non-endemic species. Similarly, a species may be rare because its biological or ecological characteristics prevent it from being abundant - for example, large species - and this local rarity is often balanced by a large geographical distribution. In any case, rare species are a source of diversity and as demonstrated in the chapter on the ecological functions of fish, available resources are more efficiently used when diversity increases. This results in more stability and resilience to environmental change, but also more ecosystem services, including the production of higher biomass.

Rare species are difficult to study

A rare species is, by definition, difficult to find and therefore difficult to study. However, sometimes, there is "false rarity" associated with sampling. For example, some species may appear to be rare because of their behavior, such as moray eels which are relatively abundant but live hidden in reef crevices all their life.

Harlequin tuskfish *(Choerodon fasciatus)* are widely distributed in the Pacific Ocean but are rare everywhere. © R. F. Myers

In addition, it is necessary to define thresholds of abundance from which a species is considered rare. In this chapter, we choose a threshold of 10,000 individuals.

Two challenges must be overcome for studying endemic species:
– the definition of the relevant scale, mentioned above;
– the level of knowledge and exploration of fish communities.

An island species can be considered endemic for a long time for the simple reason that the surrounding archipelagos have not yet been properly explored. In the Hawaii Islands, for example, the proportion of endemic species was estimated at about 30% in the 1960s. It decreased to 23% in the 1990s and reached 17% with increasing knowledge of the rest of the Pacific. Conversely, what was once thought to be a single widespread species may turn out to be part of a complex of species. The blue-spotted maskray is a good example: it used to be considered as a single species, but genetics and geographic distributions revealed 11 reproductively isolated, distinct species. Consequently, the rarity or endemism status of a reef fish may be unstable, more than what is observed in the terrestrial environment. This has implications for management policies where a biotope or ecosystem approach will be more appropriate than a species-by-species approach.

Endemic reef fishes, how many and who are they?

The number of reef fish species endemic to New Caledonia is highly debated. If we focus only on properly identified species, there are currently 27 known local or regional endemic species, representing 1.8% of reef fishes.

Endemic New Caledonian species are mostly bottom dwelling, solitary and active only during the day. They mainly belong to syngnathids, a group that includes seahorses (six species), gobies (five species), blennies (four species) and Tripterygiidae, or triplefins (four species). The three latter families are poorly known and it is likely that the status of several species currently recognized as endemic will change in the near future as new knowledge is acquired.

For example a species recently described from New Caledonia and believed to be endemic, the oblong large-eye seabream *Gymnocranius oblongus*, has since been observed in Taiwan. In contrast, one species of the blue-spotted maskray complex (*Neotrygon trigonoides*) may be unique to the Coral Sea region. To our knowledge, none of the species endemic to New Caledonia is abundant.

The next question addresses what can determine the number of endemic species. Specifically, do the number or proportion of endemic species vary from one region to another in the Pacific? And what are the possible factors that cause variation in reef fish endemism? The distribution of Pacific reef fish endemism is very heterogeneous. Regions with high endemism (between 3.8% and 28%) are all located at the periphery of the tropical Pacific. In contrast, the proportion of endemic species in the central tropical Pacific is much lower, with an average of 1.6% of known species. Regions with high endemism, with the exception of Japan, are all characterized by low species richness. In New Caledonia, more than half of the endemic species are considered "local endemic". This dominance of local endemism over regional endemism is observed throughout the periphery of the tropical Pacific, with the exception of Hawaii and Japan. In this respect, New Caledonia differs from its neighboring regions, such as the Great Barrier Reef, the Coral Sea, Vanuatu or the Solomon Islands, where regional endemism prevails.

In reef fish, the underlying causes of the level of endemism are not well known, but the proportion of endemic species increases in isolated archipelagos, especially if islands are small. Two major groups of endemism can be distinguished: sympatric and allopatric endemism. In the first group, species "split" into two or more species as a result of local isolation, a phenomenon that is often difficult to demonstrate (environmental changes, acquisition of behavior in a group of individuals, etc.). In the second group, populations are isolated from each other and evolve separately until they accumulate sufficient genetic differences to become distinct species. The analysis of the distribution of endemic species throughout the Indo-Pacific suggests that the most common group is allopatric endemism. With the succession of glaciations and subsequent warming, followed by retraction and expansion of coral reef regions, it is likely that many populations have been isolated. Depending on their capacity to recolonize from refuge areas, these populations may or may not have produced new, often endemic, species.

How many rare species?

The number of rare species depends on the definition of the level of rarity. Figure 1 shows that the proportion of rare species is very high in New Caledonia: 47% of species for a threshold of one individual per 10,000 and 18% for a threshold of 1/100,000. This ratio changes slightly depending on the environment, with poorly diversified reefs having a smaller proportion of rare species. The proportion of rare species increases with island size: for example, it is higher on Grande Terre than on the Loyalty Islands. This proportion also increases with the number of species in the region: the proportion of rare species in Polynesia is only 14% but in Fiji it reaches 29% (at a rarity threshold of 1/10,000).

New caledonian maskray (*Neotrygon trigonoides*). © J.-L Menou

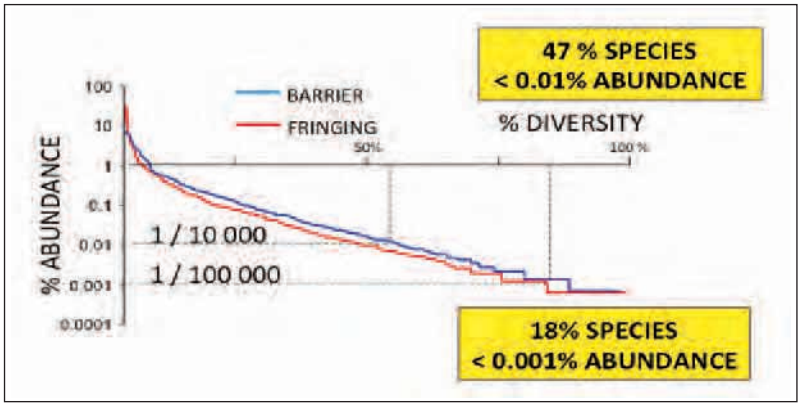

Figure 1: Proportion of rare species on fringing and barrier reefs in New Caledonia. Adapted from JONES, *et al.*, 2002 and MOUILLOT *et al.*, 2013

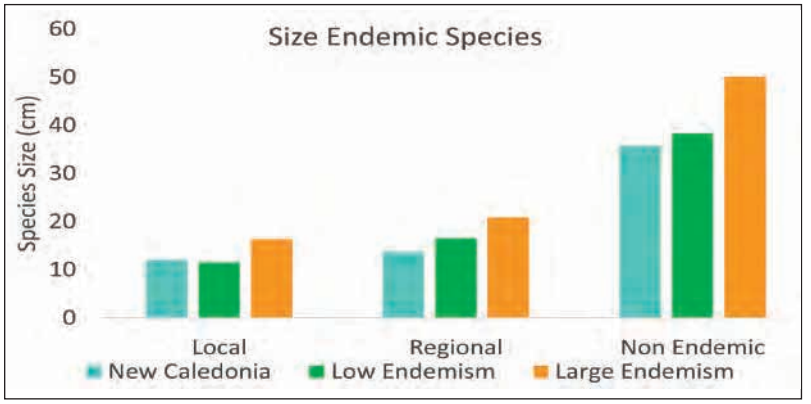

Figure 2: Average size of reef fish species according to their level of endemism (local, regional, non-endemic) and the proportion of endemic species. Regions of low endemism in New Caledonia: < 3.8%; regions of high endemism: > 3.8%.
Adapted from JONES, *et al.*, 2002 and MOUILLOT *et al.*, 2013

Characteristics of endemic and rare species

Endemic species are, on average, three times smaller (Fig. 2) than other species, with local endemic species being slightly smaller than regional endemics. Similarly, regions with high endemism have larger endemic species than regions with low endemism. These size differences are correlated to the remoteness and size of islands: the smaller an island is and the farther away from the central Indo-Pacific region, the more reef fishes are represented by large species. For example, in Hawaii, the numerous endemic species are represented by a large proportion (30%) of species over 30 cm long, whereas in New Caledonia only 8% of species are over this size.

Endemic species have diets that differ from the average (Fig. 3). They are less often piscivorous, herbivorous or sessile invertebrate (mainly corals) feeders than other species. New Caledonia is distinguished by the absence of these three types of diet among its endemic species. In contrast, endemic species in New Caledonia are more frequently omnivorous than in other regions.

Rare species are mostly carnivorous (50% of carnivorous species are rare) or piscivorous (20%) and are mostly (55%) of medium size (8-30 cm). More importantly, the ecological function of rare species is often unique. In other words, each rare species tends to have a very specific ecological function. Its disappearance would therefore lead to the disappearance of its function.

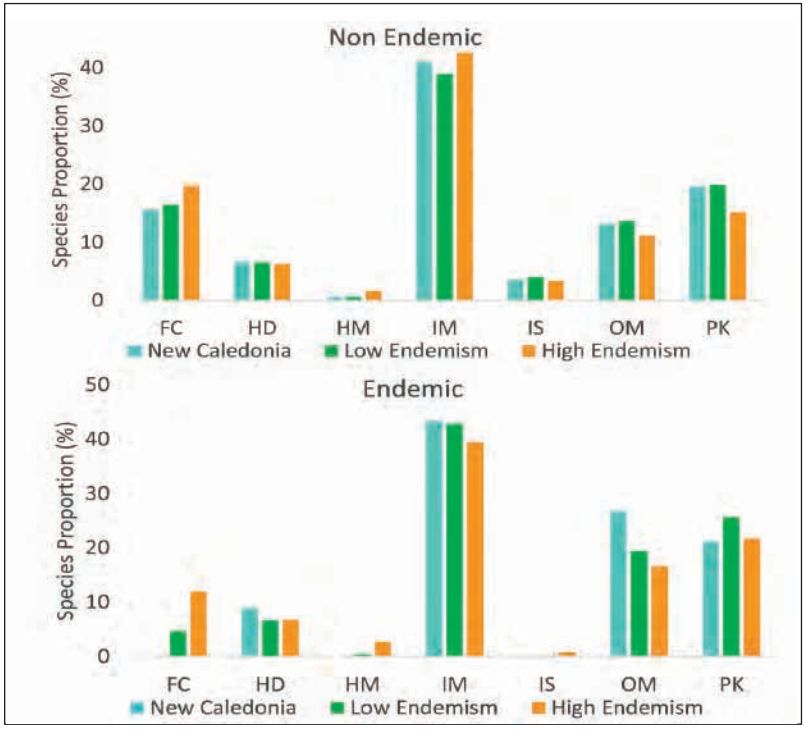

Figure 3: Diet of reef fish species according to their endemism and the level of regional endemism.
FC: Piscivorous; HD: Turf herbivorous; HM: Macroalgae herbivorous; IM: Mobile invertebrate feeders; IS: Sessile invertebrate feeders (corals); OM: Omnivorous; PK: plankton feeders.
Adapted from JONES, *et al.*, 2002 and MOUILLOT *et al.*, 2013

Mandarinfish *(Synchiropus splendidus)* are rare and difficult to observe, they often hide among *Diadema* sea urchins in coastal areas. © R.F. Myer

On the role of endemic and rare species

The role of rare species is still very poorly understood, but their rare ecological functions suggest that, although they are not essential, they contribute significantly to the diversity and thus to the stability and resilience of reef communities. The role of endemic reef fish species in New Caledonia is probably negligible for the functioning of the reef communities because they are never abundant. The situation is different in regions with a high diversity of endemic species (>8%), particularly in the Hawaii Islands and Easter Island, where these fish species represent 30% to 60% of the abundance depending on the island.

Management and conservation

Rare and endemic species are frequently the focus of conservation programs in terrestrial environments because they are often threatened. The same applies to certain marine species, such as the endemic shellfish, dugongs or lobsters off Bourail. The reef fishes that are currently threatened in New Caledonia are all emblematic species (chap. 38), which is not, or almost not, the case for rare or endemic reef fishes. So how and why should we protect them?

How? In New Caledonia, rare or endemic species occupy very diverse habitats. It is therefore difficult to manage these species specifically. For this reason, it is necessary to implement a comprehensive management policy that focuses more on protecting habitats and preserving environmental conditions than on protecting particular species. This is very different from the terrestrial environment, where it is possible to protect targeted species such as kagu, parakeets, crow honeyeater or endemic plants, although habitat conservation, such as dry forest, also protects a range of species, including endemic or rare species.

Why? These species often provide specific ecological functions which lead to an increase in ecosystem services that is often much more important than would be expected given their rarity. Many of these species are particularly beautiful, the angelfish being perhaps the archetype of such a species. A decline in diversity, which most commonly involves these species (Fig. 1), is often a strong signal of disturbance. The analysis of the diversity-abundance curves can provide a prompt detection of the early stages of degradation.

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