Chapter 10
Interaction Networks in Tropical Reefs

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Abstract Tropical reefs are, figuratively, the underwater counterparts of tropical rainforests. Both complex, three-dimensional natural systems harbour an impressive diversity of species. The diversity of ecological interactions taking place among these species is no less striking: their intricate webs add another level of complexity to these natural systems. In this chapter, we dive into the ecological networks of tropical reefs to present an overview of some of the negative, positive, and neutral interactions among inhabitants of rocky and coral reef ecosystems. We discuss trophic interactions among species as food webs; territorialism and chasing behaviour as competitive networks of reef fish; cleaning behaviour illustrating mutualistic networks, and following associations exemplifying commensalistic networks among fish species. We close the chapter with a biogeographical perspective of interaction networks in tropical reefs across the globe to discuss how human activities have been threatening their plentiful life.

10.1 Introduction

Tropical reefs are one of the most productive and biologically diverse ecosystems (Odum and Odum 1955). Paired with tropical rainforests, reefs are the archetypes of natural ordered systems. These two three-dimensional systems host species with a

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large variety of life histories in regulated populations within complex ecological communities (Connell 1978).

Now imagine you could fly and see through these complex, diverse ecosystems. While this may be difficult in a rainforest, it is not so much when you dive in a colourful tropical reef. Reefs are oasis of life in the otherwise blue desert of open oceans. Biogenic reefs are built by corals, sponges, and coralline algae, and rocky reefs are geological formations that may result from rocks of different kinds and sizes; moreover, reefs can even be artificial structures such as shipwrecks. These habitats harbour an impressive collection of species: corals, gorgonians, crustaceans, worms, echinoderms, seaweeds, not to mention the most notable creatures, the abundant reef fish. None of these organisms are living isolated. A key component of this underwater kaleidoscope of colour and forms often escapes the eyes—ecological interactions. A more careful look into a tropical reef system reveals the many intricate webs of ecological interactions submersed in its plentiful live.

As in all ecological communities, dwellers and visitants of tropical reefs interact with one another (Odum and Odum 1955). These interactions are intra- and interspecific, and can be negative, positive, or neutral for the interacting individuals. Interestingly, the effects of these ecological interactions can scale up from individuals to populations (i.e. affecting fitness), to communities (i.e. affecting structure), and even to ecosystems (i.e. affecting functioning). Several types of ecological interactions can be observed in a tropical reef, and fish are a conspicuous component of many of them. To name a few, reef fish interact trophically among themselves and with benthic organisms (e.g. invertebrates and seaweeds); some fish are territorial and aggressive towards other fish (and sometimes towards divers too); while others may be helpful by removing parasites from other animals. Such diversity of interaction types reflects the myriad of ecological processes taking place in the fascinating reef environment (e.g. Moberg and Folke 1999).

Assessing these interactions to understand the processes they mediate, however, is not an easy task. Apart from the obvious fact that they occur underwater—indifferent to our curiosity—recording the dynamic interactions among reef species is laborious, demanding many hours at sea and a combination of methods. Data on reef species interactions usually come from dedicated scuba or free dive underwater surveys (e.g. Grutter 2005), remote video recordings (e.g. Longo et al. 2014), and indirect evidence such as stomach contents and literature review (e.g. Arias-González et al. 2011). As data accumulate, one can employ the formalism of complex networks to unravel patterns of species interactions occurring underwater from the local (e.g. within 2 m^2 sampling quadrats) to the global scales (e.g. across biogeographical provinces).

When ecology meets network theory, species depicted as nodes are connected by links representing their biological interactions—be these negative, positive, or neutral (Fig. 10.1). The nature of the biological interaction describes if the network is directed or undirected (i.e., symmetric or asymmetric interactions between *i* and *j*), binary or weighted (i.e., qualitative or quantitative interactions), one- or two-mode (i.e., all species can interact, or there are two distinct sets of interacting species) (Boccaletti et al. 2006). Food webs, for instance, are traditionally represented by

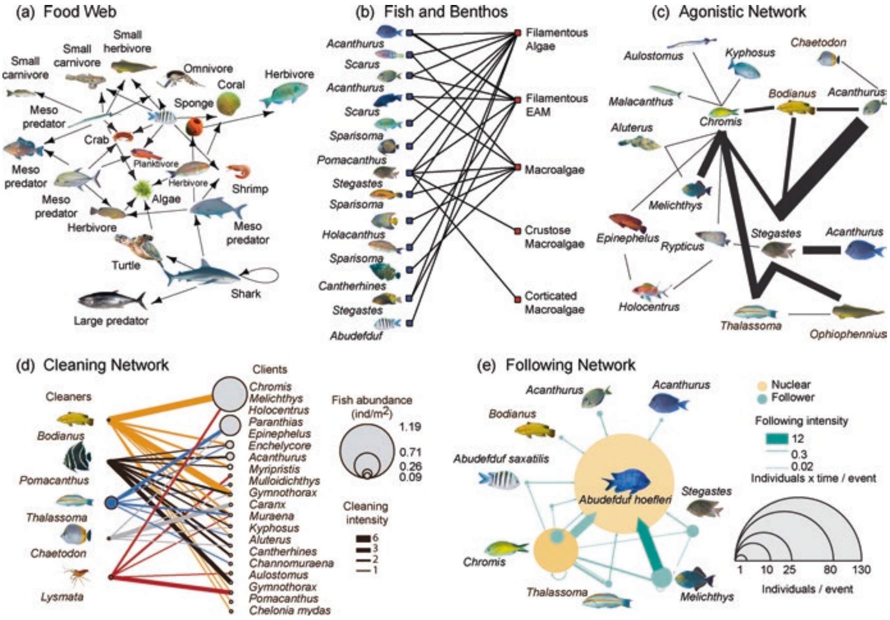

Fig. 10.1 Tropical reef interaction networks. (**a**) Direct binary one-mode network of a simplified food web. Nodes representing functional groups are linked to those they predate upon off the Virgin Islands (Opitz 1996). (**b**) Binary two-mode network of reef fish and benthos. Nodes representing fish genera are linked to the benthic functional groups they consume in Abrolhos, Brazil (Longo, unpub. data). (**c**) Indirect weighted one-mode network of agonistic behaviour among reef fish. Nodes representing genera are linked by the frequency they engage in territorial disputes at Ascension Island (Fontoura, Bonaldo, Floeter, unpub. data). (**d**) Weighted two-mode network of mutualism between cleaner and client reef species. Nodes representing genera (sizes proportional to abundance, individual/m^2) are linked by number of cleaning events in Ascension Island (Morais et al. 2017). (**e**) Directed weighted one-mode network of following associations among reef fish. Nodes representing genera (sizes proportional to abundance) are linked by weighted directed links proportional to intensity of interactions from follower to nuclear species off Ascension Island (Morais et al. 2017)

directed one-mode networks (e.g. Yen et al. 2016). Species are connected by trophic interactions, either weighted arrows indicating the relative rate of energy transfer (e.g. grams of carbon/day) or interaction strength between taxa, or binary arrows indicating which resources a given species feeds on (Fig. 10.1a). If the focus is on a subset of trophic interactions—e.g. between reef fish and benthic community (Longo et al. 2014)—one can use two-mode networks to depict the interactions between two trophic levels (Fig. 10.1b). The same approach can be used to explore cleaning interactions (e.g. Guimarães et al. 2007). Although essentially trophic, cleaning interactions are by contrast mutualistic (e.g. Côté 2000) between two sets of species—cleaners and clients—which communally benefit from the interaction (Fig. 10.1d). Agonistic interactions among reef fish (Robertson 1996), on the other hand, can be represented by undirected one-mode networks in which species are linked whenever they engage in disputes for resources, such as territory (Fig. 10.1c). Finally, commensalistic interactions such as following association among reef fish (e.g. Sazima et al. 2007) can be depicted by directed one-mode networks indicating which species follows and which is followed (Fig. 10.1e).

Networks give a panoramic snapshot of the liveliness of biological interactions. These static depictions are very useful to describe structure (e.g. Bascompte et al. 2003), infer function (e.g. Yen et al. 2016), and predict changes (Memmott et al. 2004) in ecological communities. By summarizing a wealth of empirical data into a network, we can immerse in its tangled structure in the search for emergent regularities. Some non-random network properties are common across biological systems. For instance, food webs can display similarities in connectance (i.e. proportion of realized links), degree distributions (i.e. number of trophic interactions across species; Dunne et al. 2002), and modularity (i.e. subsets of highly connected species; Stouffer and Bascompte 2011); whereas nestedness (i.e. hierarchical organization of interacting species into inclusive subsets) is a common pattern of two-mode mutualistic networks (e.g. Bascompte et al. 2003). Even though distinct processes may give rise to these structures, their implications for the ecological and evolutionary dynamics of the systems may be similar. Nested networks, for instance, may be robust against random species extinction regardless of the interaction type (Memmott et al. 2004), potentially reducing competition among sets of species and increasing the number of coexisting species (Bastolla et al. 2009). Therefore, the network approach offers us a privileged viewpoint to the biological processes operating on ecosystems, including tropical reefs.

Here, we explore interactions among tropical reef species to provide an underwater perspective to ecological networks and equalize the focus on terrestrial environments given so far in the previous chapters. Our goal is to offer an overview of some of the negative, positive, and neutral interactions among inhabitants of reef ecosystems. In the following sections, we briefly dive into marine food webs to examine trophic interactions among reef species; into networks of agonistic interactions (e.g. territorialism and chasing) to illustrate competitive behaviour between reef fish; and into cleaning behaviour to illustrate mutualism and following associations among fish to exemplify commensalism in rocky and coral reefs. We return from this dive to close the chapter with a biogeographical perspective of interaction networks in tropical reefs across the globe and ponder upon how human activities are threatening them.

10.2 Trophic Networks: Marine Food Webs

Predation is perhaps the most notable of the interactions among species—including marine ones. This notion and the interest on trophic interactions date back from Darwin's first descriptions of communities (Darwin 1859). The term food web, however, emerged in the early 1900s when Elton (1927) defined a set of "monophagous" consumers as a food chain, and a food web as a group of chains that incorporated “polyphagous” consumers (Fig. 10.1a). The first representations of these trophic interactions consisted in descriptive diagrams with different trophic levels, indicating a link connecting predator and prey with notes on the natural history of these organisms. These diagrams provided a general scheme of “who eats whom” that were not necessarily taxonomically rigorous or comprised all the components within a community (Paine 1980). However, only when the consequences of the trophic interactions started to be revealed in the mid-1900s, Darwin’s interests on species coexistence started to benefit from our understanding of food webs.

The effects of trophic interactions in community dynamics were unravelled by Paine’s (1966) seminal experiment removing the ochre starfish (*Pisaster ochraceus*) from a rocky shore. This experiment demonstrated that predation by the ochre starfish could regulate the abundance, diversity, and distribution of benthic organisms in that rocky shore, enabling more species to coexist. This study also gave rise to the concept of keystone species (i.e. those whose interactions may have critical consequences for community dynamics) and had a remarkable impact on how food webs were studied and interpreted since then. It was no longer enough to describe who eats whom. Other metrics such as interaction strength (i.e. a quantitative approach of the link between predator and prey), connectance, and energy flow through trophic links (Lindeman 1942) were necessary to move forward in the understanding of food web dynamics.

Marine food webs are good examples of how dynamic interaction networks can be. Here, interaction strength, connectance, and the structure and length of food webs can be affected by multiple factors, for example, wave exposure, tides, currents, winds, upwelling regime, nutrient availability and, certainly, human interference (McClanahan and Branch 2008). Despite being highly dynamic, some general properties emerge from these webs. Most of the marine food webs characterized in the literature present a relatively large richness of trophic interactions, a high level of intermediate omnivore taxa, and an abundance of top predators comparable to terrestrial ecosystems (Dunne et al. 2004). Chain length may also vary among marine food webs depending on species richness, diversity, and complexity of the system (Link 2002; Dunne et al. 2004).

The association of high species diversity in highly connected webs could result in high structural robustness (Dunne et al. 2004). However, trophic interaction networks in reef ecosystems seem to be structured by “few strong and several weak” interactions with keystone species and groups (e.g. Longo et al. 2014). Central species can be identified in interaction networks by combining connectance and interaction strength. A simplified network of trophic interactions between fish and the benthos (Fig. 10.1b) of the Abrolhos Archipelago, north-eastern Brazil, shows that herbivorous fish are central species in this reef habitat. Interestingly, in tropical reef food webs, herbivores often play a central role or are keystone species, determining the structure and complexity of reef communities by controlling macroalgae abundance and diversity (e.g. Rasher et al. 2013). The loss of these strong interactions could have profound impacts in the structure of ecosystems, such as triggering phase shifts from a coral to an algae-dominated community, regardless of high species diversity and connectance.

The role of trophic interactions in structuring reef ecosystems goes beyond interaction strength. More than high abundance of herbivores, a proper assemblage of these consumers is necessary to establish trophic links with a larger array of primary producers (Rasher et al. 2013), generating redundancy (i.e. species that have common trophic links) and complementarity (i.e. species whose trophic links do not overlap but that contribute to high connectance when combined). Another emergent property in reef food webs is modularity, which may relate to redundancy and habitat partitioning. In the North Pacific Ocean, for instance, sea otters connect an oceanic and a coastal module of a food web (Estes et al. 2016). The emergence of these structures will also depend on reef characteristics—e.g. productivity, temperature, and habitat complexity—not to mention other kinds of interspecific interactions embedded in larger, multi-interaction ecological networks (e.g. Pocock et al. 2012; Dáttilo et al. 2016). The ecological consequences of trophic interactions are, therefore, inherently linked to other ecological interactions.

10.3 Agonistic Networks: Territoriality and Chasing Among Reef Fish

Living in a tropical reef may be costly. Resources are not always abundant, thus tropical reef species often engage in agonistic interactions related to resource partitioning, parental care, and territoriality (Robertson 1996; Bonin et al. 2015). The outcomes of the agonistic behaviour are generally non-lethal, and subtler than trophic interactions. Similarly to predation, parasitism, and competition, agonistic interactions can be asymmetrical: while one individual benefits from protecting a resource, the others may not only be deprived of it but also suffer physical aggression. These interactions can also be detrimental for both species by reducing growth, reproduction, and survival rates (Robertson 1996). Therefore, agonistic behaviour imposes trade-offs to the participants. Partitioning and/or competing for limited resources is a daily task for the inhabitant of a tropical reef—but not an obvious one for the outsider observer.

Direct and indirect competition are often not easy to observe, despite their clear influence on the structure of ecological networks (e.g. Dáttilo et al. 2014). This difficulty is particularly true in the heterogeneous, complex underwater reef ecosystems. Alternatively, agonistic disputes for resources are much more conspicuous and thus indicate resource-use overlap which essentially underpins direct or indirect competition among species (Peiman and Robinson 2010). In tropical reefs, fish species are constantly competing for shelter, food, and sexual mates (Bonin et al. 2015). Consequently, several species defend territories and are aggressive (e.g. Forrester 2015). Chasing events among individuals are common indicators of such disputes for resources; and serve as measurable, and reliable, proxies of interspecific competition (Robertson 1996).

The resultant network from these agonistic interactions can shed light into the prevalence of intra and interspecific disputes, and how these interactions can mediate resource partitioning and competition. Moreover, they give insights on the consequences of agonistic behaviour and territoriality. For instance, engaging in these behaviours demands considerable energy (potentially influencing individual fitness) and can alter the density of fish populations in coral reefs, which in turn can influence community structure (see Robertson 1996; Bonin et al. 2015).

A network of agonistic chasing events depict species linked according to the frequency they chase each other (Fig. 10.1c). If these agonistic interactions are organized into a modular network, it could indicate either spatial segregation or association of taxonomically related species, or even reveal patterns of trait association (e.g. smaller species would not chase after potential predators). Modules could also emerge from neutral processes driven by species abundance (see Vázquez et al. 2007). Interaction strength can also be affected by those drivers. For example, in the agonistic network of fish in the reefs of Ascension Island, South Atlantic Ocean, the interaction strength among pairs of species were not driven by species abundance. Instead, species traits (e.g. the degree of diet overlap and/or aggressive territorial behaviour) influenced the intensity of agonism (Morais et al. 2017). Although agonistic behaviour is frequent in tropical reefs, there is another way to deal with limited resources: cooperation.

10.4 Mutualistic and Commensalistic Networks: Cleaning and Following Behaviour

Life in a tropical reef can be risky and competitive, especially if you are someone's resource or must compete for resources with someone else. Beyond escaping from and chasing after a competitor, risk and competition sometimes can be tempered by cooperative efforts. Interactions among reef species can also be positive. For instance, one species may benefit from other species' help on removing parasites or dead tissues (cleaning mutualism) while a smaller fish may benefit from following a larger one (following commensalism). In these interactions, the payoffs for the involved parties can be bilateral or neutral—but are rarely absent.

Cleaning mutualism is one of the most intriguing interactions among reef species both from an ecological (i.e. what are the consequences of cleaning?) and evolutionary (i.e. how these interactions were established or selected over time?) perspective (Floeter et al. 2007). During these associations, a "cleaner" species removes parasites, necrotic tissue, and mucus from the body surface of "clients", contributing to its health (Grutter 2005). Cleaning behaviour has been reported in ca. 130 species of fish and crustaceans (Côté 2000), which can be facultative (i.e. species cleaning sporadically or only during juvenile stages) or obligate cleaners (i.e. species that clean throughout their lives; Grutter 2005). These interactions often occur at specific sites known as "cleaning stations", characterized by prominent structures such as massive corals, sponges, and large rocks (Côté 2000), forming two-mode networks between cleaners and clients (Fig. 10.1d).

Following association is a neutral interaction observed among reef fish (Sazima et al. 2007) characterized as a temporary feeding association. Here, opportunistic species ("followers") benefit from following bottom-foraging species ("nuclears") by consuming the exposed food resources made available from the disturbed substrata (Sazima et al. 2007). The nuclear species does not receive any payoff, and also does not pay any costs or is harmed by this association. While the nuclear role is mostly played by fish (less often by octopuses, sea-stars, and turtles) several species may be followers (Sazima et al. 2007). Following interactions can be complex, involving large groups of individuals (up to several hundred) from different species: the "shoaling" associations (Lukoschek and McCormick 2000). On the other hand, when following involves only up to four individuals, they are called "attendant associations". Attendant associations can be divided into four groups (Ormond 1980): when species aggregates to feed from exposed or leftover resources gained from the nuclear species (following and scavenging); when it aggregates to hunt cooperatively with other species with similar feeding habits; when it hunts by swimming alongside or above a nuclear species using it as a cover to get access to the prey (hunting by riding); and when the species has an easier access to the prey by mimicking harmless species (aggressive mimicry). Following associations can be described by one-mode networks indicating, for instance, the frequency of this commensalism in a given environment (Fig. 10.1e; Morais et al. 2017).

Both of these positive interactions are essentially trophic—directly trophic in the case of cleaning; indirectly in the following (through the exploration of a third food source). Thus, these interaction networks can give insights on underlying biological processes taking place in the community, such as niche partitioning. A nested cleaning interaction network, for instance, indicates that the distribution of mutualistic interactions is asymmetrical, with some species engaging in many interactions and others in fewer interactions that constitute subsets of the most connected species (Guimarães et al. 2007). Therefore, the community contains species with different resource-use strategies: a core of more generalist cleaner species (likely obligate mutualists) along with more specialist cleaners (likely facultative cleaners).

If these positive interactions are specific among some species, the network would be organized into modules. In this case, a given community would have cleaner species that interact only with a group of clients; or follower species that only associate with specific nuclear species. The modular structure suggests a high level of specialization among species within these interactions. For instance, fish species of the genus *Elacatinus* spp. are mainly obligate cleaners, and prefer clients associated to the bottom, such as parrotfishes, eels, and groupers. Alternatively, the network structure can be random, when only a few species interact, or when most species are generalists. This case is more common in reefs where the nuclear role is played by few species and the follower role is performed by several abundant species (e.g. feeding frenzy; Quimbayo et al. 2014). Such conditions seem to occur in some tropical reefs, particularly the more isolated ones such as oceanic islands. Therefore, comparing networks depicting different ecological interactions in tropical reefs around the globe can be profoundly revealing.

10.5 A Biogeographic Panorama of Tropical Reef Interaction Networks

The study of ecological networks at the community level provided several insights on the processes operating at local scales and on how the structure and resilience are related in ecosystems (Dunne et al. 2004; Bascompte et al. 2005). The relevance of this approach is unequivocal. However, a biogeographic perspective could shed light into the mechanisms operating at larger spatiotemporal scales and potentially on how communities are assembled.

The diversity and composition of biological communities are shaped by different processes across space and time. Large-scale processes (e.g. extinction, dispersal) and environmental filters determine which species will successfully colonize a site in a broader temporal scale (Mittelbach and Schemske 2015). Once established in a local community, species engage in biotic interactions (e.g. predation, competition, mutualism) that may affect the spatial distribution of species at local and regional scales. This balance between evolutionary and ecological processes, and the relative importance of biotic interactions on community structure across different spatial scales can be assessed through studies of species interactions in a macroecological context (Kissling and Schleuning 2015; Cantor et al. 2017).

Food webs, for instance, might conserve structural properties across a biogeographic scale (Fig. 10.2a). However, in a latitudinal comparison, food webs from temperate reefs would differ from tropical reefs by exhibiting lower species diversity, larger biomass, and for being more susceptible to changes in nutrient levels and seasonal dynamics. These webs also differ in their major consumers (McClanahan and Branch 2008). While fish are more central in tropical food webs, invertebrates are more important in temperate reefs (e.g. Estes et al. 2011, 2016).

Environmental and ecological gradients are also crucial to the understanding of large-scale patterns of interacting species (e.g. Trøjelsgaard et al. 2015). Temperature and isolation are examples of abiotic factors that affect the spatial distribution of species and, consequently, the diversity of species across spatial scales (Schemske et al. 2009). Regional diversity patterns have a clear influence over the topology of reef fish agonistic interactions networks, with a higher number of nodes and lower values of connectance and centralization according to the fish diversity gradient (Fig. 10.2b). Diversity may also promote stability and increase resilience (Dunne et al. 2004). On the other hand, while high regional diversity implies higher diversity of interacting species, we hypothesize that high modularity and lower connectance in agonistic networks can suggest and indicate spatial heterogeneity of species distribution or decreasing functional redundancy due to spatial segregation of species.

At larger scales, ecological and mutualistic networks may display general structural patterns such as nestedness and asymmetry of interaction distributions (Bascompte et al. 2003; Cantor et al. 2017). These resemblances among disparate networked systems motivated studies testing whether neutrality could explain the occurrence and strength of species interactions (e.g. Vázquez et al. 2009). In the

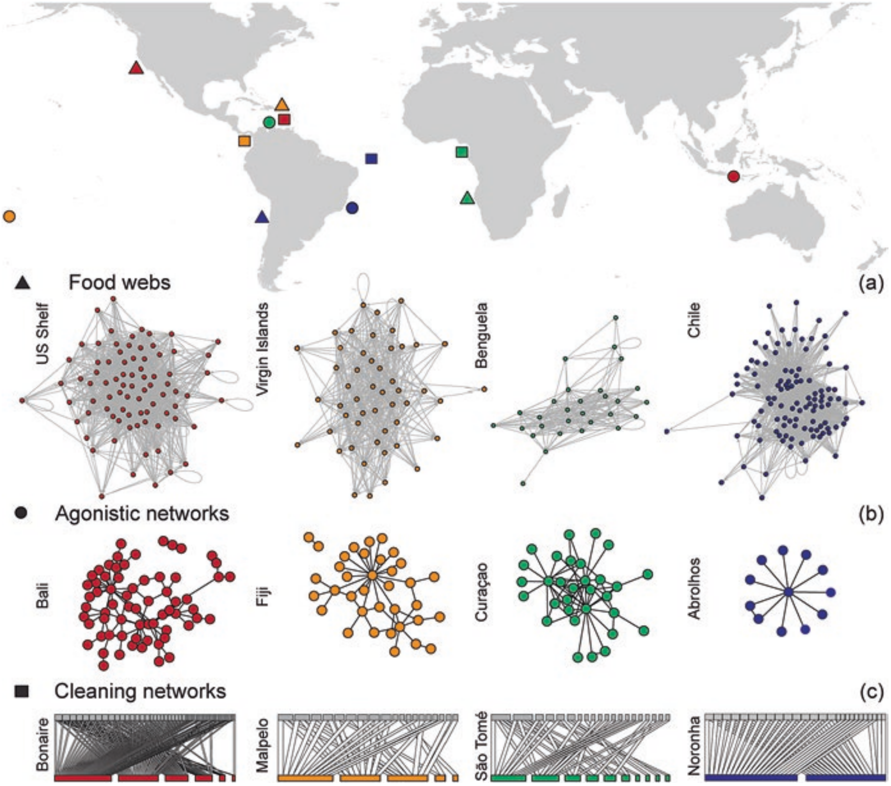

Fig. 10.2 Ecological networks from reefs across the globe. Positive (squares), negative (circles), and trophic (triangles) indicate networks from 12 representative tropical reef communities. In food webs (**a**), species (or functional groups when taxonomical level was unresolved) are connected by trophic interactions (see Yen et al. 2016). In agonistic networks (**b**), fish species are connected by territorial disputes (Fontoura, unpub. Data). In cleaning networks (**c**), cleaners (coloured) are connected to the client species (Quimbayo, unpub. Data)

case of cleaning mutualism among reef fishes, species abundance is the major driver of the frequency of species interactions, but it does not explain network structure alone. Evolutionary signals can influence cleaning interactions (since specialized cleaners from distinct biogeographic regions are taxonomically closer), and more mobile species are more likely to interact (Floeter et al. 2007). Binary cleaning networks from distinct reefs across the globe (Fig. 10.2c) vary in the number of cleaner and client species. However, the constant presence of some cleaners with a few links and others with many links suggests an evolutionary pressure over specialization and a wide array of opportunistic species.

The current theoretical challenges are to assess whether the structure of local ecological interactions scale up to larger spatial scales and whether these structures contribute to shape species distributions and diversity patterns at macroecological scales. A general overview of intrinsic properties of species associated with abundance, phylogeny, and their functional role within networks can reveal evolutionary conservatism of functional roles and whether neutral processes (e.g. density-dependence) predict the structure of biotic interactions (e.g. Vázquez et al. 2007). Comparing the structure of ecological networks along geographic gradients can indicate how natural selection and evolutionary processes might vary according to environmental conditions. This is particularly important given the increasing human interference in the environment, especially large-scale disturbances such as climate change and habitat loss.

10.6 The Undesirable Link Between Humans and Reef Environments

It is no longer a mystery that ecological interactions are key components of life on Earth. Species are never isolated, but are inserted in multilevel interaction networks: from individuals to ecosystems, from local to biogeographic scales. The complex, combined effect of positive, negative, and neutral biotic interactions can shape the structure of biological communities (Paine 1980) and the dynamics of the populations within them (e.g. Pires et al. 2011). A current motivation for understanding the structure and dynamics of biological networks is to predict how this ecological complexity will respond to the growing anthropogenic impact on nature, and how one could alleviate its negative consequences (e.g. Pocock et al. 2012).

Tropical reefs suffer from a variety of anthropogenic impacts that operate at multiple spatial and temporal scales. These include overfishing, over harvesting of reef organisms, pollution, increasing sediment and nutrient output in the reefs, uncontrolled tourism, introduction of allien species and diseases, and climate change (e.g. Moberg and Folke 1999). These activities have dramatically changed interaction networks in reefs worldwide. Clear examples come from destabilization of marine food webs due to overexploitation of resources (e.g. Jackson et al. 2001; Estes et al. 2011, 2016). In theory, marine food webs should be relatively robust to overfishing of random species; however, fisheries industries are selective and often target key species, whose removal can subvert the food web structure. For instance, the loss of top predators and primary consumers caused dramatic changes in the biotic and abiotic conditions of ecosystems (i.e. phase shifts; Jackson et al. 2001; Estes et al. 2011, 2016). In tropical reefs, overfishing may cascade to decline herbivorous fish, contributing for a shift from healthy and coral-rich ecosystems to impoverished and algae-dominated systems (e.g. Bascompte et al. 2005).

Interaction networks can also be affected by the introduction of invasive species. When the lionfish (*Pterois volitans*, a Pacific species introduced in the Caribbean by the mid-1980s) was added to food web models of Caribbean reefs it figured above the native top predators which are sharks, rays, and groupers (Arias-González et al. 2011). These novel trophic interactions could lead to higher mortality but could also modulate competition. Climate change could have similar effects on food webs by facilitating tropical species to expand their ranges and enter subtropical food webs (tropicalization; Vergés et al. 2014). The negative impact of humans on marine food webs (consequently, the functioning and structure of marine ecosystems) is clear; there is no reason to doubt that networks of other biotic interactions are disturbed too.

There are few clearer ways of capturing the urgency of understanding biotic interactions than the famous quote by Janzen (1974) on tropical rainforests: “*What escapes the eyes (...) is a much more insidious kind of extinction: the extinction of ecological interactions*”. It goes without saying that the warning also fits perfectly to tropical reefs. May we keep these underwater worlds complex, productive, and diverse in shapes, colours, and functions. Only then the coming generations can dive in their plentiful life to discover the importance of preserving their fragile interaction networks.

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