THE FISH COMMUNITY

INTRODUCTION

As a scuba diver, you have a remarkable capability. Unlike most of the planet's inhabitants, your ability to breathe underwater gives you a front-row seat to explore a largely unknown world. Of Earth's population of 8.1 billion, fewer than 10 million are certified divers and thus blessed with the unique privilege of understanding why Earth has been called the "Blue Planet."

Still, there is an obstacle to gaining a full appreciation of the underwater world. The emphasis during your scuba training was almost entirely on the knowledge and skills required to dive safely. Yet, learning the theory and practice of scuba diving was probably not why you chose to become a diver. After all, learning to dive is just a means to an end – a way to get there – not the end itself. For most people, the real motivation to dive is to explore the 71 percent of the Earth that most others cannot experience and to observe creatures and phenomena most people only see in movies and social media.

The lack of emphasis on the environment during scuba training means that most divers graduate without a clear understanding of the underwater world and are therefore unable to fully appreciate what they see around them. As a result, many divers quit diving once the excitement and adventure of simply being underwater begins to wane.

The Reef Smart Guides Ocean Explorer program is designed to enhance your underwater experience. The contents of this program include waterproof handheld cards and guided activities provided by a Reef Smart-trained dive professional, as well as optional online reading materials that provide additional context. The program's goal is to provide an intimate understanding of how coral reef ecosystems function, the challenges they face, and the action that is being taken to protect them.

The Reef Smart Guides Ocean Explorer Program is ideal for any avid diver or snorkeler who wants to learn more about the marine environment, particularly coral reefs, irrespective of their age or educational background. The Ocean Explorer Program consists of several individual modules that are designed to provide insight into a particular facet of the marine environment. Each module listed below is designed to complement the others in the program and can be completed in any order:

THE BENTHOS

This experience familiarizes divers and snorkelers with critical environmental aspects of coral reefs and the key benthic species that form the basis of this incredibly productive and diverse ecosystem. The objective is to hone observational skills and gain an understanding of subtle yet vital indicators of coral reef health.

THE FISH COMMUNITY

This experience familiarizes divers and snorkelers with coral reef fishes, but it involves so much more than "fish ID." The objective is to introduce the concept of how fish morphology (form) drives their behavior and role (function) in the coral reef ecosystem.

THE REEF AT NIGHT

This experience familiarizes divers and snorkelers with various phenomena that can be observed on coral reefs at night, such as bioluminescence and bioflorescence. The objective is to raise awareness of how the

coral reef community's "night shift" differs from its "day shift" and some of the behaviors that can be observed.

While each module covers the background material required to enhance your dive experience, it does not include many in-depth aspects of coral reef ecology. For a more thorough treatment of the topic, we suggest purchasing a copy of *Beneath the Blue Planet: A Diver's Guide to the Ocean* for a more thorough treatment of the topic.

THE FISH COMMUNITY

Typically, the most evident and charismatic creatures on a coral reef are the fishes. While many divers are content to know little more than the names of the most common species, this dive is designed for those who want to learn much more. Becoming adept at "fish ID" can be an excellent way to begin appreciating coral reef ecosystems, but it alone is insufficient if your goal is to really understand the full story of how coral reefs function. The vital role fishes play in the ecology of coral reef ecosystems requires understanding not only their identity but also their morphology (form), their behavior, and how they interact with other community members.

DID YOU KNOW?

When should one use the term "fish" versus "fishes"? "Fishes" is the proper English plural form of "fish" that biologists use when speaking about two or more fish species, as in "There are over 34,000 fishes in the world" (meaning there are over 34,000 fish species in the world). When speaking about two or more individual fish, then the word "fish" is used, as in "There are several million fish of the species *Gadus morhua*" (meaning that *G. morhua* – Atlantic Cod – comprise millions of individuals). To see both in action, consider the statement "There are twelve fish in this aquarium, representing five fishes" (meaning that the aquarium contains twelve individuals, some of the same species and some of different species, for a total of five species). The usage of these two words is similar to that of "people" and "peoples."

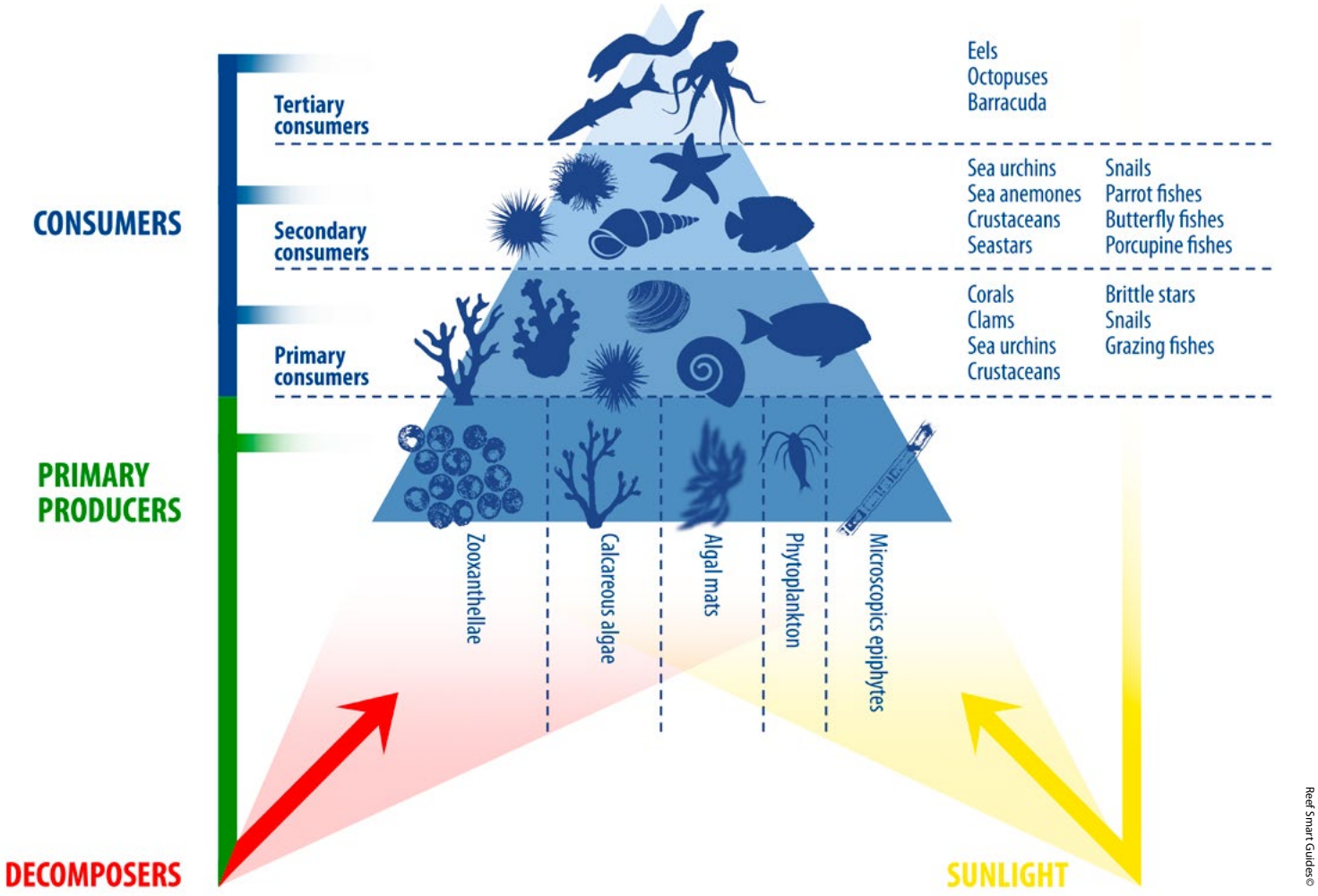
LEARNING OBJECTIVES

1. Explain the behavior of coral reef fishes regarding what, how, and when they eat.
2. Define "feeding guilds" and explain how this concept relates to the major families of fishes found on Caribbean coral reefs.
3. Explain how a fish's morphology (form) can be used to understand its ecological role (function) within the coral reef community.
4. Explain why coral reefs are highly vulnerable to overfishing, and what signs might indicate that a reef is overfished.
5. Identify the most common fishes on a local coral reef dive or snorkel site.

WHAT A FISH EATS AND WHY THAT MATTERS

One aspect of gaining insight into how coral reefs work is understanding how energy (food) is transferred through the food web. But before you can see how food can be used to understand fishes, it is essential to understand what food is available on a coral reef.

As shown in the diagram below, there are three main groups of animals in the food web: Primary producers, consumers and decomposers.



The coral reef food pyramid can be summarized in simple terms.

Primary producers, also known as autotrophs, are organisms capable of feeding themselves through photosynthesis. This group includes plants and algae. While plants are uncommon on a healthy coral reef, algae are far more abundant. That said, you may never notice the actual quantity of algae present on a healthy reef because most of it gets eaten quickly by herbivores.

Consumers, also known as heterotrophs, are organisms that cannot feed themselves through photosynthesis, and must therefore eat primary producers or other organisms to survive. This group is sub-divided depending on what level of the food web is consumed. As there are plenty of organisms to serve as prey, it is perhaps not surprising that most coral reef fishes are carnivorous, some specializing in eating other animals such as fish and some specializing in consuming invertebrates.

Decomposers mainly consist of micro-organisms, such as fungi and bacteria, which recycle nutrients by consuming dead organisms from the other two groups. As you probably discovered the last time you cleaned out your refrigerator, dead plants and animals that are not eaten eventually decay. Besides making a mess, decay is a necessary process whereby once-living tissue is rendered back into its original inorganic

components. Decaying material, called detritus, feeds an essential part of the food web. Detrital food webs are both critical and complex, particularly in marine environments.

What a reef fish eats is less a question of choice than it is of evolution. Over the millions of years that fishes have occupied modern coral reefs, they have pretty much figured out how to make a living, and their bodies and lifestyles have adapted accordingly.

Whether a creature is an herbivore or a carnivore actually determines much of its behavior and lifestyle. This connection is because meat and vegetables represent vastly different nutritional potential. Meat is easier to digest than plants since animal cells have no cellulose wall to break down, and it has a higher nutritional value. Herbivores, therefore, need a longer digestive tract to break down their tough food and must feed almost continuously because of the relatively low nutritional value of the plants or algae they eat. By contrast, carnivores can have a shorter digestive tract and do not have to feed as often.

To put this comparison in context, consider the feeding habits of lions versus gazelles or wolves versus cows. The meat eaters spend much of their time lying around, eating only occasionally. Meanwhile, plant eaters graze continuously. Now consider how the same comparison might play out on a coral reef, but in this case, compare grouper to parrotfishes. Do you see that the same idea applies underwater? A diver rarely, if ever, sees a grouper actively feeding. And when a grouper does feed, it is usually on a whole fish that can last it for days. By comparison, most divers have seen parrotfish feeding, since they eat constantly, biting the reef thousands of times per day to ingest the necessary nutritional requirements from the macroalgae they are targeting.

waldo81/Shutterstock ©

Grouper are often found resting on the reef and may feed by ambushing unsuspecting prey.

Laura Dts/Shutterstock ©

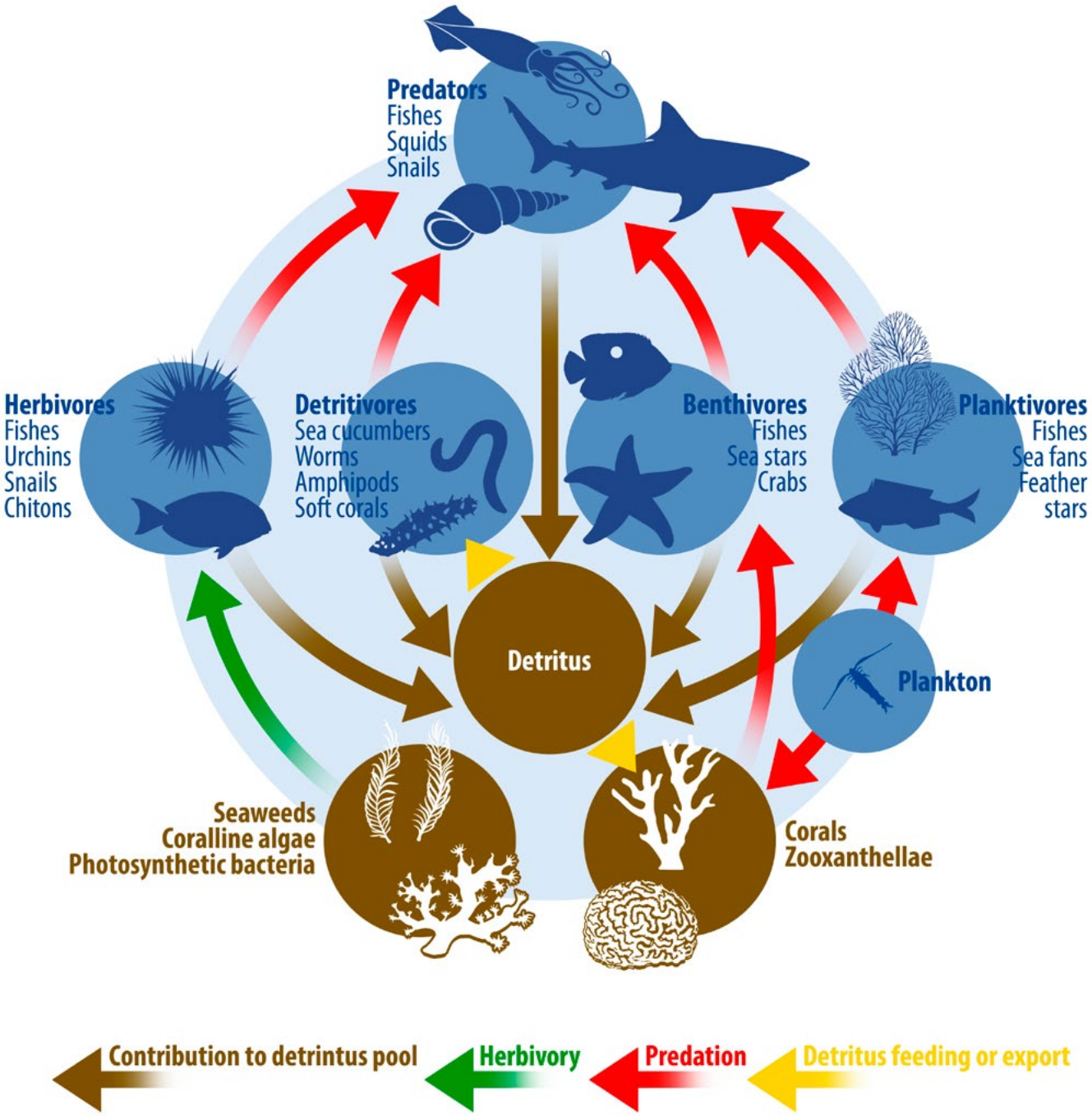
During the day, parrotfish are constantly in motion, cruising the reef and feeding.

There are positives and negatives to each feeding strategy. On the plus side for herbivores, there is a lot of algae to eat, which means the reef can support many herbivores. The downside is that since herbivores must feed constantly, they are also easy prey for consumers higher up the food web. Moreover, scientists believe that the incredible amount of predation on coral reefs has had a significant evolutionary effect. The large number of carnivores is one reason most invertebrates are so cryptic, and why those not well hidden are often highly toxic.

Another example of how a predator-prey relationship can drive fish evolution involves risk behavior in herbivores. There is compelling evidence that herbivores are willing to risk greater exposure to predators to consume better quality food, rather than staying in relatively safe areas and eating less nourishing or noxious algae.

Biologists once thought that food preference in fishes was absolute – in that predators only ate meat and herbivores only ate plants. But as scientists began spending more time underwater, they quickly saw that the line between feeding strategies sometimes blurs. In reality, coral reef fishes are much more opportunistic than was initially believed. Indeed, as most experienced divers and snorkelers can attest, sometimes carnivores eat plants, and sometimes herbivores eat fish. Their food preference is just that, a preference, rather than a law of nature.

A useful way of viewing the food preferences of fishes, and one of the keys to better understanding fish behavior in general, is through the concept of *feeding guilds*. In formal terms, a guild is an association of individuals with similar interests or pursuits. The term was first used to describe medieval associations of merchants or craftsmen. The term feeding guild can be used to define a group of organisms that use the same ecological resource in a similar way. There are many different feeding guilds, such as herbivores (plant- and algae-eaters), detritivores (detritus-eaters), benthivores (bottom-feeders) and planktivores (plankton-eaters). Some of these guilds are sub-divided based on their food preference. Corallivores (coral-eaters) and spongivores (sponge-eaters) are both types of benthivore, and predators might be piscivores (fish-eaters) if they consume fish, for example.



A coral reef food web can be viewed as a composite of various feeding guilds. Energy moves through a coral reef food web where each organism belongs to a specialist guild. In total, the reef community can access food on the reef in any form, alive or dead. As a result, very little is wasted on a coral reef in an energetic sense, making coral reefs highly efficient ecosystems.

So long as there is more than one member of each individual guild in an ecosystem, no ecological role is lost should a particular species disappear. In this way, diversity within a feeding guild provides some redundancy to a reef ecosystem in terms of its ecological functions. As guild members have similar food preferences, they also tend to demonstrate similar behaviors. These similarities are often reflected in the body shape of fishes as well.

FORM FOLLOWS FUNCTION

With thousands of coral reef fishes in the world, the ability to identify them all on sight is virtually impossible. Most divers are lucky if they can commit a few dozen to memory, and even experienced naturalists are lucky to know more than a few hundred. But knowing names is not an essential part of pulling order out of the seeming chaos of the coral reef community. Fishes give us valuable clues about their lives in how they are designed. If we know what to look for, a fish's features can tell us as much about who it is and what it does as any field guide.

There is a logical relationship between what a fish looks like and how it makes its living. First, consider its basic body shape: Is it streamlined or not? A cigar shape, or what scientists call fusiform, is a good clue that this fish is a fast swimmer. Fast swimmers are usually hunters that seek to chase down their prey, such as the yellowtail snapper *(Ocyurus chrysurus)* pictured below.

Marty Snyderman©

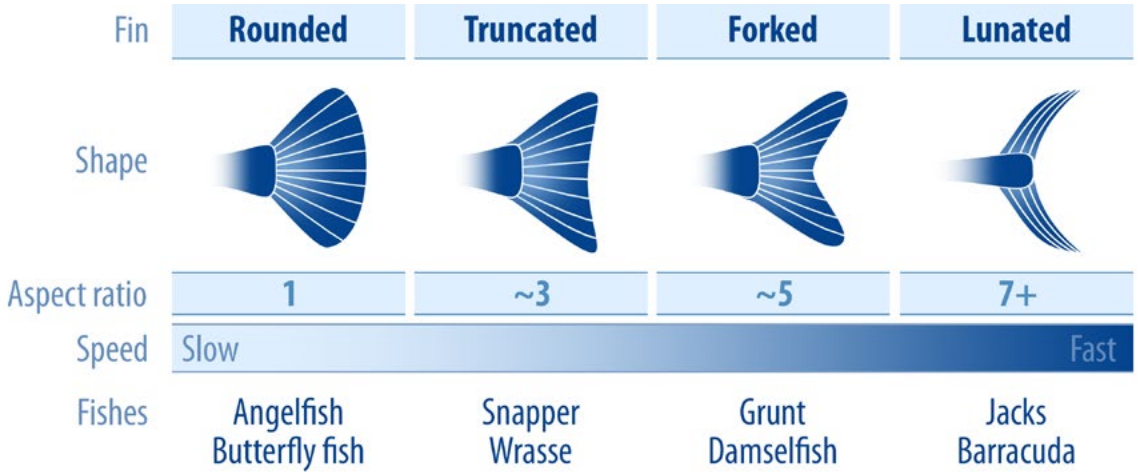
The highly streamlined body and deeply forked tail make this yellowtail snapper a formidable pursuit predator.

By comparison, the Queen angelfish *(Holacanthus ciliaris)* as seen below, may appear streamlined in the sense that it is skinny, but it really does not have a very efficient hydrodynamic design. So, what explains its form? It need not be fast because its primary food source is sponges and other invertebrates, which do not move – or at least do not move very fast. Its body is skinny (known as laterally compressed) so it can quickly maneuver in and out of the cracks and crevices of the reef, which is a handy ability when trying to avoid being eaten by larger predators.

Jesus Cobaleda/Shutterstock©

This angelfish's body and tail are designed more for maneuverability than for speed, and for getting in and out of tight spaces.

Tail design is another giveaway about a fish's swimming ability, as shown below. For example, consider the fastest swimmers in the sea, such as tuna, swordfish, and marlin. They all have sturdy, sickle-like (lunate) tails, which can be moved swiftly through the water. It is the ultimate design for speed. The rounder a fish tail gets, the less efficient it is at high speeds. However, what is lost in speed is gained in maneuverability. The rounded tail of the angelfish is clearly not designed for speed, but it is the tail of a great acrobat instead.



Reef Smart Guides©

The aspect ratio of a fish's tail (caudal fin), which is the ratio of its width to its height, indicates whether it is modified for speed or maneuverability. The higher the aspect ratio the faster the fish.

IN-WATER ACTIVITY

Take a look at fishes around you and, along with your Reef Smart Guides cards, see how many tail types you can check off, include lunated, forked, rounded, and truncated.

The next way to understand the lifestyle of a reef fish is to determine what it is designed to eat. As omnivores, we humans are capable of eating almost anything. We have the dentition (teeth) to match our lifestyle since our teeth can cut, rip, and grind. So, whether a meal of choice is meat or vegetables (or the perfect blend of both, like pizza, perhaps), human teeth can handle it. However, most animals are not as versatile as humans when it comes to their diet. For example, look at your dog's or cat's teeth. As with all carnivorous mammals, their teeth are narrow and sharp because they are designed to tear, not grind.

Teeth are an excellent clue to diet, but the design of a fish's mouth provides additional insights. For example, the photo below shows a species of grouper with predatory teeth and an enormous gape (the size of the mouth when opened wide) that can accommodate a wide variety of prey.

By comparison, diminutive mouths with comb-like teeth, such as those seen below in butterflyfishes – whose family name, Chaetodontidae, means comb tooth – are designed for grasping tiny food such as coral polyps and marine worms. Meanwhile, the crescent-shaped mouths of angelfishes are perfect for taking bites out of sponges.

Marty Snyderman©

Grouper are known to have one of the largest gapes of all predatory fish.

Vladimir Wrangel/Shutterstock©

Butterflyfishes eat worms and polyps, and their mouth size and shape reflects that diet.

Another unique mouth trait among fishes that can provide valuable insight into their diets is what scientists call protrusive or expandable jaws, such as those found on blue chromis (*Chromis cyanea*), as seen below. The plucking ability of protrusive jaws makes them ideal for selectively capturing plankton from the water column. Fishes with this kind of diet are called planktivores.

Marty Snyderman ©

Its body shape (morphology) suggests the blue chromis is built for speed, but its prey is plankton, which is slow. So why the need for speed? Blue chromis feed out in the open, so speed is vital for eluding predators.

As you can see, the chromis also has a deep, forked tail. As we learned earlier, this is a tail built for speed. But chromis' preferred prey, namely plankton, are not particularly fast, so why is speed important for something that does not have to chase its food? The answer is for protection. The best place to catch plankton is up in the water column on the seaward side of the reef and away from the protection of the many nooks and crannies in the reef. This preferred eating area leaves chromis exposed to hungry carnivores, so they need to swim fast to escape.

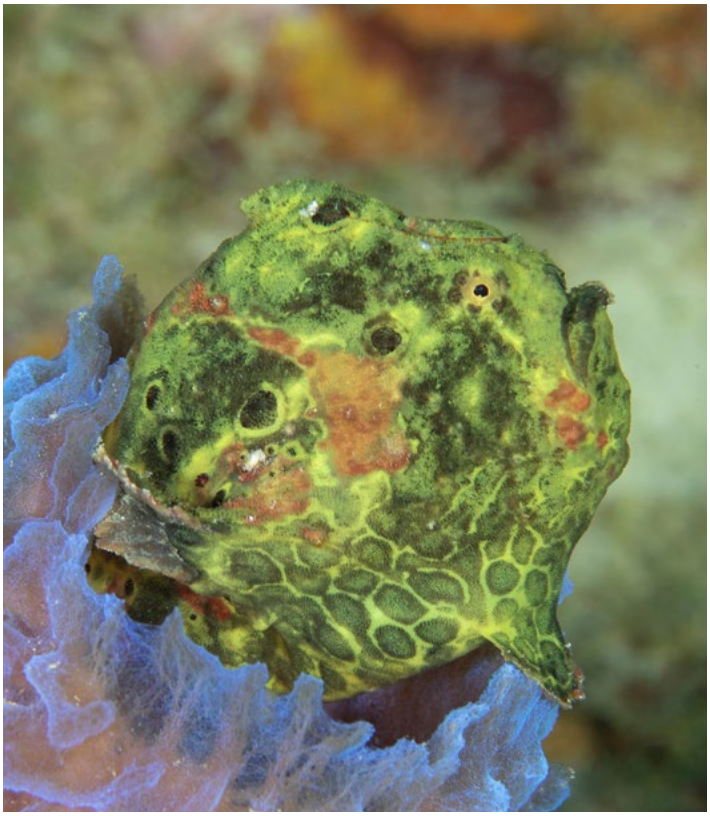
Other planktivores, such as jawfish and the fairy basslet *(Gramma loreto)*, also manage to live a successful, planktivorous life, all while remaining close to the reef for shelter. These species boast a more blunt and maneuverable tail than the chromis.

While the lifestyles of herbivores, benthivores, and planktivores are intriguing, most coral reef fishes are piscivores (fish-eaters). In fact, 50 to 70 percent of reef fishes by species are piscivores. And because there are so many fish to eat on coral reefs, this is a very opportunistic bunch. They will eat just about anything that swims – and even some things that do not. Fish eaters are so numerous on the reef that they have evolved different hunting strategies.

Pursuit hunters such as sharks, jacks, and mackerel hang back and start their charge from a distance. By contrast, stalking hunters such as trumpetfishes and barracuda use stealth and attack from closer range. Ambush hunters, such as scorpionfishes, lizardfishes, and grouper attack quickly with no preliminary maneuvering – their strategy is to lie in wait. The better hidden or camouflaged they are, the better they can surprise their prey. Frogfishes take camouflage to a whole different level by mimicking the reef to remain hidden.

While predatory fishes have adaptations that enable them to gain an advantage over their prey, the prey are not exactly defenseless themselves. Many reef creatures have adaptations that help them avoid predation, such as shells and spines. With their grinding jaws and crushing teeth, most benthivores (meaning bottom-feeders) are well-adapted to feeding on tough, slow-moving invertebrates such as crabs and mollusks. They have no reason to swim fast, but that means they need some protection against predation themselves. Pufferfish are a good example of this – they have tough skin that does not taste very good, an ability to increase their size by inflating, and a dense covering of protective spines.

Other fishes use colors and patterns to help them blend into their habitat or to survive an attack. For example, the four-eye butterflyfish *(Chaetodon capistratus)* shown below has false eye spots on either side of their anterior flank, which is the source of their common name. This pattern makes it look like the fish is pointing the other way and may distract a potential predator into aiming their attack toward the fish's rear, rather than its head. After all, a bite on the tail is less fatal than a bite on the head. Similar patterns are found in some species of damselfish and wrasses.



Brian Lasenby/Shutterstock©

*A longlure frogfish (*Antennarius multiocellatus*) is mimicking a yellow sponge in Bonaire.*

FtLaud/Shutterstock©

When fully inflated, pufferfish are not exactly mobile. But they do not need to be.

Humberto Ramirez/Shutterstock©

Certain patterns, like false eye spots, may increase the survival in some species of reef fish.

Some marine creatures have developed additional behaviors that help protect them from predation. For instance, while fish may gather in schools for several reasons, including reproduction, it can certainly reduce their predation risk. Studies have shown that fish can respond to a predator attack much quicker when part of a school than alone. In addition, schools are believed to confuse both the visual and electrosensory responses of predators, making it harder for them to zero in on a single individual to attack. Therefore, most predators attack schools by simply charging through them at great speed and hoping to collide with, or stun, their prey with part of their body. Swordfish thrash with their sword as they swim through a school, and thresher sharks do the same with their long tails.

IN-WATER ACTIVITY

Take a look at your Reef Smart Guides waterproof cards and, along with your dive leader, see how many of the different types of fish you can check off, including herbivores, planktivores, benthivores, and predators, including ambush, stalking, and pursuit predators.

A VERY UNIQUE FEEDING STRATEGY

While most coral reef creatures fit into the lifestyles described above, it's worth noting that there are some rather unique feeding strategies that are fascinating to observe. One such example is the coral reef cleaning station. These are locations where many species of fish and sea turtles congregate to have their parasites cleaned off by smaller creatures, such wrasses, gobies, and shrimp. Often these stations are located on top of a coral head or in a slot between two outcroppings. Sometimes they're seen in open water under large clumps of floating seaweed.

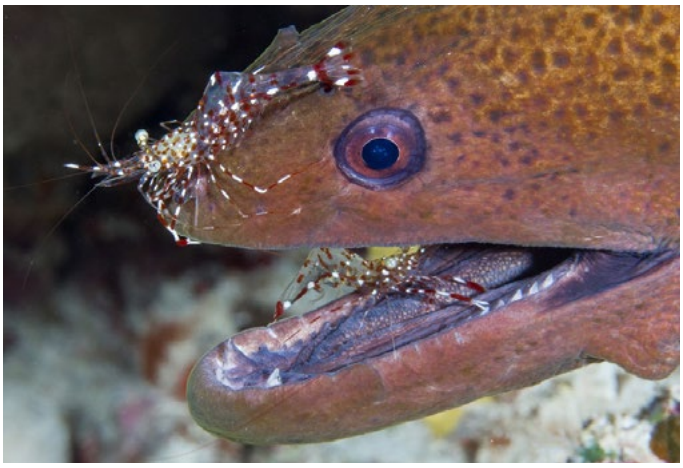
When approaching a cleaning station, a fish will open its mouth wide and signal its desire for cleaning by some unusual posture or movement. The cleaner then removes and eats the parasites and dead skin, even swimming into the mouth and gills of what might otherwise be the cleaner's predator. As both the cleaner and the creature being cleaned benefit from this arrangement, this is a form of symbiosis termed mutualism. How predatory clients recognize cleaners is still uncertain, although it has been hypothesized that color, size, and pattern indicate to clients that the fish or shrimp is a cleaner. Some fish species, such as Spanish hogfish *(Bodianus rufus)*, function as cleaners only during their juvenile stage, opting for other sources of food as adults. Overall, cleaning stations help maintain the health and hygiene of reef fish populations, reducing the prevalence of parasites and promoting overall well-being within the community.

An interesting nuance of cleaner fish behavior involves the combtooth blennies. Many species, such as the sabertooth (Petroscirtes xestus), fangblenny *(Plagiotremus rhinorhynchos)*, and false blenny *(Aspidontus taeniatus)*, mimic several cleaner fishes like the common blue streak cleaner wrasse *(Labroidies dimidiatus)*. But unlike their look-alike, these impostors do not clean; instead, they take bites from their hosts and quickly escape. The mimics are not pursued because the bite contains a morphine-like venom and a blood pressure suppressant. So, not only is it pain-free, but the drop in blood pressure also makes the victim slow to respond, giving the tiny predators time to escape.

It can be difficult to memorize every species you might encounter on the reef, particularly considering there are 6,000 species globally and over 500 in the Caribbean alone. But with a knowledge of basic form and function, you only need to remember how different morphological characteristics, such as the body shape and structure of the mouth and tail, can provide clues about what a fish eats and how it lives. So, even if you cannot remember the name of the individual fish you are observing, you can know with confidence how it fits into the complex web that exists on a coral reef.

SCIENTIFIC INSIGHT

There are several forms of symbiosis in nature. As discussed, mutualism is where both organisms benefit. Another common example of mutualism on coral reefs is the relationship between cleaners and the organisms they clean. The cleaners get a fairly easy meal of parasites, whereas the larger organisms being cleaned are rid of the parasites that negatively effect their health. Research show that fish with parasites are up 20 percent smaller in both length and weight than fish without parasites



Marty Snyderman©

A moray is cleaned by a couple of eager shrimp – an example of mutualism where all those involved benefit.

Commensalism is a form of symbiosis where one organism benefits and the other remains unharmed. The relationship between a shark and remora is an example of commensalism. Research suggests that while not exactly comfortable, the suction disk that remoras use to attach themselves to large marine organisms is not usually damaging to their health. Remoras on the other hand, benefit from a free ride and food scraps that the larger organism may leave behind.

kaschibo/Shutterstock©

*Several remoras attach to the underside of a lemon shark (*Negaprion brevirostris*), which is an example of commensalism.*

Parasitism is a form of symbiosis where one organism benefits at the expense of the other. The relationship between a fish and a parasite is an example of parasitism. There are about 450 different species of isopod, such as the one shown here attached to a longnose hawkfish (*Oxycirrhites typus*), that are known to parasitize marine and freshwater fishes.

.

SergeUWPhoto/Shutterstock©

An isopod parasite attached to a longnose hawkfish – an example of parasitism.

DIVE PREVIEW

Dive/Snorkel Preview

The Fish Community dive with your Reef Smart-trained dive leader will be an opportunity to observe some of what was discussed here. Using the Reef Smart Guide Fish Community waterproof cards, you will identify various fish based on the shape of their body, mouth and tail, as well as their color and pattern. These fish have been grouped into the following feeding guilds:

- Herbivores
- Benthivores
- Planktivores
- Predators

We have sub-divided predators based on the way they capture their prey, including ambush predators, stalking predators, and pursuit predators. These groupings help to highlight differences in their respective morphologies. We have also included a few unique creatures and exceptions, which your dive leader will be able to explain in greater detail.

Your waterproof cards also allow you to estimate the abundance of the creatures you see on your dive or snorkel experience. The health of a coral reef can often be determined by the number, or absence, of certain creatures. The system used in this module to quantify abundance was developed by the Reef Environmental Education Foundation (REEF) for their internationally recognized roving diver survey methodology, so the information we collect can be used in their database.

Afterward, you will debrief and discuss the observations made on your waterproof cards with your dive leaders to gain insight into guild membership and gain a sense of the health status of the dive site.