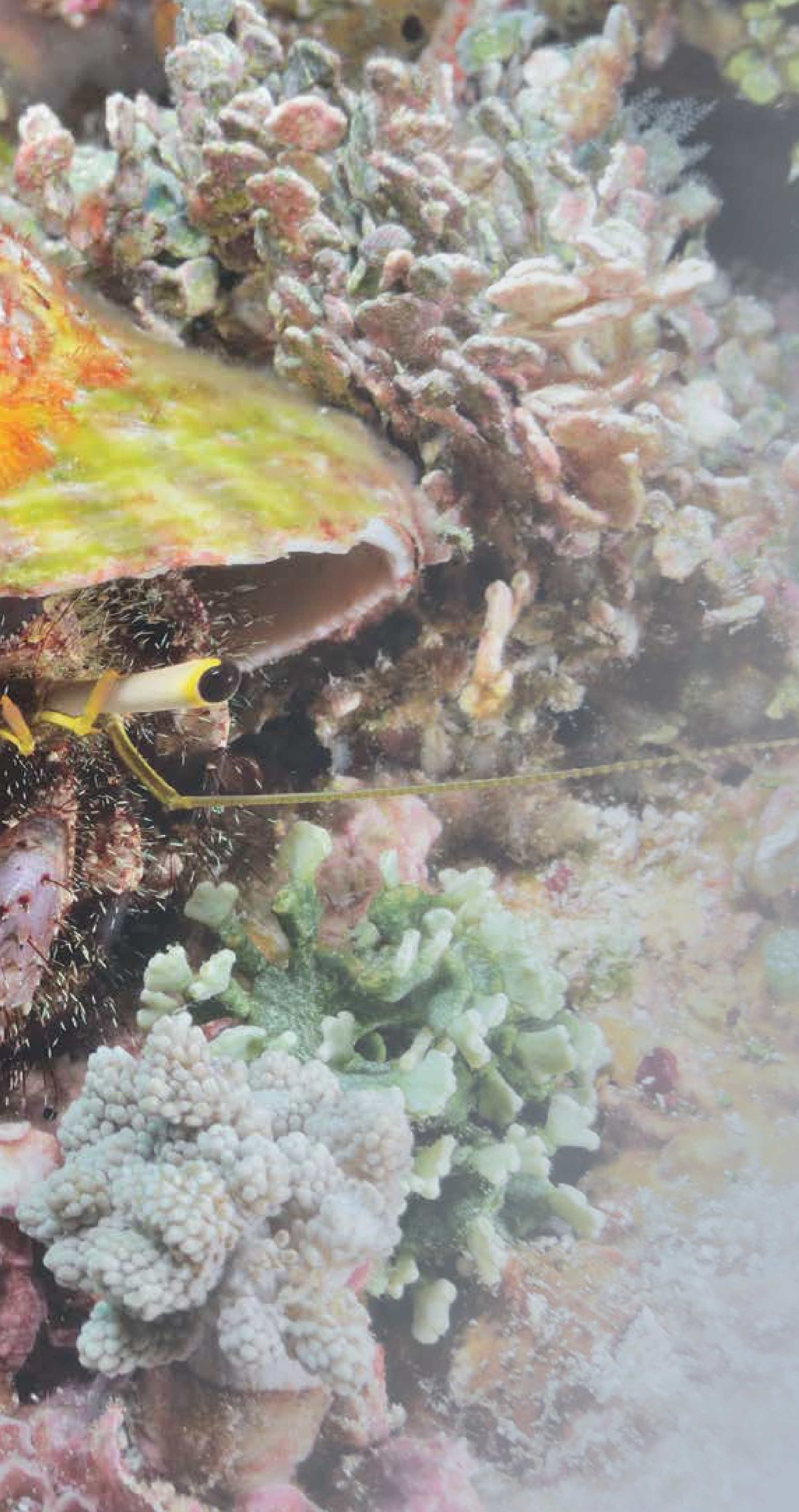


Now you see me ...

For all marine creatures, sustenance is a driving force in their daily lives. The seaweeds require light and nutrients, the herbivores suitable vegetation to graze, and the carnivores are almost constantly on the hunt for prey. For most, the need to eat and avoid being eaten have been major evolutionary pressures, influencing not only where they live and the way they behave, but also the way they look. The latter can be expressed in a variety of ways, including some that would seem to be totally at odds with what might be expected.

by John Huisman
and Alan Kendrick
Photos by John Huisman

A healthy ecosystem with a diverse range of species is a joy to behold. But essential to this is a balance between the primary producers, the herbivores and the carnivores. Too many, or too few, of one group can impact on the others, upsetting the equilibrium and potentially causing the entire ecosystem to undergo sometimes quite dramatic changes in structure and function. To maintain this fine ecological balance, species have evolved numerous survival strategies, both to keep themselves fed and to avoid being eaten. Here we look at just a few of the myriad ways that marine species have achieved this.

"The most obvious strategy to elude predators is to be inconspicuous – in shape, colour, or both – to blend imperceptibly with the surroundings and remain unseen by any potential predator looking for a meal."

NOW YOU SEE ME … NOW YOU DON'T

The most obvious strategy to elude predators is to be inconspicuous – in shape, colour, or both – to blend imperceptibly with the surroundings and remain unseen by any potential predator looking for a meal. One of the best practitioners of this strategy is the flounder, a bottom-dwelling fish, which has undergone a massive rearrangement of body parts. Evolution in the flounder has resulted in a flat body that can lie snug against the sea floor, while at the same time one eye has shifted so that both sit on the upper side. Interestingly, the eyes of larval flounder are on both sides of their head and this remarkable change occurs as they grow into juveniles on the seabed. The pale, mottled colour of the tropical leopard flounder (*Bothus pantherinus*) almost precisely matches the colours of the sandy seabed where it most commonly occurs. Such cryptic colouration, or crypsis, is common among marine organisms. Of course, this strategy will only work if the animal remains still, as any movement will usually draw attention.

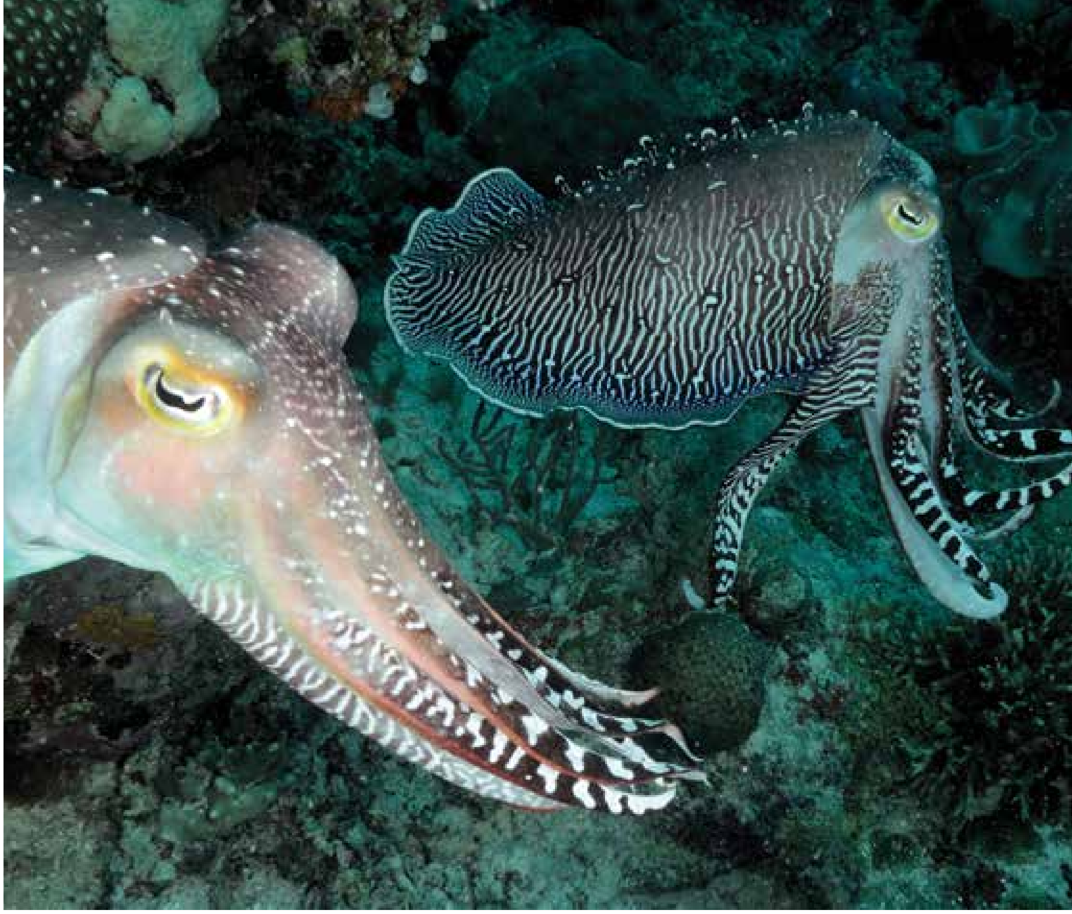
Cryptic colouration can also be very effective for predators, as they can remain hidden and lie in wait for unsuspecting prey. The tasselled wobbegong shark (*Eucrossorhinus dasypogon*) is found in northern Australia and can grow up to 1.8 metres in length. During the day the shark often settles in caves, where its strongly patterned camouflage blends effectively with the rocky seabed and its colourful mosaic of algae and encrusting invertebrates. The wobbegong's dangerous mouth is even obscured by the presence of branched, seaweed-like skin extensions around the front of its head, which soften its outline and enables it to blend in smoothly with the natural surroundings. The shark remains perfectly still, other than sometimes waving its tail to lure smaller fish, before launching a fast and unexpected ambush on prey that stray too close.

Numerous other species of marine fish and invertebrates have evolved cryptic colouration. The prickly leatherjacket (*Chaetodermis penicilligerus*) merges almost imperceptibly with the background and has a few seaweed-like frills to complete the effect. The broadclub cuttlefish (*Sepia latimanus*), which is a cephalopod like octopuses and squid, has the ability to change its skin colour at will, blending instantly with its surroundings. When a cuttlefish swims from a reef to a sandy area, its colour will change to match the new background. It also uses evolving colour patterns to communicate with other cuttlefish, or as warning signals. Unsurprisingly, they are often called the 'chameleons of the sea'.

Previous page
Main Hermit crabs use empty mollusc shells as their home.

Above A decorator crab (*Naxia* sp.) with its clever camouflage of seagrass and seaweed.

Left Leopard flounders (*Bothus pantherinus*) have both eyes on one side so they can lay undetected on the ocean floor.



Above Prickly leatherjackets (*Chaetodermis penicilligerus*) blend into their environment.

Right Broadclub cuttlefish (*Sepia latimanus*) change their colour to match their surrounds and to communicate.

NATURAL DISGUISES

Of course if changing colour or modifying body shape is not possible, you can always sequester parts of the surrounding vegetation to hide beneath. The decorator crab (*Naxia* sp.) is expert at attaching pieces of seaweed and even seagrass to its hard carapace, resulting in an almost perfect disguise. The crab selects suitable material from its surroundings, coats the ends with a gland secretion that hardens in seawater, and then attaches it to special hooks that cover its shell. The algae and seagrass even continue to grow, ensuring that the crab looks exactly like a small rock when it remains still.

Decorator crabs are remarkably attentive to the effectiveness of this protection. When moved to a different habitat, they rapidly shed the original camouflage and attach materials from the new home, ensuring that their disguise blends into the most recent surroundings. Similarly, other crabs can use anemones, sponges and an assortment of invertebrates as camouflage and protection. In another form of camouflage, hermit crabs adopt empty mollusc shells as a home, providing the crab with a mobile protective casing that also hides it from potential predators.

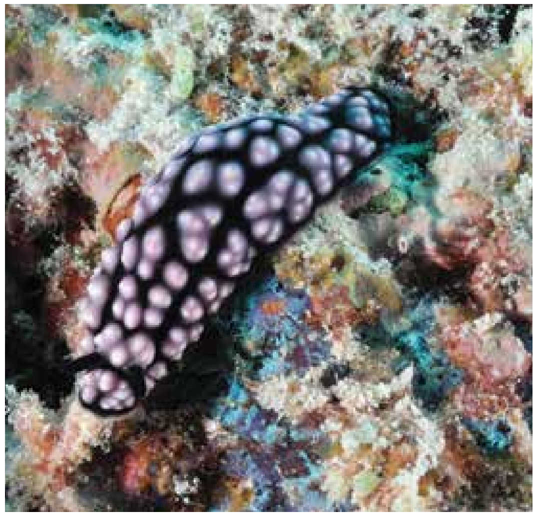
EAT ME IF YOU DARE!

While camouflage and remaining inconspicuous are intuitively excellent strategies to avoid predators, there are numerous marine species that have evolved to be outstandingly bright and colourful. So how does being so obvious help to avoid predation? The answer lies in an unusual phenomenon, not unique to the marine environment, but certainly prevalent among marine creatures. Many species that are poisonous, or at least contain distasteful compounds, are also the most colourful. These bright colours warn potential predators that if you eat me you could die, or if you survive, it will have been a very unpleasant experience.

This strategy is perhaps best developed by the spectacularly colourful shell-less molluscs known as nudibranchs, which are much loved by underwater photographers. Many nudibranchs make no effort to hide, and their visibility is accentuated by bright colours and bold patterns. They embrace this seemingly carefree attitude because their colours signal to potential predators that they are distasteful and not to be eaten. Fish, it seems, are fast learners, and an unpleasant encounter with a toxic nudibranch ensures they will no longer try them as food. Some nudibranchs produce their own toxins, but others store compounds derived from their own food, such as sponges. Such is the case of the spectacular nudibranch *Chromodoris kuniei*, which feeds on sponges and uses its toxic chemicals for its own defence.

This bright warning colouration, also known as aposematic colouration, is such an effective deterrent strategy that many other species have now evolved apparently vivid warning colours, but do not have the poisonous compounds that are so often advertised by such patterns. Why bother wasting valuable energy developing toxic defences, which can otherwise be spent on growth and reproduction, when you can get the desired outcome with a relatively simple disguise?

Looking like another species is known as mimicry, with the imitator known as the mimic and the species being mimicked known as the model. Mimicry of a toxic species by a non-toxic species is known as Batesian mimicry, after the English naturalist Henry Bates, who first



Above A Western Australian sea hare (*Aplysia gigantea*).

Right top and right Nudibranch *(Phyllidiella pustulosa*) and flatworm (*Pseudoceros imitatus*) look almost identical with the flatworm enjoying the protection brought by resembling a tropical nudibranch.

recognised the phenomenon in butterflies. Batesian mimicry can only be effective if the prevalence of the mimic species does not exceed that of the model, otherwise potential predators may encounter the non-toxic species more often, and not associate the warning colours with an unpleasant taste. In some cases both the mimic and model are toxic, which serves as a strong reinforcement of the warning to predators to stay away. This type of mimicry is known as Müllerian mimicry, after the German naturalist Fritz Müller, who, like Bates, worked with butterflies.

Batesian or Müllerian mimicry is often seen in polyclad flatworms, many of which display colours and patterns remarkably similar to those of nudibranchs. Flatworms are carnivorous members of the phylum Platyhelminthes and are common in the marine environment, where they are often conspicuous due to their bright colours. The flatworm *Pseudoceros imitatus* mimics the colour pattern of the unrelated *Phyllidiella pustulosa*, a tropical nudibranch that deters fish predators by secreting a milky substance containing noxious compounds. The flatworm has evolved an almost exact copy of the nudibranch's colour and patterns, undoubtedly reaping the benefits of looking like its distasteful model. These two are not the only lookalikes; several other species of nudibranchs are mimicked by other organisms, including flatworms, juvenile holothurians (sea cucumbers) and even other nudibranchs.

Not all toxic sea slugs flag their toxicity with bright colours. The Western Australian sea hare (*Aplysia gigantea*) has cryptic colours, but is also toxic. This species is short-lived and spawns in shallow water during summer and early autumn. They often wash up in large numbers on WA beaches, where they attract the interest of dogs. This has led to numerous poisonings, but fortunately most are treatable and the dog survives.

The toxic red-eyed rock crab (*Eriphia sebana*) seems to be hedging its bets. It has a fairly bland colour that merges well with the background, but also has vivid red eyes that standout like beacons and presumably warn off potential predators. Like many marine animals, the toxic compounds in crabs are not produced by the animals themselves but are derived from external sources, such as diet or possibly symbiotic bacteria.

SEAWEED MIMICS

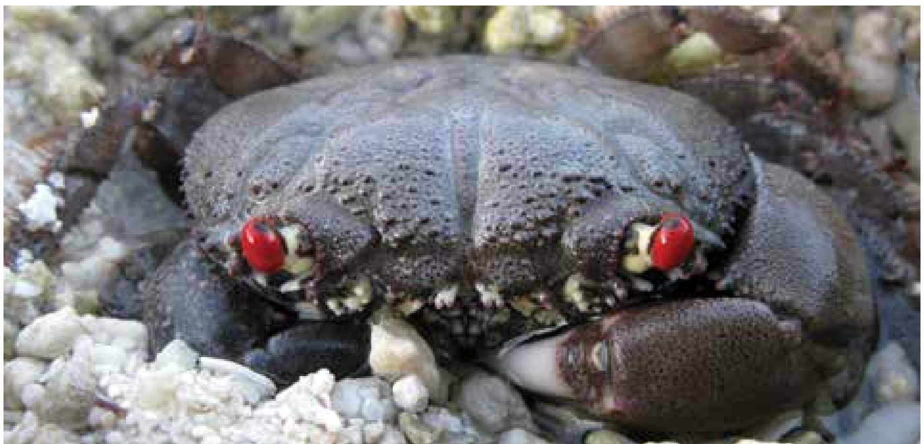
Mimicry is most often associated with animals, but a few seaweeds are also excellent at hiding their true identity. In this case, rather than adopting the guise of a toxic species, the seaweeds take on the appearance of a less palatable organism. The red seaweed *Rhodogorgon* was named due to its uncanny resemblance to a gorgonian coral, and this mimicry deceived seaweed and coral biologists until very recently. Another red seaweed, *Eucheuma arnoldii*, has evolved to mimic the very common hard coral *Acropora*, presumably taking advantage of the fact

that herbivorous predators have little interest in eating the stony coral skeleton. This disguise is so perfectly rendered that the algae even has the distinctive bluish branch tips with a polyp-like structure, a distinguishing feature of *Acropora* corals and is in fact the source of its name (the Greek word *acro* means 'tip'). The alga in the photo was seen recently at Ashmore Reef, and actually went unnoticed by seaweed biologist and WA Herbarium curator John Huisman but was picked up by the WA Museum's coral biologist Zoe Richards, who was stunned to find that what she thought was a stony *Acropora* coral was actually flexible. The disguise clearly confuses more than just potential grazers!

Seaweeds can also be protected from grazing by producing a calcium carbonate skeleton. Numerous species do this, but it is most well-developed in the coralline red algae, many of which can be rock-hard and bear little resemblance to their more plant-like relatives. Coralline algae are not immune to grazing fishes and often bear teeth marks and scars, but the number of grazers is considerably reduced by their calcified structure. Other algae, such as the rubbery *Titanophora pikeana*, can appear strikingly like coralline algae, presumably gaining protection from the similarity.

Several seaweeds, like animals, produce compounds that make them unpalatable to fish. The turtle weed (*Chlorodesmis fastigiata*) produces a cytotoxic terpene that deters grazing by fish, but surprisingly the chemical stimulates grazing by the aptly named turtle weed crab (*Caphyra rotundifrons*), which lives exclusively among the seaweed filaments and feeds on them. The crab benefits further by its association with the seaweed, as it experiences significantly reduced predation. There are several other examples of seaweeds that are chemically defended against grazing by most species, but are eaten by a small number of specialists that can tolerate or sequester the active compound. These include the red seaweed *Asparagopsis*, which produces halogenated metabolite bromide as a chemical defence, but is grazed by the pygmy sea hare (*Aplysia parvula*). Perhaps surprisingly, *Asparagopsis* is highly prized in Hawaiian cuisine, where it is known as 'limu kohu' and is used to flavour raw fish and stews.

The struggle to survive could be described as an ongoing battle between species, each evolving novel ways to gain sustenance while avoiding being eaten. It's not surprising that this has resulted in a seemingly endless array of different strategies, many of which, undoubtedly, are yet to be discovered by biologists.



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Above and above right Red seaweed (*Eucheuma arnoldii*) has evolved to mimic a hard coral (*Acropora vaughani*).
Photo (right) – Zoe Richards/WA Museum

Right A red-eyed rock crab (*Eriphia sebana*).