

The constant gardener

by John Huisman and Shaun Wilson

Western Australia's Ningaloo Reef is home to many hundreds of fish species, each occupying a unique position within the intricate coral reef ecosystem. The physical and biological complexities of the reef result in a multitude of potential habitats and have accommodated the evolution of highly specific behaviours, with each species of fish essentially acting like no other. Possibly the most unusual of these lifestyles is that displayed by a small group of damselfish, who have undergone their own agricultural revolution and developed a wholly unique behaviour: seaweed farming!

Imagine the scene. You're snorkelling at Coral Bay, on one of Western Australia's pristine coral reefs, placidly enjoying the constantly evolving kaleidoscope of colours and shapes that are the myriad fish of such places. Suddenly, out of nowhere, you're confronted by a smallish pale-coloured fish, its aggressive body language and posturing telling you that you've stumbled into a forbidden territory, and that you are most certainly not a welcome visitor. Much like a small dog with attitude, this fish is seemingly unaware that you are many times its size, and swims aggressively at you, even attempting the odd bite when your attention is distracted. When you eventually leave the scene, the fish finally settles with a seemingly smug air of victory—yet another intruder sent packing!

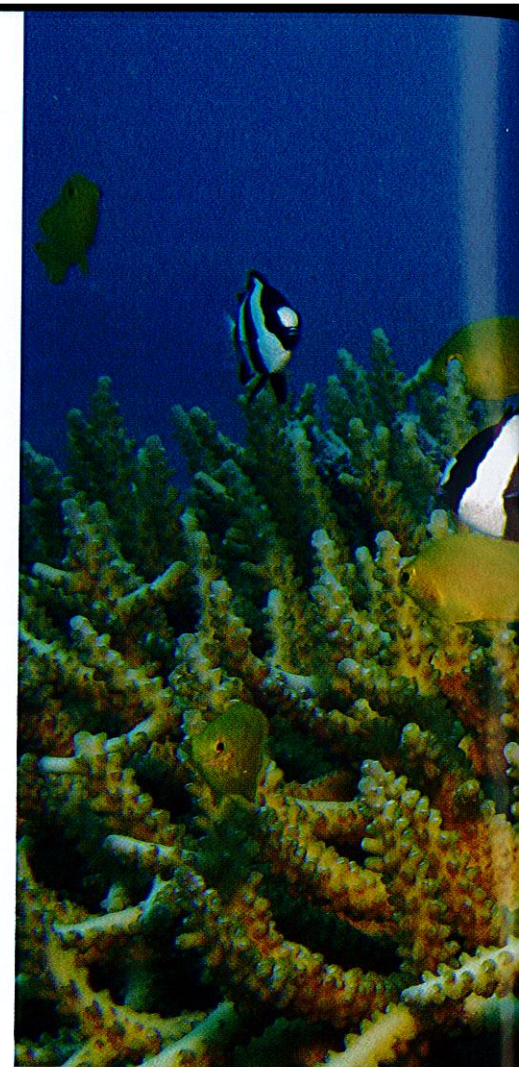
What, you might ask, caused such a reaction? What was the fish so protective of? Perhaps it was a cache of valuable eggs, or a territory suitable to entice a mate. While both of these can elicit defensive behaviour in fish, what you have most likely stumbled across is considerably more mundane,



but at the same time wholly unique. Your pugnacious fish is protecting, of all things, its seaweed garden. What you've just encountered is a honeyhead damsel (*Dischistodus prosopotaenia*), one of several species of damselfish that have developed a most unusual territorial behaviour. These fish actively promote the growth of turf seaweed in their immediate territory, and after expending the energy to do so, they aggressively defend their crop from all potential poachers.

Subsea gardening

Globally there are more than 300 species of damselfish, of which about a third can be found in Western Australian waters. A dozen or so species



are known to be turf farmers and, much like terrestrial farmers, they have adopted several habits that modify their territorial gardens to improve crop yield, including site preparation, weeding, fertilising, and fending off poachers. The evidence for each of these activities varies from convincing to possibly circumstantial, but there is no doubt that damselfishes play a major role in modifying their territories for the purpose of promoting algal growth. The first is that they selectively remove unwanted species of algae, those that they might consider unpalatable, and thereby promote the growth of desired species. This behaviour is most pronounced in the dusky gregory (*Stegastes nigricans*), and in some tropical locations outside Australia the damselfish's selective

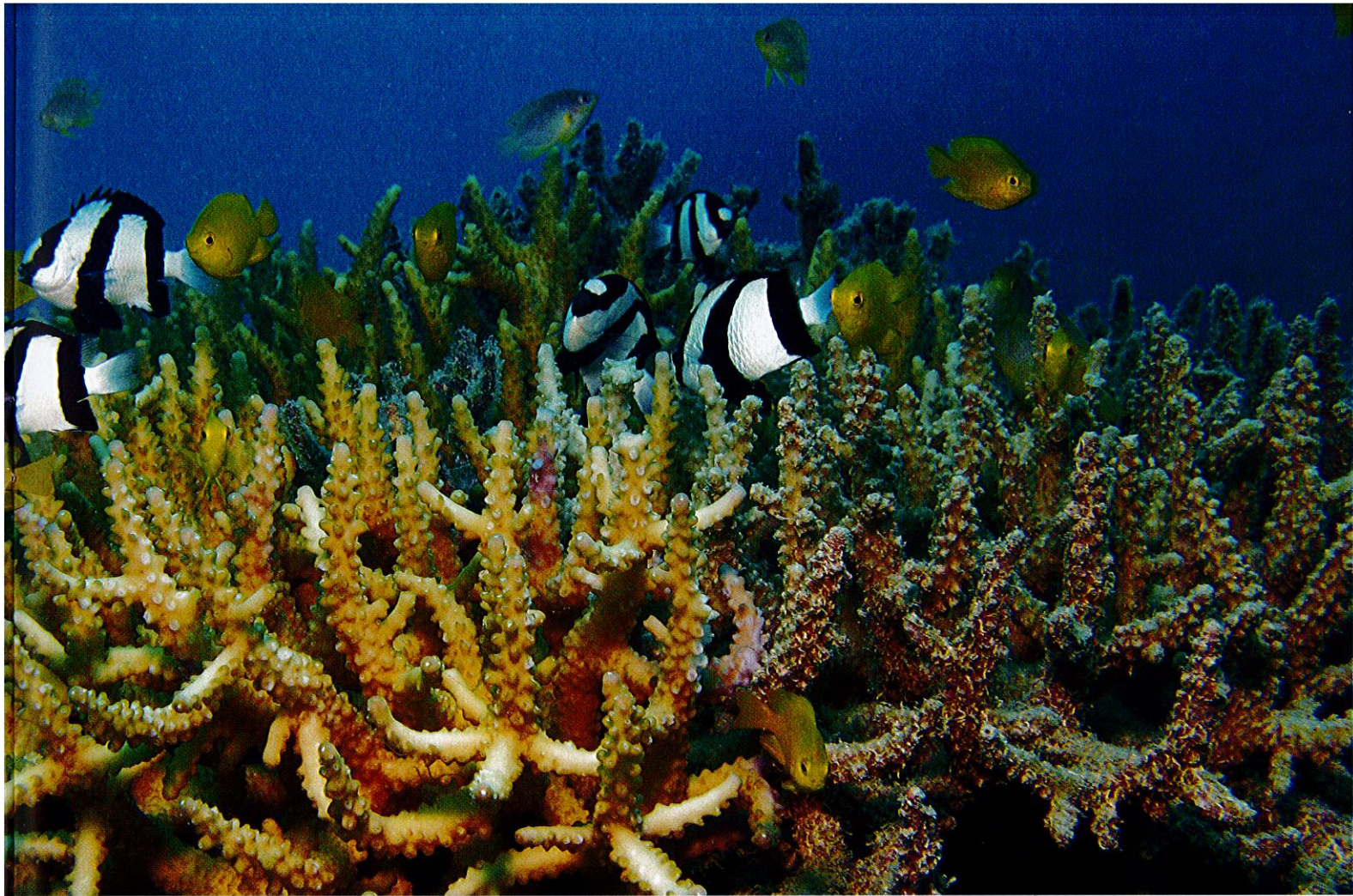


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The dusky gregory removes unwanted species of algae to promote the growth of desired species.

Left Honeyhead damsel.

Above Humbugs and lemon damsels.
Photos – John Huisman/DEC



weeding has resulted in its territory being composed of only a single species, a small red seaweed known as *Polysiphonia*. This practice is described as 'intensive' farming and results in a monoculture comparable to most terrestrial agriculture; in many cases the seaweed is so palatable to other herbivores that the only place it can be found is in the damselfish's territory. Other species of damselfish, such as the jewel damsel (*Plectroglyphidodon lacrymatus*) are more generalist and promote the growth of their turf primarily by defending it against other herbivores. This is regarded as 'extensive' farming and results in a multi-species turf, but with *Polysiphonia* often as a common element. Other components of the turf include various species of filamentous or turf-like red algae, green algae, and brown algae, plus species of cyanobacteria (blue-green algae), although the actual species composition is dependent on many factors, including local availability. Both farming methods undoubtedly promote the growth of the damselfish's preferred algae, but the motivation for doing so remains unclear. The most obvious interpretation is that the fish's



aim is to produce a food crop that is grazed directly, but alternatively the algae might house or trap other dietary elements such as detritus, invertebrates or eggs of other species. In recent studies researchers have examined the gut contents of several territorial damselfish species and demonstrated that although seaweed is prominent in the diet of some species, other species target detritus or invertebrates within the fish's seaweed garden. Some of these farmers may therefore be considered as cleaners of seaweed or ranchers of invertebrates, rather than herbivores.

As any gardener will tell you, site preparation is essential. No plants can

Above Jewel damsels defend their algae against other herbivores.

Photo - John Huisman/DEC

flourish if the ground into which they are planted is unsuited to their particular needs. Although algae do not require soil, as they do not have roots, they do require space and an appropriate surface on which to attach and grow. Some damselfish provide this by repeatedly nipping at corals within their territories, thereby removing the coral tissue. The cleared coral skeletons then become a surface on which the algae can grow. Any newly settled coral is also quickly dispatched.



Above A bluntsnout damselfish guarding its turf seaweed garden.

Photo - John Huisman/DEC

Left Lined surgeonfish are among the species damselfish regard as potential algae poachers.

Photo - Takamasa Tonozuka/Lochman Transparencies



Another key factor in a successful garden is maintenance—the provision of sufficient water and nutrients to promote growth. Our damselfish clearly does not have to worry about water, but what about nutrients? Some studies have suggested that when the damselfish defecates within its territory, the growth of preferred algae may be promoted by nutrient enrichment. Whether this is actively pursued or purely coincidental hasn't been convincingly demonstrated. In fact, other studies have shown that some damselfish will seek out areas outside their territories in which to defecate. It's tempting to suggest this might be more socially acceptable, but in truth it's unlikely our fish pays any heed to such concerns.

Farmers or foragers

Herbivorous reef fish fall into two general behavioural categories: the 'farmers'—such as our damsels—that maintain a discrete garden territory, and the 'foragers', which are more wide-ranging and graze over vast areas. Schools of foragers such as surgeonfish (*Acanthurus* spp.) are commonly seen at Coral Bay, picking over the algae and generally keeping it in low densities, in doing so maintaining the overall health of the reef. If these foraging fish are removed from the system, the reef can often be overgrown by the competitively superior algae, resulting in what is known as a 'phase-shift' to an algal-dominated system. Once this happens, returning the reef to a healthier, coral-dominated system can

take years, and can only occur if all components of the reef ecosystem are restored to their optimum. However, in the eyes of our farming damselfish, these foragers are all potential poachers. Thus, of greatest impact on the damsel's gardening success is its aggressive defence of its territory, the behaviour that first attracted our attention. By keeping out other herbivorous fish, the damsel not only reserves its garden for its sole use, it increases grazing intensity in other areas. When damsels leave their territories, for whatever reason, the roving grazers take full advantage and quickly decimate the carefully nurtured garden. Studies have shown that the algal biomass (the 'weight' of living algal material) is generally greater within territories than in adjacent areas. The degree varies considerably; in some cases only slight increases occur, but in others an almost 30-fold increase in biomass has been recorded. In experiments where damsels have been removed from their territories, the foraging fish quickly consume the carefully nurtured crop.

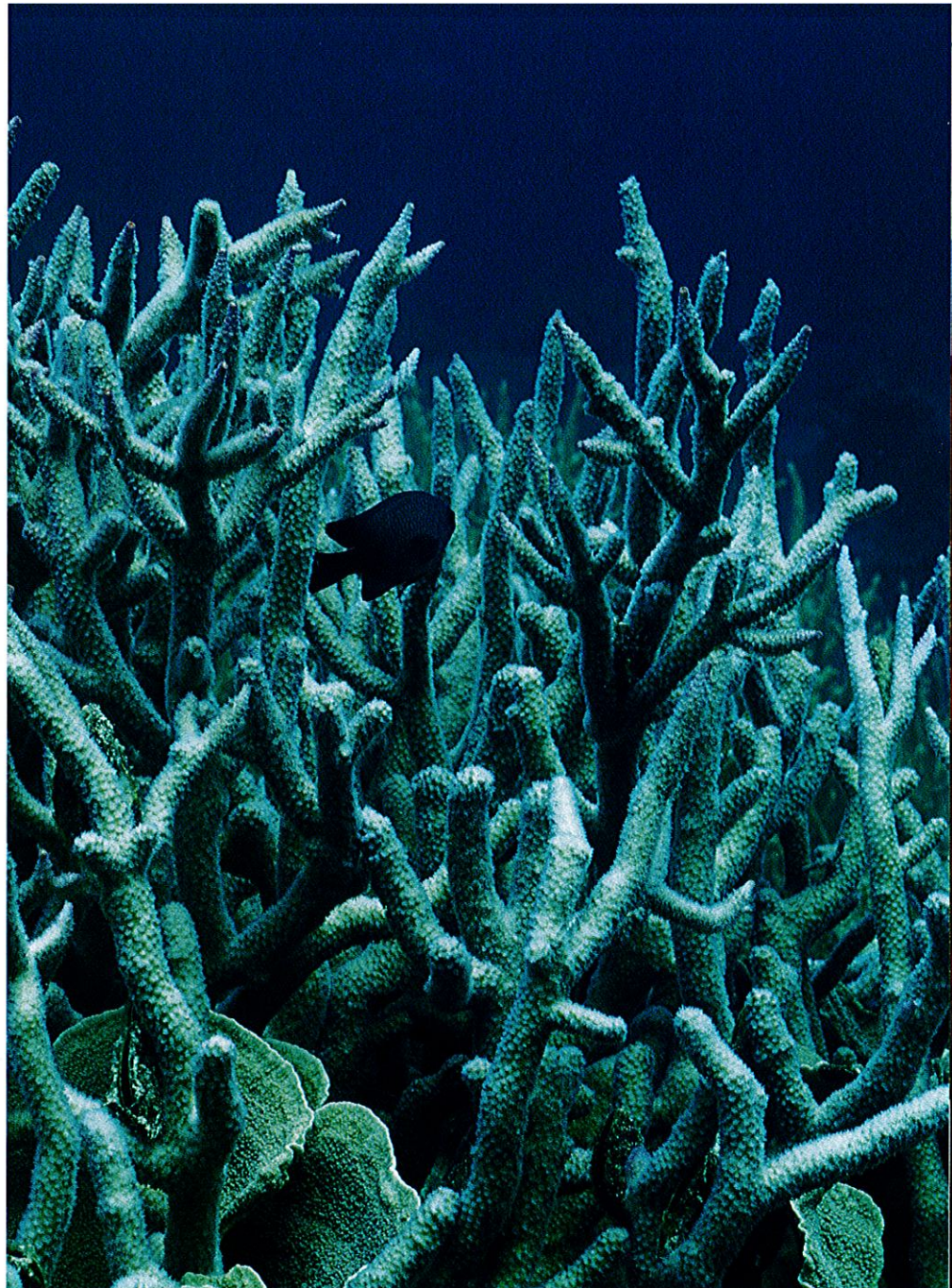
The impact of farming damselfish on the reef ecosystem varies considerably, but they can significantly alter their

Right Staghorn coral is a preferred territory for farming damselfish at Coral Bay.
Photo - Jiri Lochman

habitat. Studies in Brazil have recorded damselfish territories occupying up to 70 per cent of the available space. In French Polynesia, the dusky gregory can form groups of up to 80 individuals with adjoining territories, covering an area many metres in diameter. Preliminary research by Department of Environment and Conservation scientists at Coral Bay has shown farming damselfish to be appreciably modifying the near-shore ecosystem. At some sites more than 15 territories were observed per 100 square metres. The abundance seemed to be linked to the availability of potential territory, with the preferred abode being among the lower branches of dead staghorn coral (*Acropora* spp.). In locations where the staghorn was growing in a more horizontal, crowded form with little space between branches, the damsels established territories between the sheets of plate-forming corals such as *Montipora* spp.

Coral Bay's farmer damsels

As well as the honeyhead damsel, which often has a pale colour, sometimes with a blue patch at the base of the pectoral fin, there are several other species at Coral Bay that establish garden territories, including the bluntsnout gregory (*Stegastes punctatus*), dusky gregory, and jewel damsel. The former is rather variable in colour, but can be distinguished by its body shape and (you guessed it) blunt snout. The dusky gregory can generally be recognised by a dark patch at the base of the last dorsal fin ray, but it is also variable in colour and males guarding nests with a markedly different colour with distinct black and white segments. The jewel damsel is a fairly nondescript dark grey, but can be distinguished by the several bright blue spots on the body. These various species of farmer damselfish do not appear to be actively weeding and their gardens comprise several different species of algae. They are all relatively small turf species, however, and based on this feature observant

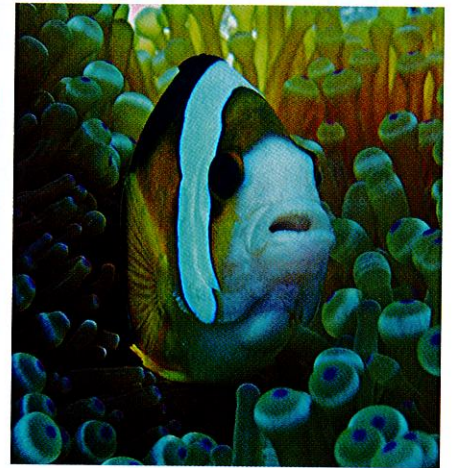
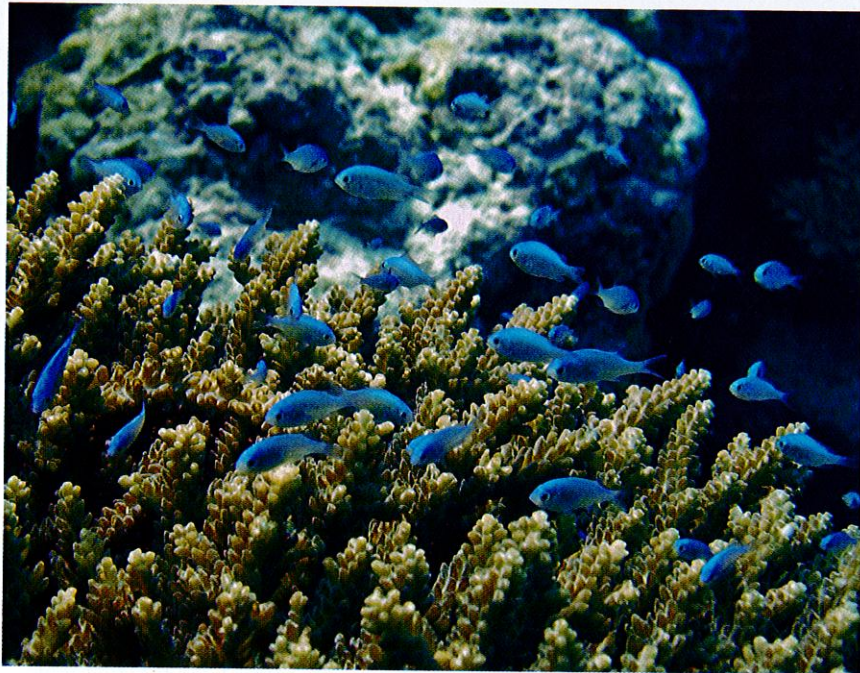


snorkellers can often recognise a damselfish territory well before the caretaker fish is seen.

Some things are more important ...

Being a blustery, aggressive fish is all well and good when defending your garden resource, but what about when the time comes, as it always will, when the urge to become a parent kicks in? The spawning behaviour of the dusky gregory has been well documented. This species tends to live in colonies, with both sexes maintaining turf gardens and defending them vigorously, but when the time is right the female will visit the male's territory and deposit its eggs, which the male will fertilise and then guard until they hatch. These liaisons usually

occur at dawn, and can come at some cost: the female must leave its territory exposed to visits by other herbivorous fish, which can then sneak in and steal the carefully tended crop. For this reason the females tend to stay within the damselfish colony, do not venture far from their home territory, and will repeatedly return to fend off intruders. If they are required to travel some distance, to another colony for example, they will generally deposit all their eggs in one batch. Once the eggs are safely deposited and fertilised, the male fish must then defend both its garden and the nest of its potential offspring. In the dusky gregory, this can be accompanied by the male assuming a different colouration, changing from a rather drab grey to a more dramatic black and white pattern.



While also types of damselfish, pink anemone fish (top), blue chromis (left) and clown fish (above) do not practise seaweed farming.

Photos - Eva Boogaard/Lochman Transparencies (top), John Huisman/DEC (left and above)

Close relatives

Turf gardening is practised by only a handful of damselfish species. The group also includes numerous others with different, but equally bizarre, behaviours. Perhaps the most well known are the clownfish (*Amphiprion* spp.), which establish their homes among the stinging tentacles of anemones. They are protected from the anemone's lethal sting by a mucous coating on their skin, although the fish does require a period of acclimation in which it carefully touches the anemone with various parts of its body. Other damselfish such as the blue chromis (*Chromis viridis*) travel in large schools

and are one of the most common species on coral reefs, including those at Coral Bay. When disturbed, these fish will seek the protection of a nearby staghorn coral, its hard skeleton preventing the intrusion of larger fish.

From the farming dusky gregory, the anemone-loving clownfish, to the schooling blue chromis, the damselfish of WA's coral reefs are a beguiling bunch. When next you get the opportunity, spend some quiet time observing their unique behaviours and you will not be disappointed. Best to avoid, however, the honeyhead damsel, who will no doubt let you know when you have crossed the line. You have been warned!

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