A tropical cleaner wrasse finds new clients at the frontier

The cleaner wrasse, *Labroides dimidiatus*, is a highly specialized reef fish that removes and consumes ectoparasites, and occasionally dead tissues, from the bodies of other fishes – which we call "clients" (Figure 1; Grutter 2004; Grutter and Irving 2007). This species is the most widespread of all obligate cleaners, occurring from Africa to French Polynesia, but it has historically remained largely confined to the tropics. Although it cleans over 100 different fish species on the Great Barrier Reef (Bansemer *et al.* 2002), 99% of the food items it consumes are ectoparasitic crustaceans (gnathiid isopods; Grutter and Irving 2007), so this wrasse apparently has a very specific diet.

Individuals of *L. dimidiatus* in eastern Australia have been observed as far south as Narooma, New South Wales (36°S; Booth *et al.* 2007) even though the southernmost established population of this species is located in the Solitary Islands (30°S; Figure 2). The Solitary Islands are in a tropical–temperate transition zone that forms the southernmost range limit for several tropical species and the northernmost limit of distribution for a number of temperate species (Malcolm *et al.* 2010).

It is not clear, however, if the inability of *L. dimidiatus* to establish resident populations at latitudes above 30°S is due to a lack of their customary tropical clients, an absence of food sources, thermal intolerance to low water temperatures during austral winter, or all three of these factors. During two field trips to the Solitary Islands (in March 2013 and December 2014) intended primarily to study coral assemblage, we observed and photographed cleaning interactions between the cleaner wrasse and six other fish species that range broadly into temperate southeastern (SE) Australian waters at latitudes above 30°S (Figure 1; WebTable 1; WebFigure 1). Our observations suggest that the cleaner wrasse's array of potential clients is broader than previously thought. This generality in client choice may enable cleaner wrasse populations to permanently establish themselves in latitudes that are currently too cold but that may become thermally tolerable as a result of global climate change.

Typically, the cleaner wrasse uses a unique behavior called "tactile stimulation", which involves physically "massaging" the client with its pelvic fins and body to reduce conflict (Grutter 2004). Its behavior toward predator species in particular is very specific, presumably because of the possibly fatal consequences of failing to pacify the client before beginning the cleaning process. In general, clients will pose for the cleaner, assuming postures that signal their interest in being cleaned and allowing the wrasse to approach and access their bodies (Grutter 2004). Importantly, cleaner fishes are visually recognized by clients by their color and pattern (Cheney *et al.* 2009). We would therefore expect the population establishment of cleaner wrasse to depend on the presence of their usual client species and food source. But our observations – of *L. dimidiatus* feeding on previously unrecognized client species that occur widely outside its normal tropical range – suggest otherwise.

If the set of clients that *L. dimidiatus* cleans is composed exclusively of the primarily tropical species that have coevolved with it on coral reefs, then the lack of feeding opportunities should constrain the wrasse from expanding its range to temperate reefs. Alternatively, if *L. dimidiatus* is capable of cleaning additional species in the temperate zone, we would expect low winter temperatures to be the main factor preventing its establishment in colder waters. However, a comprehensive list of *L. dimidiatus* clients in the southwestern Pacific is available only for tropical coral reef areas (Bansemer *et al.* 2002), and there have

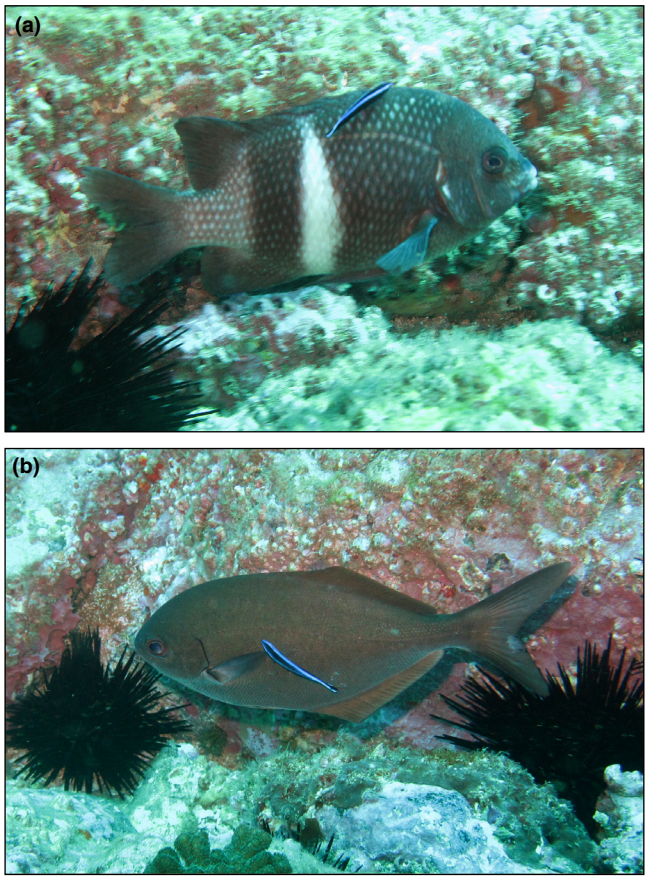

Figure 1. *Cleaning events between* Labroides dimidiatus *and two temperate species: (a)* Parma unifasciata *and (b)* Scorpis lineolata *in the Solitary Islands Marine Park, southeastern Australia.*

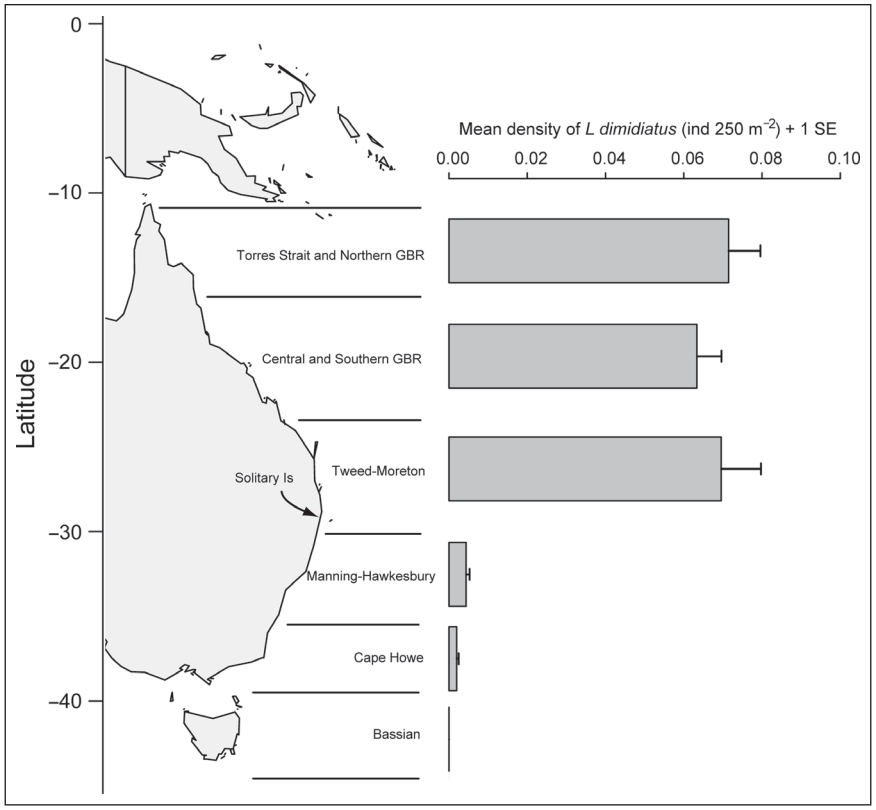

Figure 2. *Densities of* Labroides dimidiatus *estimated by visual transects across six ecoregions in eastern Australia. Data from Edgar and Stuart-Smith (2014). GBR = Great Barrier Reef; SE = standard error.*

been no reports to date on which species from temperate SE Australia it cleans, if any.

Whether the response of clients to the cleaners' visual signals is instinctual or learned also remains unclear (Losey *et al.* 1995). Given that the temperate client species are relatively common in these and poleward areas, our findings suggest that, rather than lack of clients, the cleaner wrasse's incapacity to cope with cold winters or low densities of ectoparasites in cold waters (Smit and Davies 2004) are the most likely causes of this species' rarity in the temperate zone. To better understand whether and how this wrasse and similar species can expand or otherwise adjust their ranges in response to climate change, we need more observations of these species associating with novel clients outside their normal range, studies on the dynamics of gnathiid populations in temperate reefs, and experiments investigating the thermal tolerances of both the cleaner wrasse and its prey.

Climate-change-induced range shifts among dietary specialists are likely to be limited by their specific resource requirements (Feary *et al.* 2014). However, despite its behavioral specialization, the apparent ability of the cleaner wrasse to interact with new clients at the margins of its range makes it a strong candidate for poleward expansion into the temperate SE Australian coastal zone if the current ocean warming trend continues (Poloczanska *et al.* 2007).

There are important ecological implications of a shift in this species' geographic range. The removal of cleaner wrasse from experimental coral reefs increases the abundance of gnathiid isopods on client fish approximately fourfold (Grutter and Irving 2007) and decreases the abundance and diversity of resident and visiting fishes (Grutter 2012). The cleaner wrasse is therefore important to the functioning of tropical marine ecosystems, and could potentially have similar effects if its range shifts to include more temperate waters.

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Supporting Information

References and additional web-only materials may be found in the online version of this article at http://onlinelibrary.wiley.com/doi/10.1002/fee.1232/suppinfo

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