

Coral mutualists enhance fish abundance and diversity through a morphology-mediated facilitation cascade

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ABSTRACT: Taxa that alter the morphology of foundation species have the potential to indirectly affect organisms that use the foundation species for habitat. On tropical reefs, coral morphology can be altered by epibiotic symbionts, potentially affecting fish populations that use coral as refuge. In the lagoons of Moorea, French Polynesia, mutualistic gammarid amphipods and chaetopterid polychaetes induce the growth of branch-like 'fingers' on corals of the genus *Montipora*. I tested whether these fingers create habitat for reef fish, and found that juvenile and adult fish sheltered and larvae settled among fingers on both natural and experimental reefs. While the habitat structure induced by the mutualists appears to be of lower quality than that provided by branching corals such as *Pocillopora* sp., the presence of these structures in areas of the reef devoid of branching corals likely means that mutualist-induced structures increase the abundance and diversity of reef fish at the landscape scale.

KEY WORDS: Trait-mediated indirect interaction · Facilitation cascade · Habitat complexity · Mutualism · Coral morphology · Fish recruitment · *Montipora* · Gammarid amphipod

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INTRODUCTION

Species that create biogenic structure or alter the physical environment can facilitate other organisms in the environment by creating habitat (Bertness & Callaway 1994, Jones et al. 1994, Stachowicz 2001). Such foundation species or ecosystem engineers give rise to important indirect interactions (Wootton 1994, Menge 1995), including facilitation cascades that can alter abundance, diversity, and productivity of organisms within their community (Altieri et al. 2007, Thomsen et al. 2010).

The effects of habitat-forming species arise from the physical structure they provide, and the degree of facilitation can relate to the habitat complexity that they generate (Jones et al. 1997, Bruno & Bertness 2001). Community structure is therefore

directly linked to the behavioral and physical traits of individuals of these species; changes in the properties of their traits can influence the strength of the positive interactions they form (Gribben et al. 2009, Irving & Bertness 2009). This creates potential for trait-mediated indirect interactions to structure communities; for example, Gribben et al. (2009) showed that behavior-mediated interactions among habitat-forming plants and mussels controlled species richness in a soft-bottom marine community. Because many important habitat-forming species are morphologically plastic (e.g. Callaway et al. 2003, Todd 2008), morphology-mediated indirect interactions are also likely to be ecologically important, but the effects of induced morphological traits on community processes are largely unexplored.

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I sought to demonstrate how the morphological response of a foundation species to an epibiotic mutualist affects species diversity and abundance. On tropical reefs, coral growth and morphology drive the local diversity and abundance of reef-associated species (Kohn 1983, Vytopil & Willis 2001, Holbrook et al. 2002). Many reef fish shelter within corals at various life stages. For example, many newly settling larvae, which are particularly vulnerable to predation, settle to corals with high structural complexity (Ohman et al. 1998, Nakamura et al. 2009). Reef fish demographics are therefore closely coupled to coral habitat; fish recruitment and abundance are limited by habitat availability (Holbrook et al. 2000, 2008, Schmitt & Holbrook 2000), and increase with habitat complexity (Gladfelter & Gladfelter 1978, Holbrook & Schmitt 2002). Factors increasing the availability and complexity of coral structure may enhance reef fish populations.

Symbiotic organisms can change growth patterns and alter the physical structure of corals (Abelson et al. 1991, Liu & Hsieh 2000, Wielgus et al. 2002). Mutualistic gammarid amphipods and chaetopterid polychaetes, for example, induce the growth of long, finger-like coral projections ('fingers') on colonies of *Montipora* in Moorea, French Polynesia (Bergsma 2009; Fig. 1). The presence of this induced biogenic structure enhances coral growth and survival (Bergsma & Martinez 2011). The fingers also add significant 3-dimensional structure to the reef; Bergsma (2009) estimated that ~2400 cm³ of space is created between fingers for each 1000 cm² of coral basal area on fingered colonies. If fingers provide shelter to fish, then the coral mutualists may indirectly increase reef fish populations by augmenting refuge space and increasing habitat area across the lagoons. In this study, I tested whether fish utilize fingered *Montipora* as refuge from predation and as settlement habitat, and sought to understand how the presence of coral symbionts might impact reef fish abundance and diversity across lagoons.

MATERIALS AND METHODS

Collection and study sites

I conducted laboratory experiments at the UC Berkeley Gump South Pacific Research Station and field activities along the north shore of Moorea, French Polynesia. A barrier reef encloses lagoons ranging 0.8 to 1.3 km in width that comprise reef flats, channels, and fringe reefs (for detailed descriptions of the lagoons see Galzin & Pointier 1985). Reef flats ranged from 2 to 6 m in depth and consisted of areas with continuous coral cover, patch reefs interspersed with coral rubble and sand, and large sand flats.

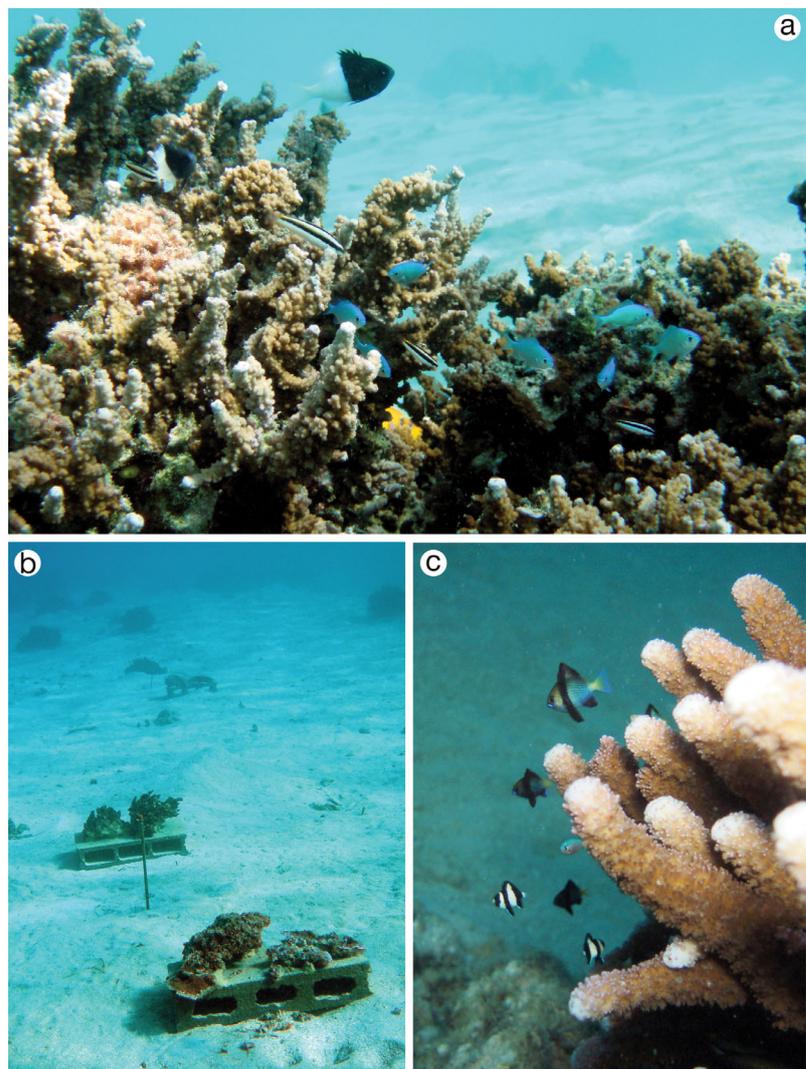


Fig. 1. (a) Juvenile reef fish sheltering among *Montipora* fingers, (b) experimental reefs placed within a sand flat, and (c) newly settled damselfish on an experimental reef with fingers

Surveys documenting the use of fingers by reef fish were conducted in continuous reef, patch reef, and sand flat habitats in 6 of the lagoons: Ahuru (17° 29' 55" S, 149° 55' 10" W), Tiahura (17° 29' 21" S, 149° 54' 0" W), Vaipahu (17° 28' 49" S, 149° 50' 12" W), Maharepa (17° 28' 57" S, 149° 49' 42" W), Teharoa (17° 28' 27" S, 149° 47' 12" W), and Temae (17° 29' 59" S, 149° 45' 27" W). *Montipora* colonies used for artificial reefs in the fish settlement experiment were collected in the Vaipahu lagoon and deployed at the eastern edge of the lagoon, near the opening of Cook's Bay (17° 28' 55" S, 149° 49' 31" W). Coral colonies and juvenile bluegreen chromis *Chromis viridis* were collected for the refuge quality experiment from the Vaipahu and Teharoa lagoons, and spotfin squirrelfish *Neoniphon sammara* were collected from the fringe reef adjacent to the research station (17° 29' 27" S, 149° 49' 34" W).

Study species

Tube-dwelling amphipods (*Gammaropsis* sp.) and polychaetes (*Spiochaetopterus* sp.) induce the formation of branch-like fingers on *Montipora* spp. corals (Bergsma 2009). *Montipora* is typically encrusting or plating, but the symbionts alter the colonies morphology by forming tubes that are encrusted by the coral. Colonies with fingers resemble branching corals in morphology, and are ubiquitous throughout Moorea's northern lagoons where *Montipora* is one of the dominant coral genera (Bergsma 2009).

Species of the genus *Montipora* are difficult to distinguish and have poorly resolved taxonomy, so all corals were treated at the generic level (see Bergsma 2009 for a list of *Montipora* species that may associate with finger-forming symbionts). However, I attempted to use a single morphospecies (possibly *M. aequituberculata*) for experiments. The fingers formed by the amphipods and polychaete worms are similar in shape and size and may co-occur on the same colonies, so I did not distinguish among symbiont species when selecting corals for this study.

At least 37 fishes belonging to 18 families were observed sheltering on *Montipora* (Appendix 1). Of these, the Pomacentridae were most abundant and speciose, followed by the Apogonidae, Labridae, Holocentridae, Acanthuridae, and Chaetodontidae. Most fish were resident juveniles that sheltered among the fingers. The pomacentrids, apogonids, and holocentrids likely use the finger structures

throughout their lives, and were commonly observed occupying the coral as both juveniles and adults. The labrids, acanthurids, and chaetodontids, however, were mostly observed using fingers as juveniles. They do not appear to reside in *Montipora* as adults, although transient adults sometimes took refuge among fingers when divers approached. The few fish encountered on *Montipora* without fingers were mostly pairs of adult pomacentrids that appeared to be defending ledges formed by coral plates presumably used as nesting sites.

Species that were difficult to distinguish were only identified to family. The gobies (Gobiidae) proved especially difficult to quantify because of their cryptic habits and the difficulty in separating those that were residing on the substratum beneath ledges formed by fingers from those that actually used fingers for shelter, and so were excluded from analysis. Fish that use large holes and crevices within or under corals (e.g. Balistidae, Muraenidae, Serranidae) were only included when the fingers composed a major part of the structure in which they were sheltering.

Fish settlement on experimental reefs

I tested the effects of fingers on fish settlement and habitation using a field experiment. I selected *Montipora* colonies from the lagoon and categorized their morphology as 'fingered' for encrusting colonies covered with mutualist-induced structures >2 cm in length, or 'flat' for encrusting or plating colonies with no fingers. Corals were then brought to the study site, a large sandy slope with low coral cover ranging 1 to 6 m in depth.

At the study site, I attached corals to cement blocks using marine epoxy to form small artificial reefs ranging from 600 to 800 cm² in coral basal area. Reefs consisted of either fingered or flat colonies. Fingered reefs were paired with flat reefs of similar coral basal area and distributed in pairs spaced 6 m apart across the slope at 3 m depth (e.g. Fig. 1). Reefs within each pair were spaced 2 m apart and at least 4 m from natural corals, isolating them so that divers could unambiguously determine which fish associated with each reef. In total, 34 reefs (17 pairs) were used in the study.

At the beginning of the experiment, divers cleared the reefs of fish using hand nets. The reefs were first surveyed 2 wk after clearing, and then monitored every 2 to 3 d for 2 wk. For each survey, all fish residing within or hovering above the experimental reefs

were identified, categorized as new settlers, juveniles, or adults, and counted.

I tested for differences in the abundance and species richness of juvenile and adult fish between reefs with and without fingers using repeated measures analyses of variance (ANOVAs), with modeling time and morphology as fixed effects and reef pair as a random effect. Near the end of the experiment, a pulse of larval fish settled on the reefs, allowing a test of the effects of the morphology on fish settlement. Due to the small number of newly settled fish and high variance among reefs, I used a Fisher's sign test to detect differences among reefs in the abundance and species richness of settlers.

Patterns of fish occurrence in *Montipora*

I surveyed for fish using fingers as refuge at 18 sites in continuous reef, patch reef, and sand flat habitats throughout the northern lagoons. I selected *Montipora* colonies with fingers (defined as colonies with at least 2 mutualist-induced structures >2 cm in length) using haphazardly placed band transects. In continuous and patch reef habitats, I surveyed all fingered *Montipora* colonies found within 25 m long and 2 m wide band transects. To survey similar numbers of corals in sand patch habitats, I used 25 m long and 10 m wide transects. I measured the diameter of each colony along its major and minor axis, and the distance to the nearest branching coral (including *Acropora* spp., *Pocillopora* spp., and *Porites rus*, but excluding other *Montipora* with fingers). All fish found hiding among the fingers were identified and counted.

Colony diameter measurements were used to calculate the individual density and species density of fish inhabiting each coral by estimating the basal area of colonies as an ellipse. A 1-way ANOVA, with a post hoc Tukey test, tested for differences in density of fish and of species among habitats. To further explore fish-habitat relationships in sand flats, I performed a multiple regression to test the effects of colony area and distance from the nearest branching coral on fish abundance.

Quality of coral structure as refuge

I conducted laboratory experiments to test for differences among corals in refuge quality for juvenile fish. Small colonies of *Pocillopora verrucosa* and fingered and flat *Montipora* sp., ranging in size from 12

to 20 cm in maximum diameter, were collected from the lagoon and placed individually in 60 × 30 × 30 cm acrylic aquaria maintained with continuously flowing sea water in a covered outdoor laboratory. For each trial, 10 randomly selected juvenile bluegreen chromis *Chromis viridis* were introduced into each aquarium and acclimated for ~15 min to allow the fish to shelter within the coral. Individuals of the spotfin squirrelfish *Neoniphon sammara*, a common piscivore, were then placed in each tank and left for 24 h. At the end of the trial, the coral and fish were removed from the tank, and the number of surviving chromis was counted.

New chromis were used for each trial. I employed a repeated measures design where each individual predator was used in trials with all 3 coral types. In total, 18 squirrelfish were used, and to refine estimates for individual squirrelfish, I used each predator in 4 trials with each type of coral (for a total of 12 measures per predator). Trials were conducted consecutively for each predator; following each trial, predators were immediately placed into a new trial. The predators continued to eat through all trials, and there did not appear to be any trends in the number of prey consumed over time for individual predators for a given coral type. The order in which different corals were paired with each predator was randomized to account for behavioral conditioning of predators to certain coral types. I tested for differences in the mean number of fish remaining among coral types using a mixed-effect linear model. I included squirrelfish as a random effect in the model to account for repeated measures of each individual, and tested for pairwise differences between coral types using a post hoc Tukey test on the estimated least squares means derived from the model.

Quantification of lagoon habitats

Preliminary observations indicated differences in the use of *Montipora* by fish among different lagoon habitats and that the lagoon-scale effects of the finger structures might be tied to the spatial distribution of habitats within the lagoon. Therefore, I determined the spatial arrangement of habitats and the percent of the northern lagoons that were sand flats using satellite imagery from Google Earth™. The images show topographical features of the shallow benthos, and were used to differentiate sand flats from patch and contiguous reef habitats. I imported images of lagoons into ImageJ image analysis software (Rasband 2005), and used the

pixel area of polygons encompassing entire lagoons and areas identified as sand flats to calculate the percent of each lagoon composed of sand flats. I defined lagoons as reef flats and backreef areas between reef passes, extending from the reef crest to either shore or deep water (i.e. the benthos was not visible in the satellite images); I excluded bays, deep-water channels, and fringe reefs that were separated from the reef flat by deep-water channels from the estimates.

RESULTS

Fish settlement on experimental reefs

The field experiments showed that morphology had a significant effect on the number of individual fish present ($F_{1,16} = 33.21$, $p < 0.0001$), with fingered reefs harboring 4 to 6 times more fish during the experiment (Fig. 2a). The corals did not saturate with fish over the course of the experi-

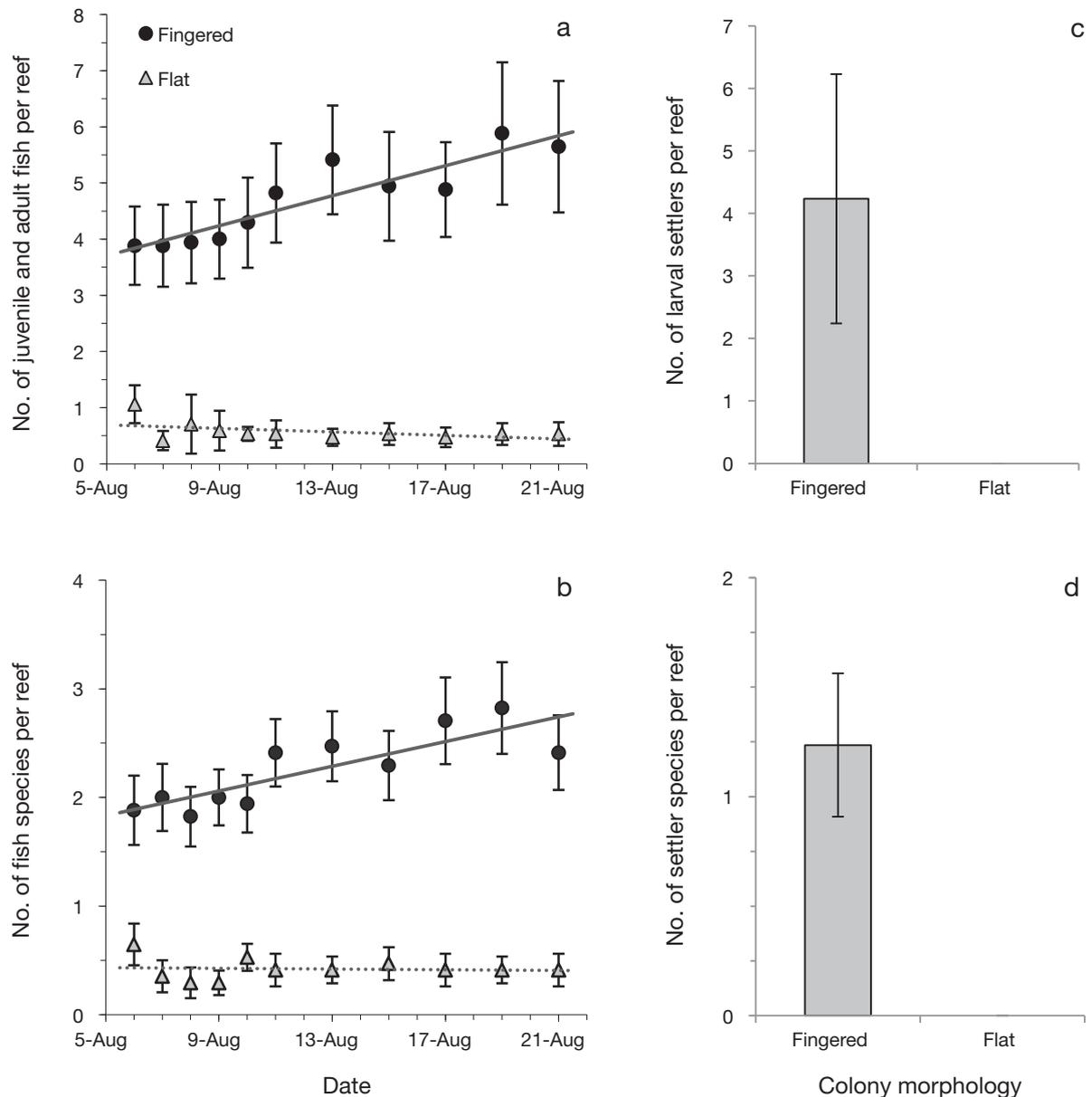


Fig. 2. (a) Number of juvenile and adult fish and (b) number of fish species inhabiting outplanted reefs with either fingered or flat colonies of *Montipora* during the last 2 wk of the 4 experimental weeks. (c) Number of newly settled fish and (d) number of species of new settlers inhabiting outplanted reefs with either fingered or flat colonies of *Montipora* following a pulse of settlement to the lagoon. All means \pm SE

ment, and a non-crossing interaction between fish abundance and time arose from fingered reefs accruing fish at a greater rate than flat reefs (Time \times Morphology: $F_{1,356} = 18.08$, $p < 0.0001$). Reef morphology similarly had a significant effect on species richness ($F_{1,16} = 46.71$, $p < 0.0001$), with fingered reefs having 2 to 3 times more species than flat reefs (Fig. 2b). Again, fingered reefs gained species at a greater rate than flat reefs (Time \times Morphology: $F_{1,356} = 21.00$, $p < 0.0001$).

Reefs with fingers also had a significantly greater number (Fisher binary test: $B_{F, n=11} = 11$, $p = 0.001$; Fig. 2c) and more species ($B_{F, n=11} = 11$, $p = 0.001$; Fig. 2d) of new settlers than those without. No new settlers were seen on flat corals, indicating either that larvae preferentially settle on fingered *Montipora*, or that they are quickly consumed upon settling on flat *Montipora*.

Patterns of fish occurrence in *Montipora*

Fish density differed among corals in different habitats, with *Montipora* in sand flats harboring $\sim 10\times$ more fish than those in continuous or patch reefs ($F_{2,254} = 65.61$, $p < 0.0001$; Fig. 3a). Species richness similarly differed among habitats, with *Montipora* in sand flats having greater species richness per area than continuous or patch reefs ($F_{2,254} = 105.20$, $p < 0.0001$; Fig. 3b).

Corals in sand flats were almost exclusively *Montipora*, which were larger and more distantly separated from other corals than *Montipora* in continuous or patch reefs. Both colony area ($F_{1,781.18} = 7.8668$, $p = 0.0080$) and distance from the nearest branching coral ($F_{1,454.21} = 4.5741$, $p = 0.0391$) had significant effects on reef fish abundance on colonies within sand flats. The number of fish inhabiting corals increased with increasing size ($F_{1,39} = 18.17$, $p < 0.0001$, $R^2 = 0.32$; Fig. 4a) and increasing distance from other branching corals ($F_{1,39} = 6.64$, $p = 0.0139$, $R^2 = 0.15$; Fig. 4b).

Quality of coral structure as refuge

The laboratory experiment demonstrated that bluegreen chromis survival differed among coral types ($F_{2,32.93} = 48.59$, $p < 0.0001$). Post hoc analysis revealed significant differences among all 3 coral types, with twice as many fish surviving on *Pocillopora* as on fingered *Montipora*, and about twice as many surviving on fingered *Montipora* as on flat

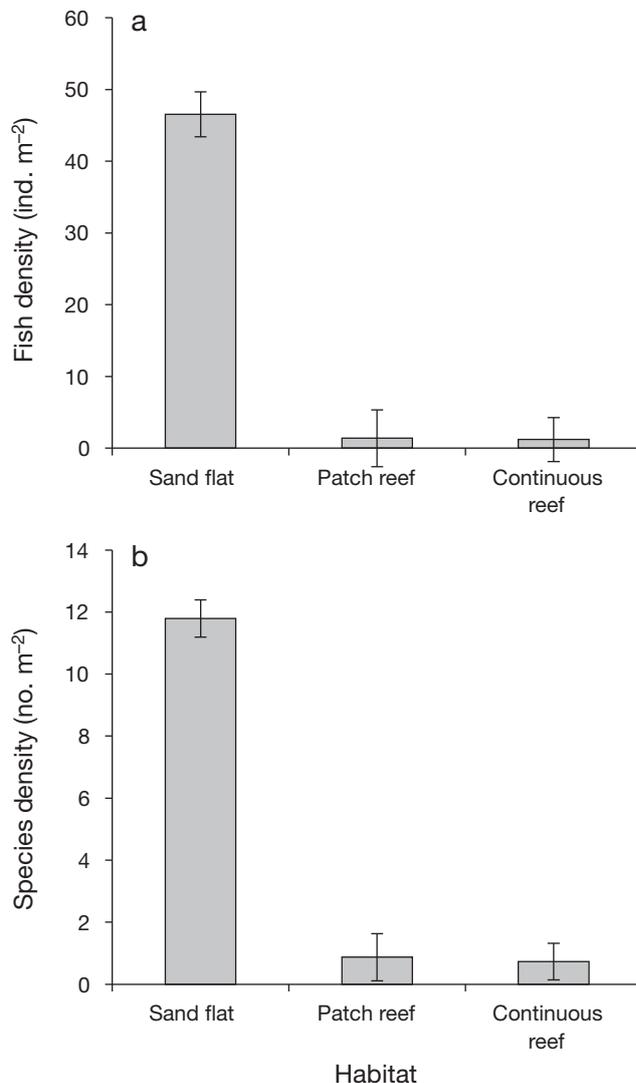


Fig. 3. (a) Number of individual fish per m² of coral and (b) number of fish species per m² of coral found on fingered *Montipora* colonies surveyed in continuous reef (n = 100), patch reef (n = 60), and sand flat (n = 97) habitats in the northern lagoons of Moorea. Means \pm SE

Montipora (Fig. 5). *Pocillopora* therefore represents the highest-quality refuge among the 3 coral types tested, with fingered *Montipora* providing an intermediate level and flat *Montipora* providing the lowest quality refuge.

Quantification of sand flats within the lagoon

Image analysis revealed that sand flats compose $20.02 \pm 2.76\%$ (mean \pm SE) of the northern lagoon's area. Continuous and patch reef areas were generally located on the seaward half of the lagoon,

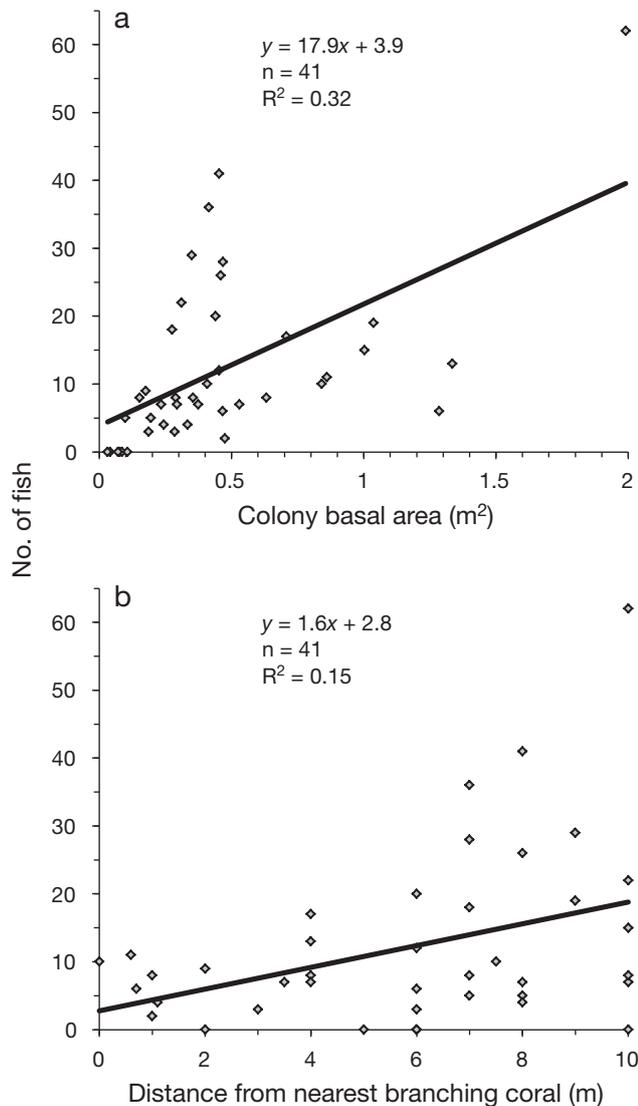


Fig. 4. Linear least-squares fit between the number of reef fish and (a) colony basal area and (b) distance from the nearest branching coral for fingered *Montipora* colonies found in sand flat habitats

whereas sand flats were generally shoreward of continuous and patch reefs and adjacent to deep-water channels (Fig. 6).

DISCUSSION

The results show that *Montipora* colonies with fingers harbor greater numbers and diversity of fish than those without (Fig. 2). This could be due to a number of factors, including the presence of the symbionts as prey, the increased structural complexity induced by the symbionts, or the greater surface area

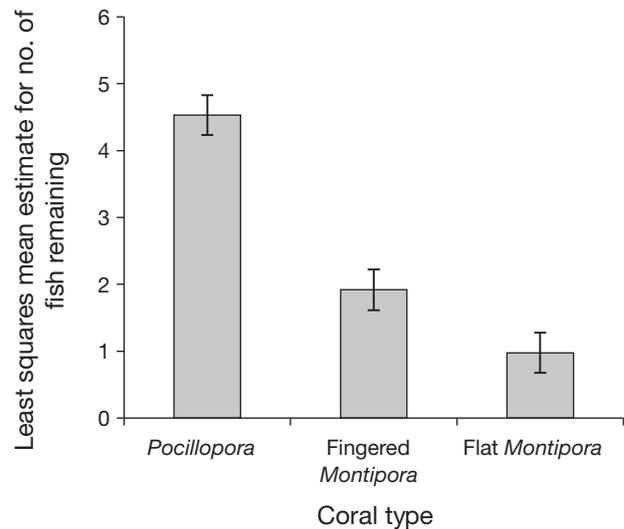


Fig. 5. Least-squares mean estimates (\pm SE) from a mixed effect linear model for the number of juvenile fish remaining on 3 types of coral following exposure to a predator ($n = 216$)

of living coral arising from the induced structure. While fish readily eat amphipods removed from their tubes in the laboratory, Bergsma & Martinez (2011) found no evidence that fish eat symbionts within their tubes in the laboratory or in the field. Furthermore, the damselfish species that were most abundant on fingered *Montipora* are planktivores, and would not likely forage on embedded symbionts. This suggests that the patterns observed are not driven by differences in the availability of symbionts as a food source. Coral surface area is also unlikely to drive the observed patterns. Few of the observed fish were corallivores, and the surveys found numerous instances of fish inhabiting small fingered corals, but few instances of fish inhabiting large flat corals.

Fish abundance and diversity are therefore most likely responding to changes in the structural complexity of coral. This is consistent with numerous previous studies (e.g. Gladfelter & Gladfelter 1978, Chabanet et al. 1997, Holbrook et al. 2002), and might arise through a number of mechanisms. For example, structures can act as physical barriers, attenuating currents and wave force (Kohn & Leviten 1976). The fingered *Montipora* may attract fish because the fingers baffle flow, providing fish refuge from currents and preventing larvae from being swept away. Structural complexity also alters predator-prey dynamics (Huffaker 1958, Connell & Jones 1991), and coral structure provides fish with important refuge from predation (Hixon & Beets 1993, Holbrook & Schmitt 2002). The laboratory experiment found that juvenile fish avoided predation better on *Montipora* with fin-

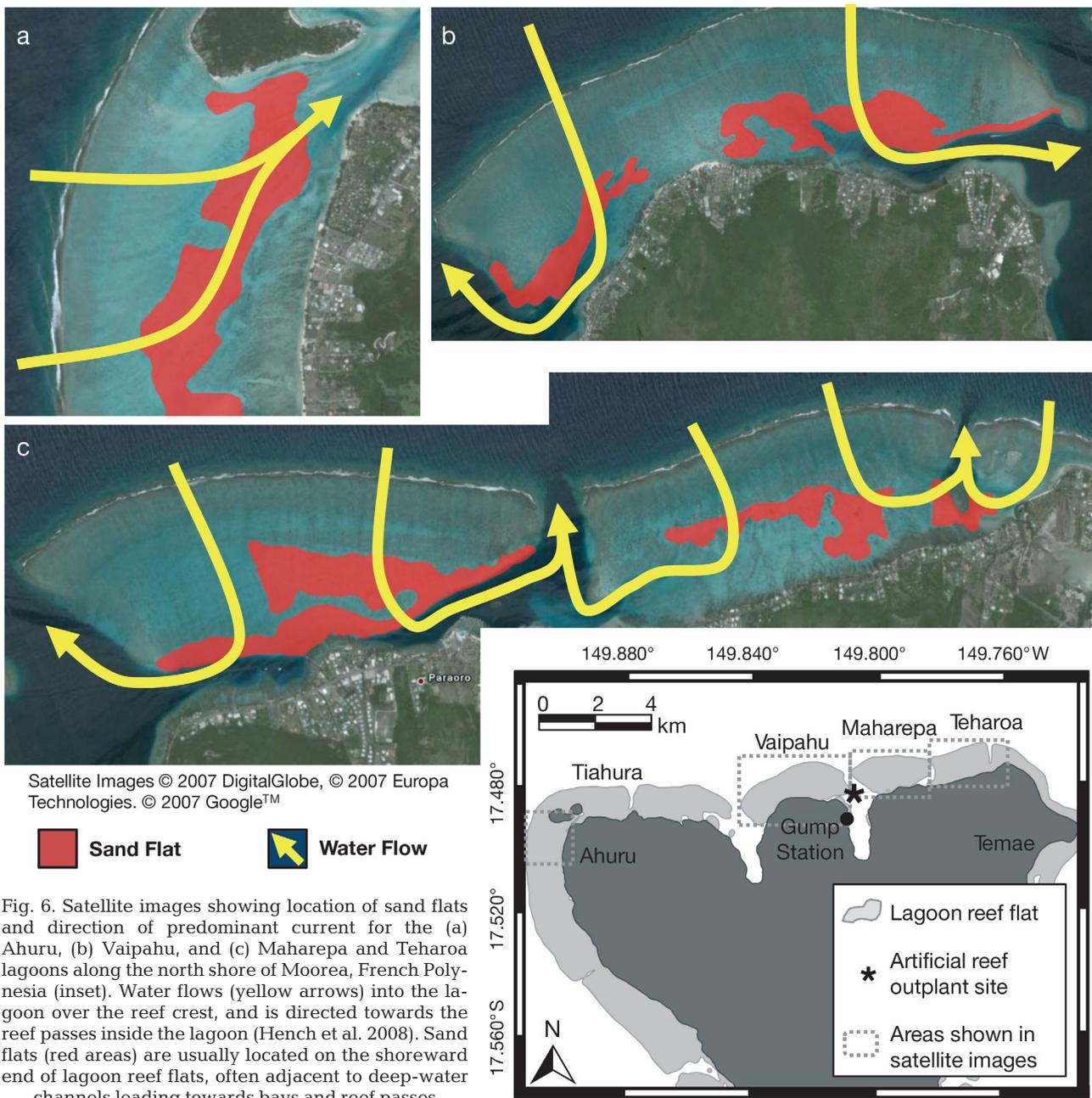


Fig. 6. Satellite images showing location of sand flats and direction of predominant current for the (a) Ahuru, (b) Vaipahu, and (c) Maharepa and Teharaoa lagoons along the north shore of Moorea, French Polynesia (inset). Water flows (yellow arrows) into the lagoon over the reef crest, and is directed towards the reef passes inside the lagoon (Hench et al. 2008). Sand flats (red areas) are usually located on the shoreward end of lagoon reef flats, often adjacent to deep-water channels leading towards bays and reef passes

gers than *Montipora* without fingers (Fig. 5), indicating that fingers improve the habitat characteristics of *Montipora* and increase the amount of refuge space available to fish across the reef. This demonstrates that induced morphological changes in a foundation species can alter the diversity and abundance of organisms the species facilitates. The worms and amphipods are acting as allogenic ecosystem engineers by inducing morphological changes in a habitat-forming species, thereby altering benthic habitat for coral-associated organisms.

While the surveys found fish utilizing fingered *Montipora* across Moorea’s lagoons, interestingly, only big, isolated colonies of fingered *Montipora* in sand flats harbored large numbers of fish (Figs. 3 & 4). *Pocillopora* provided better refuge to fish than *Montipora* in the laboratory (Fig. 5), suggesting that *Montipora* may be lower-quality habitat than true branching corals. This could explain why fish do not utilize *Montipora* in continuous and patch reef habitats where branching corals are abundant. In sand flats, where *Montipora* is dominant, fish density

increased with distance from the nearest branching coral (Fig. 4), indicating that fish might only inhabit *Montipora* when nothing better is readily available.

Despite the lower quality of *Montipora* as habitat, the fingered *Montipora* may augment lagoon fish populations due to the spatial arrangement of the sand flats and current patterns. Current flow across Moorea's lagoons is nearly unidirectional, with waves driving water over the reef crest and across the back reef towards the deep-water channels and bays before exiting the lagoon system through reef passes (Hench et al. 2008). Sand flats are commonly found on the shoreward side of the lagoons, often near deeper channels and bays (Fig. 6). Water velocities reported for the lagoon (Hench et al. 2008) are greater than the swimming speeds reported for late-stage fish larvae (Stobutzki & Bellwood 1997, Leis & Carson-Ewart 2002), so larvae that are competent to settle are likely to be carried along by the current. Fish larvae being swept over the reef have passed over preferred habitats before they encounter sand flats and pass over sand flats just before they are carried into deep-water channels and bays (Fig. 6). *Montipora* in these sand flats could therefore be the last chance for larvae to settle on the reef flat. Additionally, the bays accumulate larvae (Leis et al. 2003) that can increase settlement to sandy areas at the deep water's periphery. *Montipora* in sand flats might therefore act as catchments, collecting fish settlers that would otherwise be lost from the system.

The sand flats also compose a large proportion of the lagoon's area, and the ability of *Montipora* to inhabit these areas substantially increases the amount of coral habitat across the reef flat. Fish recruitment and abundance in Moorea are limited by habitat availability (Holbrook et al. 2000, Schmitt & Holbrook 2000). Additional habitat should therefore enhance reef fish recruitment and abundance, and the structures provided by the fingers in sand flats likely positively impact reef fish populations. Furthermore, the presence of competitively dominant fish on *Pocillopora* greatly suppresses successful settlement and early recruitment (Schmitt & Holbrook 2000, Holbrook et al. 2011). Hence, even though fingered *Montipora* provides poorer refuge habitat than *Pocillopora*, fingered *Montipora* might be important settlement habitat if settlers are competitively excluded from their preferred habitat. Settlers may initially settle to *Montipora* and subsequently move to *Pocillopora* when they are stronger space competitors.

Ultimately, this study suggests that the presence of the epibiotic amphipods and worms serves to

increase coral-associated fish abundance and diversity across the lagoons. Tube-building amphipods and worms are important ecosystem engineers in many temperate, soft-bottom communities (Bell 1985, Rabaut et al. 2007), but their role in creating habitat structure in coral has not been previously recognized. By augmenting settlement and refuge space, the epibiotic mutualists act as keystone facilitators, driving community structure through trait-mediated indirect interactions. Because the mutualists facilitate coral growth and survival through induced morphological changes (Bergsma & Martinez 2011) and the corals with altered morphology facilitate coral-associated reef fish, this is a unique example of a morphology-mediated facilitation cascade (Altieri et al. 2007, Thomsen et al. 2010). Trait-mediated facilitation likely occurs in many ecosystems; mycorrhizal-plant and plant root-root interactions, for example, demonstrate that positive interactions can induce morphological changes in terrestrial foundation species (Hetrick 1991, Haugaard-Nielsen & Jensen 2005, Bais et al. 2006). However, the indirect effects of these changes have not been previously explored, and may be more important in structuring communities than previously thought.

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Appendix 1. Fish taxa that used *Montipora* fingers as habitat

Family	Species	Common name
Acanthuridae	<i>Acanthurus nigrofuscus</i>	Brown surgeonfish
Acanthuridae	<i>Acanthurus triostegus</i>	Convict tang
Acanthuridae	<i>Ctenochaetus striatus</i>	Striped bristletooth
Acanthuridae	<i>Zebrasoma scopas</i>	Brushtail tang
Antennariidae	<i>Antennarius</i>	Frogfish
Apogonidae	<i>Apogon fraenatus</i>	Bridled cardinalfish
Apogonidae	<i>Cheilodipterus quinquelineatus</i>	Fivelined cardinalfish
Balistidae	<i>Balistapus undulatus</i>	Orange-lined triggerfish
Chaetodontidae	<i>Chaetodon citrinellus</i>	Speckled butterflyfish
Chaetodontidae	<i>Chaetodon lunulatus</i>	Oval (redfin) butterflyfish
Chaetodontidae	<i>Chaetodon unimaculatus</i>	Teardrop butterflyfish
Cirrhitidae	<i>Paracirrhites arcatus</i>	Arc-eye hawkfish
Gobiidae		Gobies
Holocentridae	<i>Neoniphon sammara</i>	Spotfin squirrelfish
Holocentridae	<i>Sargocentron melanospilos</i>	Finelined squirrelfish
Labridae	<i>Cheilinus chlorourus</i>	Floral wrasse
Labridae	<i>Halichoeres trimaculatus</i>	Threespot wrasse
Labridae	<i>Pseudocheilinus hexataenia</i>	Sixline wrasse
Labridae	<i>Thalassoma amblycephalum</i>	Blunt-head wrasse
Labridae	<i>Thalassoma hardwicke</i>	Sixbar wrasse
Lethrinidae	<i>Monotaxis grandoculis</i>	Bigeye bream
Mullidae	<i>Mulloidichthys flavolineatus</i>	Yellowstripe goatfish
Muraenidae	<i>Echidna nebulosa</i>	Snowflake moray
Ostraciidae	<i>Ostracion meleagris</i>	Spotted trunkfish
Pomacanthidae	<i>Centropyge flavissima</i>	Lemonpeel angel
Pomacentridae	<i>Chromis iomelas</i>	Half & half chromis
Pomacentridae	<i>Chromis margaritifer</i>	Bicolor chromis
Pomacentridae	<i>Chromis viridis</i>	Bluegreen chromis
Pomacentridae	<i>Dascyllus aruanus</i>	Humbug dascyllus
Pomacentridae	<i>Dascyllus flavicaudus</i>	Yellowtail dascyllus
Pomacentridae	<i>Dascyllus trimaculatus</i>	Threespot dascyllus
Pomacentridae	<i>Pomacentrus pavo</i>	Sapphire damsel
Pomacentridae	<i>Stegastes nigricans</i>	Dusky gregory
Scorpaenidae		Scorpionfish
Serranidae	<i>Cephalopholis argus</i>	Peacock grouper
Serranidae	<i>Epinephelus merra</i>	Honeycomb grouper
Tetradontidae	<i>Canthigaster solandri</i>	Speckled toby

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