Warm and cold water corals as engineers of reef ecosystems
Warm water corals as engineers of reef ecosystems
Definition „ecosystem engineer“

Organisms modulating resource availability by causing physical state changes in biotic or abiotic materials (Jones et al. 1994, Oikos 69)

**autogenic**: creation of habitats
**allogenic**: transformation of organic or inorganic material (Jones et al. 1997, Ecology 78)
How can corals possibly act as engineers of their reef ecosystem?

1) Generate diverse habitats for fauna, flora and microbes (autogenic)

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Schöttner et al. (2009), ISME Journal 3
How can corals possibly act as engineers of their reef ecosystem?

2) Control pelagic-benthic coupling via biogenous sediment generation (allogenic)

Wild et al. 2006, Mar Freshw Res 57
Red Sea fringing reef

<table>
<thead>
<tr>
<th>Sediment</th>
<th>Substrate</th>
<th>C turnover (% h⁻¹)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Carbonate</td>
<td>Clam eggs</td>
<td>1.4</td>
</tr>
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<td>Clam eggs</td>
<td>1.9</td>
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<tr>
<td>Carbonate</td>
<td>Coral mucus</td>
<td>4.8</td>
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<td>Zooxanthellae</td>
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<tr>
<td>Silicate</td>
<td>Clam eggs</td>
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<tr>
<td>Silicate</td>
<td>Coral mucus</td>
<td>0.04</td>
</tr>
</tbody>
</table>

Wild et al. (2005), Mar Ecol Prog Ser 298
How can corals possibly act as engineers of their reef ecosystem?

3) Release of organic matter and resulting particle trapping (allogenic)
Daily mucus production:
1.7 to 4.8 L m⁻²
Total: > 10,000,000 L
Australian platform reef
Australian platform reef
Australian platform reef
Australian platform reef
Australian platform reef
Australian platform reef

Wild et al. (2004), Nature 428
Australian platform reef

Wild et al. (2004), Nature 428

Cycles of coral mucus in reef ecosystems (example Heron Island)

Mucus float

Water column

Undissolved mucus

Mucus with particles

C: 181.8 kmol d⁻¹
N: 17.0 kmol d⁻¹
P: 0.2 kmol d⁻¹

Trapping of suspended particles, loss of phosphorus

Dissolved mucus

Consumption by pelagic fauna and bacteria

Contribution to water oxygen consumption 0.1-2.5%

Soluble mucus release

C: 90.9 kmol d⁻¹
N: 7.6 kmol d⁻¹
P: 1.3 kmol d⁻¹

Insoluble mucus release

C: 27.7 kmol d⁻¹
N: 1.9 kmol d⁻¹
P: 0.3 kmol d⁻¹

Rapid sedimentation

Consumption by benthic fauna and bacteria

15.5% of lagoon water filtered per day

Contribution to sedimentary oxygen consumption 10-20%

Permeable lagoon sediment

Potential nutrient release

N: 18.2 kmol d⁻¹
P: 0.40 kmol d⁻¹

Carbon turnover at least 7% per h
Red Sea fringing reef

Wild et al. (2005), Mar Ecol Prog Ser 298; Mayer & Wild (2010), Mar Freshw Res 61
Red Sea fringing reef

Naumann et al. (2009), Mar Ecol Prog Ser 385
Engineering capacity in response to coral bleaching

Habitat provisioning

Generation of biocatalytical sand filter systems

Release of organic matter and influence on particle trapping

Wild et al. (2011), Mar Freshw Res 62
Reefs are changing through impediment of coral engineers.

Coral dominated

Algae dominated
Climate change → Acidification
Warming → Coral Bleaching

Coral dominated

Algae dominated
Climate change

- Acidification
- Warming

Local factors: e.g. Overfishing, Eutrophication

Coral Bleaching

Coral dominated

Algae dominated
Summary

• Corals act as reef engineers (habitat provisioning, sediment generation, organic matter release & particle trapping)

• Impediment of the engineer strongly affects reef ecosystem functioning
Future KAUST-ZMT collaboration

• Effect of bottom-up versus top-down factors on coral engineering capacity and ecosystem functioning/resilience of local coral reefs

• Organic C and N cycling

• Coral mucus as a trap and collector for genetic and molecular reef diversity