Coral Reef Fishes

I. Introduction to coral reefs
II. Characteristics of coral reef fishes
III. Maintenance of diversity

What is a ‘coral reef’?
• complex structures formed by reef-building corals, algae, mollusks, and sponges
• result from a balance between constructive and destructive processes
• external framework provides habitat, refuge from predators, and food
• distribution is limited by light, temperature, and hard substrate for initial colonization (between 30° N and 30° S latitude)

Physical structure of coral skeletons (cracks and crevices) provides refuge from predators

Distribution
• worldwide in tropical seas
• lower abundance on western margins continents, where upwelling occurs (cooler & murkier)

Diversity of corals and fishes highest in central Indo-Pacific
Reef Zones
• reef flat (& lagoon)
• reef crest
• reef slope

Coral Morphology – variety of colony skeletal structures

Primary Productivity is very high on coral reefs

<table>
<thead>
<tr>
<th>Production (kg Carbon per m² per year)</th>
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<tr>
<td>Average Oceanic areas 0.1 kg</td>
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<tr>
<td>Rainforest 2 kg</td>
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<tr>
<td>Kelp forest 2 kg</td>
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<tr>
<td>Coral Reef 1.5-5 kg</td>
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• ocean waters where coral occur are very nutrient poor (“oligotrophic”)
• high productivity possible because of tight recycling of nutrients, photosynthetic fixation of carbon (by corals and algae) and nitrogen (by blue-green algae)

Dynamics: coral reefs change over time
1. Physical disturbances
   • storms, hurricanes, cyclones (affect fast-growing branching corals most)
   • sedimentation
   • heating (coral bleaching)
2. Biological disturbances
   • disease
   • predation

Summary of coral reef attributes
• high structural complexity provides habitats for fishes
• high productivity provides food
• many different habitat types (e.g., zones)
• dynamic (though not as much as kelp forests!)

II. Coral reef fishes
A. Taxonomy: dominated by perciforms
   • in Micronesia, for example, 51 of 103 Families are Perciforms
   • 17 of the 20 most speciose families Perciforms
B. Morphology (general characteristics):
   Generally:
   • laterally compressed
   • physoclistous swim bladders
   • highly modified jaw and pharyngeal apparatus (provides powerful and efficient feeding mechanisms)
   • pectoral fin locomotion common (MPF rowing)
      but very high morphological diversity (though dominated by families with small species)
C. Diversity: extremely high
   • approximately 1/3rd to 1/2 of all fishes live on coral reefs (i.e., 10,000+ species)
D. Vision especially important (apparent in diversity of coloration)

E. Strong Habitat Associations
- Many species associate with particular features of the reef
- May remain tightly associated with particular site for entire life

F. Life-history characteristics
- Mostly egg layers (oviparous) -- broadcast or demersal spawners
- 95%+ have pelagic larval stage & sedentary adult stage (bipartite life cycle)

Major Families of Coral Reef Fishes
1. The Labroids
   a. Labridae (wrasses)
   b. Scaridae (parrotfishes)

2. Pomacentridae (damselfishes)
3. The Acanthuroids (mostly herbivores)
   a. Acanthuridae (surgeonfishes)

3. The Acanthuroids
   a. Acanthuridae
   b. Siganidae (rabbitfishes) – Indo-Pacific only

3. The Acanthuroids
   a. Acanthuridae
   b. Siganidae
   c. Zanclidae (moorish idol) – Indo-Pacific only

4. The Chaetodontoids
   a. Chaetodontidae (butterflyfishes)

4. The Chaetodontoids
   a. Chaetodontidae
   b. Pomacanthidae (angelfishes)

5. Haemulidae (Grunts)
6. Gobiidae (gobies)

7. Blenniidae (blennies)

8. Synodontidae (lizardfishes)

9. Mullidae (goatfishes)

Nocturnal Families
1. Apogonidae (cardinalfishes)

Nocturnal Families
2. Holocentridae (squirrelfishes)
Nocturnal Families
1. Apogonidae
2. Holocentridae
3. Muraenidae (moray eels)

The highly evolved:
1. Ostraciidae (boxfishes)
2. Tetraodontidae (pufferfishes)
3. Diodontidae (pupkefishes)
4. Balistidae (triggerfish)

The large predators:
1. Serranidae (groupers)
2. Lutjanidae (snappers)
The large predators:
1. Serranidae
2. Lutjanidae
3. Lethrinidae (emperors)
4. Carangidae (jacks)

III. Diversity

What allows so many species to coexist without some being outcompeted?

(e.g., thousands of species on Philippine reefs)

- basic ecological theory: species that share resources should compete and eventually a competitive dominant excludes all other species, causing low species diversity

Hypotheses to explain high diversity:
A. Resource partitioning

- reef fishes have obvious trophic specializations: specialized feeding behavior, territoriality (may be defense of food), and modified mouths

- but is there evidence of current competition?
  - most species have overlapping resource use
  - experimental studies give mixed results

B. Does predation keep fish populations below carrying capacity?

- evidence that predation is potent force affecting reef assemblages:
  - high abundance of piscivores; tremendous losses in many fishes just after settlement
  - defensive structures, colors, & toxins
  - behavioral defenses: schooling, twilight changeover behavior
C. Is settlement of larvae too low to reach carrying capacity (Recruitment limitation hypothesis)

Evidence:
- removal of adults does not increase recruitment rate
- after total removal of adults, can take several years to return to original numbers
- recruitment pulses are sporadic & unrelated to reproductive output

Summary of evidence for mechanisms that allow species coexistence in high diversity coral reef fish communities

Competition may not cause competitive exclusion because...
- species use resources in different ways
- predators keep densities low
- limited return of planktonic larvae to reef keeps densities low