

Fish as Predators

- Predator-prey relations:
 - Predators have to eat (if they don't eat, fitness = 0)
 - Prey die if they are eaten (if they are eaten, fitness = 0)
- Predator-prey "arms race" can drive evolution of form and function
 - In other words, as predators get better at finding/consuming prey, prey must get better at avoiding predators

Predation Cycle-5 parts

- **Searching**
- Pursuing
- Attacking
- Capturing
- Handling

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Searching-Active or Passive

- **Active Searching** (fish swims around, actively searching for food!)
 - **Make use of all senses**
 - Vision (lots of fish), olfaction (sharks), gustation (sharks), hearing (sharks), touch (sturgeon and cod), electroreception (eels, catfish, and knife fish)
 - **Speculation searching** (e.g. chicken scratch)
 - Probe into potential hiding places (e.g. goatfish - pictured)
 - Actively flush prey out via some disturbance (e.g. turning over rocks, etc.)



Searching-Active or Passive

- **Passive Searching** (sit & wait predators!)
 - Buried by sediment (e.g. Synodontids)
 - Projections and color have frequently evolved to match substrates for "camouflage."
 - Passive water column predators just hang in water column.
 - Allow prey to habituate and/or make use of counter shading
 - Most passive predators use **vision** to detect prey (elasmobranchs also use electroreception).



Searching

- **Reaction distance** = Maximum distance at which a prey item can be detected by the predator
 - Affected by water clarity, illumination, size of prey, prey coloration
 - Potential "arms race" b/n predator and prey
 - **Predators** want to increase their reaction distance
 - Better vision
 - **Prey** want to decrease a predator's reaction distance
 - Become smaller (Adaptively or Plastically) and/or become clear (e.g. midge larvae)



Searching-Active or Passive

- **Active vs. Passive Strategies**
 - Passive strategy saves energy, but relies on prey coming to you (hence, a tradeoff!).
 - May be risky to wait for prey, but don't spend energy looking
 - Tradeoff between certainty of prey capture and energy spent catching prey
 - Two different strategies (that are both successful) to solve the same problem (i.e. eating)

Searching Group Foraging

- **Advantages of group foraging:**
 - predators foraging in groups may locate and capture prey more quickly; group foragers tend to have higher growth rates than do solitary searchers
 - Increase in effective search area
 - Rely on others in a **shoal** (= unorganized school) to find prey and react to their feeding behavior
 - It is easier to see a 10cm fish feeding 5 meters away than it is to see 2mm long Daphnia from 5 meters away.
 - Less time on the lookout for predators
- **Tradeoff:** feeding with others increases likelihood of competition.
 - Hence, group foraging only works when prey are abundant and thus not very limiting.
 - Competition increases with group size!



Pursuit-Slow Stalking

- Many of these fish approach prey head on and make use of **disruptive coloration** (disrupts outline)
 - **Split-head color pattern** = a form of disruptive coloration that splits up the outline of the fish's head to fool prey
 - Convergent trait
 - Visually breaks up shape of whole head
 - Prey have delayed recognition of predator



Attack and Capture

- Refers to the moment a predator makes its move to engulf prey
- Predator attacks by overtaking prey with simultaneous mouth extension and suction (if they can, i.e. these are derived traits and capabilities)



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Attack and Capture

- **Fast-start predators** overtake prey
 - Target the prey's center of mass = part of prey that moves the least
- **Benthic, lie-in-wait predators** - great suction capacity
- Some fish swim and passively sieve prey from water (e.g. manta rays).
- Some incapacitate prey during attack and then "capture" (e.g. electric eels)



Attack and Capture

- Predators often separate out individual prey from the prey's shoal or school.
 - Greatly increases success rate of predation
 - Attacks on “stragglers” more likely to be successful



- Some predators mimic shoal members or non-threatening species (e.g. Indo-pacific grouper, one cichlid)

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Attack and Capture

Predators often attack those prey that are different within the shoal (i.e. don't be different, you will be eaten!)

- Produces strong selection for morphological and behavioral uniformity within schooling prey species



Handling

- Handling = Post-capture manipulation
 - Aids in ingestion and digestion
 - Removal of spines, toxic skins, etc.
 - Reducing size of prey (i.e. tearing it apart)
 - **Very important:** maneuver prey to go in head first!
 - allows prey fins to depress, also less chance of escape
 - Use jaw and head movements to maneuver prey
 - Some use the term 'handling' to include digestion

Handling

Prepare prey to swallow--use your teeth!



- Different types of predators have different types of teeth
 - Piscivores = sharp teeth for holding or shredding prey
 - Insectivores = teeth stout and recurved
 - Mollusk feeders = molar like teeth
 - Coral feeders = beak like teeth (e.g. parrotfish)

Other types of “Predation”

- Scavengers and Detritivores
 - Some fish = primarily scavengers or detritivores.



- Most fish make use of these feeding strategies to supplement primary diets (e.g. eating other fish)

Handling

- Gill rakers keep prey from escaping through opercular openings
 - Gill raker spacing related to size of prey (i.e. tighter spacing for smaller prey)
- Final handling in stomach
 - Chemical and mechanical breakdown (via gizzard)

Other types of “Predation”

- **Herbivory** (relatively rare among fish)
 - Only in teleosts (maybe Australian lungfish)
 - Mechanism necessary to breakdown plant material (e.g. gizzard)
 - Feeding is strongly deterred by plant chemical or mechanical defenses
 - Plant material is of low quality, so herbivorous fish have to eat a lot
 - Long guts and low pH



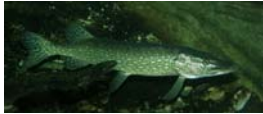
Optimal Foraging

Foraging to maximize benefit, minimize costs

- Evolutionarily, efficient foragers should be favored
 - Efficiency improves fitness
- At least some fish do forage optimally
 - Become less selective as prey availability decreases
- Why don't all fish forage optimally?

Generalist and Specialist Predators

- **Specialists** = Predators that exploit only one resource or use only one type of behavior (e.g. pike only sit-and-wait)



- **Generalists** = Predators that make use of multiple resources and behaviors (e.g. perch sit-and-wait and pursue)

