~~FiW 4614 Fish Ecology Spring 2006~~

Viscera topic
PLA NLS work

Lecture 5: Eating, and avoiding being eaten

I. Introduction
A. Objectives
1. Recognize food-getting as a primary selective pressure in determining
- fitness (survival and reproduction)
- adaptation (physiological, morphological, behavioral)
- diversification (via specialization)

functional

2. Understand evolutionary conflicts between — natural selection is a balancing act
- eating and being eaten
- choices of foods
- choices of eating places, times, methods

II. Eating
A. Evolutionary pressures
1. Obtain energy and nutrition
homeostasis
growth
reproduction
} benefits
2. Avoid/minimize costs
energy expenditure
death!

B. Dimensions of food-getting
1. What, where, how, when; dimensions interact
e.g., adaptations for planktivory not very useful in flowing waters
2. Specialists vs generalists
pros/cons of specialization?
many fishes "what" generalists but "where," "how," "when" specialists
applies to all dimensions, independently

C. What to eat
1. mud, detritus
2. algae
3. vascular plants
4. corals

Multiple ways to categorize what fishes eat; key criteria to distinguish these foods:
a. fish morphology — eg long gut for algae
big mouth for verts
b. food behavior/mobility
coral vs other inverts
c. food nutritional value
detritus vs living plants vs verts

5. other invertebrates ___ Most common among fishes

6. vertebrates (incl. blood)

D. Where to eat — aquatic zones require distinctive feeding adaptations

1. vertical position: surface, pelagic, benthic
   mouth orientation (superior, terminal, inferior)
2. horizontal position: near-shore, off-shore
   more struct. complexity (more spp)
3. standing vs flowing water
   river vs lake
   riffle is pool

E. Major feeding guilds of fishes (how to eat)

1. Predation cycle (behavioral)
   search → pursue (or lure) → capture → handle
   rel. importance of phases varies greatly w/ type of food

overhead (hammerhead)

2. Macro predators
   eat macroscopic animals
   -whole individuals
   large sharp teeth or engulfing mouth
   muscular stomach w/ strong acid
   ambush (pike), stalk (shark), chase (tuna)

3. Grazers
   eat small individ. organisms and/or bites
   small mouth
   eat plants or animals (not necess. both)
   overlap
   Plant-eaters (macrophytes)
   molariform pharyngeal teeth → grinding

4. Filterer/strainers
   eat plankton (animals or plants)
   filter water thru gill rakers
   -do not select individ. items
   usually pelagic
   group includes spp w/ highest pop biomass (clupeids) and largest body size (whale shark)

5. Suckers
   eat microscopic plants and/or animals
   sort particles from bottom (mouth or gill rakers)
   inferior, sucking lips — often w/ barbels
   carp, sturgeon, Plecostomus

6. Parasites
   feed on vertebrate animals larger than self
   - eat blood
   eg. lampreys ~50% parasitic as adults
   -juvs are filter-feeders
   fabled candiru catfish (SA)
   -attaches to fish gills to suck blood
   -reported to sometimes enter human urethras

F. Temporal variation (when to eat)

1. Daily

nearly all fishes exhibit circadian rhythms
- prey availability
- visual adaptations

70% diurnal
20% nocturnal
10% crepuscular

- day/night changeover can be dramatic
- consequences for prey behavior

2. Seasonal

temperature-dependent feeding
low metabolism, feeding rates in winter
hi metabolism but little food in fall

food-dependent feeding
eg. tambaqui in Amazon (1m, 75lb)
adults eat nuts from flooded trees

3. Ontogenetic

dramatic Δs in feeding from fry → adults common
eg parasitic lamprey
Some oceanic larvae (eels, tarpon) absorb nutrients

leptocephali

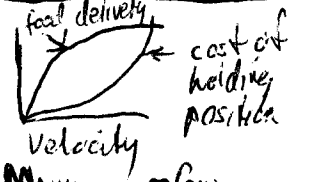
- many fishes feed little during spawning periods
- non-paras. ad. lamprey do not feed

G. Optimal foraging theory

Conceptual framework for understanding feeding choices
- what, where, when to eat

what is optimized? — energy and/or time used OR risk - death, repred. failure

relevant currency depends on supply: max e / min t } How, for example?



H. Feeding-related species radiations

Lake Baikal - Asia
(Tanganyika)
oldest, deepest lake
5000', 20 M yrs
28 cottoids

Lake Lanao - Philippines
10,000 yrs
30 cyprinids in 1 genus
most extinct (introd. pred.)

Great Rift Lakes - Africa
Victoria, Tanganyika, Malawi
↓
500 cichlids
12 major feeding types

III. Avoiding being eaten

A. Goals

Avoid detection, evade pursuit, prevent capture, impair handling, escape

B. Strategies and tactics

1. Hide - avoid & evade

a. School

~50% of fishes school
some obligate
more likely as juvs

confuses predator (too many potential targets)
graded response of school to match risk
- optimize avoidance energy

b. Camouflage

- disruptive coloration (break up outline)
- stripe thru eye
- vegetation mimic

countershading - cancels silhouette
light to make fish disappear

c. Use shade
shaded observer has visual advantage over sunlit observer
scattered light creates "veil" that impairs vision

d. Use cover
provides hiding places
impairs pursuit by predators

2. Look dangerous (prevent capture)
flare fins, gill covers
carnival coloration indicates poison (lionfish)
mimic poisonous fish

3. Be difficult to eat (impair handling)
- spines impair swallowing (sticklebacks, catfishes, triggerfishes)
- deep body
- dermal slime (slippery & distasteful)
- inflate body (pufferfish)

4. Avoid predators
a. The quiet period 10–15 min after sunset/sunrise (reefs & lakes)
diurnal fishes move for feeding to resting stations
nocturnal " " " resting to feeding "

b. Release young in safe place
interstices of substrate
water too shallow for predators
vegetation
guard young
- in mouth (cichlids)
- in habitat (many fishes)

c. Tradeoff: optimal foraging under predation threat
(diverse (predators))
fish often balance risk of predation vs availability of food
e.g. in streams, small fishes prefer pools (slow water)
but shift to riffles (fast, shallow) in presence of lrg fish preds
large fishes avoid shallow water (risk of bird/mammal predation)

IV. Human influences on trophic ecology

1) introduce predators to enhance fishing opportunities
- Nile perch introduced into L. Victoria in 1970s
- led to extinction of 100s of endemic cichlids

4) Fishing commonly targets predators

2) introduce other spp
- alewife & sea lamprey introduced into Great Lakes (NA)
- fundamentally altered plankton, lake trout dynamics

3) introduce nutrients → alter production pathways
more algae, decomposition; less macrophytes, cover