A (Mainly) Problem-Oriented Approach to Foraging

The problem: how to get the food you need to grow, stay healthy, and reproduce?

Stages of predation
• Detection
• Attack
• Capture
• Consumption

For predator: fitness is maximized by traits that ensure that the sequence goes to completion
For prey: fitness is maximized by traits that interrupt sequence (and do so as early as possible)
Detection

Detection actually has three stages:
- Search
- Detect
- Identify as edible

Searching for cryptic prey
- Luuk Tinbergen: noticed that birds seemed to get better at finding cryptic prey
- He suggested they formed a “search image”--a template that allowed them to learn to see the prey (this idea was actually first proposed by von Uexkull)

<table>
<thead>
<tr>
<th>Fraction cryptic prey in environment</th>
<th>Fraction cryptic prey in predator’s diet</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.5</td>
<td>Prey underrepresented when rare in habitat</td>
</tr>
<tr>
<td>1.0</td>
<td>Prey overrepresented when common</td>
</tr>
</tbody>
</table>

Prey intake proportional to abundance
Detection-cont’d

Laboratory tests of Search Images

1. *Can blue jay learn to see cryptic prey as function of encounter rate?*
   - Correct means peck when it is there (“hit”), and don’t peck when it is not (“correct rejection”)
   - Incorrect means peck when it is not there (“false alarm”) or fail to peck when it is (“miss”)

   ![Graph showing success of blue jays pecking at images of 2 different cryptic moth species](image)

   - Each cryptic type presented in runs
   - Two cryptic types intermixed

   Fig 10.2 Alcock
Detection-cont’d

Laboratory tests of Search Imates
2. Second-generation tests: more sophisticated stimuli
Finding widely dispersed or patchy prey: social strategies

- Vertebrate “information centers”: in colonial or roosting species

Social insects: scouts and recruits, with precise communication systems

Fire ant laying odor trail
Detection-cont’d

**Simplifying the search by letting the prey come to you**

- Sit and wait: crypsis helps
- Lures and aggressive mimicry: break into the Umwelt of your prey

*Portia*
Eats other spiders

*Bolas spider:*
Eats male moths
April 1: Foraging: Detection cont’d: ambush and deceit

More on Aggressive mimicry

Flash codes of fireflies: species-specific signals between males and females
April 1: Foraging: Detection cont’d: ambush and deceit

**Detection-cont’d**

“**Femme fatale**”

- *Photuris versicolor* female communicates with males of own species to mate
- Then switches to the flash code of another species to lure in males to eat
Attacking Prey: Decisions, Decisions

Even if predator has detected prey (or lured it to it), an attack may not ensue--the costs of attacking may outweigh the benefits

- Prey may be toxic or lacking key nutrient
Attacking Prey: Decisions, Decisions

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- Even if prey is nontoxic and nutritious, it may be lower in quality than other prey types: thus: decision is how to select prey that will maximize fitness

Prey may vary in profitability based on benefits and costs of obtaining it (simple optimality problem)

Optimal decision depends on how benefits and costs affect fitness

Gain/item: take largest item? 
Gain/time = gain/item \times \text{items/time}

Items/time: take commonest items (i.e. smallest)?
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Evidence of selectivity
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*Prey may vary in payoff depending on what other predators are foraging on (a problem for game theory)*

Spadefoot toad tadpoles
- Fairy shrimp: very nutritious
- Detritus: not so nutritious
- Why ever eat detritus?

Populations seem to stabilize with a certain % of carnivores vs. detritivores
April 1: Foraging: Attack (spadefoot games)

**Spadefoot Games**

Tadpole payoffs depend on what rest of population is eating

Payoff to you for each situation

<table>
<thead>
<tr>
<th></th>
<th>POPULATION EATS:</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Shrimp</td>
</tr>
<tr>
<td>YOU EAT</td>
<td>Detritus</td>
</tr>
</tbody>
</table>

B x r     | B x R
b x R     | b x R

B: intrinsic payoff from a gram of shrimp
b: intrinsic payoff from a gram of detritus (B > b)
R, r: feeding rate depending on what other tadpoles are doing

What if everyone is eating shrimp?
Eat detritus! (if \( r \ll R \))

What if everyone is eating detritus?
Eat shrimp!

Thus, neither extreme strategy is “evolutionarily stable” (either can be invaded by alternative strategy); a mix of strategies is stable
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- Benefit of attacking may be outweighed by risk of predation (on you!)
  - Alcock discusses this under "consumption:" predators may interfere with ability to handle and consume what predator has attacked
  - Here the issue is that the presence of predators may make attacking risky, causing you to be less likely to attack
  - Predation risk may also affect whether you bother foraging at all--it may be safer to hide than to forage
Choosing not to forage at all when foraging would be unsafe (but taking the risk when hungry)

**Bannertail kangaroo rat**
- usually forages at night when moon is below horizon
- when hungry, may forage all night
- when really hungry, may forage during day and night

Alcock Fig. 6.13
Capturing Prey

Overcoming prey defenses:
- Strategy for handling prey must be tailored to that animal’s defenses
- Role for trial-and-error learning
- Culture can play a role (observational learning and teaching)

Other group benefits
- Confusion
- Subdue difficult prey
- Cooperative hunting
  - Social carnivores
  - Social insects

Gulls benefit from confusion of prey!

Fig. 10.25: Black-headed gulls do better in flocks (Even though they have to share food)
Capturing Prey

Lions

- The only truly social cat
- Hypothesized advantage of group living is cooperative hunting
- Do individuals do better hunting in groups?

Fig. 10.29
April 1: Foraging: Capture

Capturing Prey

Cooperative foraging in social insects

Ants carrying off a live caterpillar

Army ant worker

Army ant swarm

Bivouac

50 m
Capturing prey: when to stop?

The longer you stay in a patch, the less profitable each next food item becomes

- This means you shouldn’t necessarily fill up all the way
- However, if you have to fly farther, you may need to fill up more to repay the travel cost
- This is what starlings do

Fig. 10.30 Alcock
April 1: Foraging: Capture

**Consuming prey**

**Preparing food**
- Food preparation as part of the cost of foraging (e.g., crows breaking welk shells)
- Cultural traditions (Japanese macaques)

*Moving to safety before consuming*