Predators vs. Parasites:
A Consumer-Resource Distinction due to Ecological Exclusion?

Lev R. Ginzburg, Christopher X J. Jensen, and Roberta L. Harnett
What is the Distinction between Predators and Parasites?

- Predators kill their prey (preventing future reproduction), parasites do not kill their host.
- Predators consume their entire prey, parasites consume only part of their host.
- Parasites spend the entirety of each life stage on a particular host, whereas predators do not.
- Predators are “bigger” than their prey, whereas parasites are “smaller” than their hosts.
Is there an ecological distinction between parasites and predators, or is our characterization purely linguistic?

Do evolutionary processes drive an ecological distinction?
BKA Parameter Space:

(after Berezovskaya, Karev, and Arditi 2001)
BKA Parameter Space:

\[ \alpha = r_{maxR} + \mu \]

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\[ e/h = \mu \]

\[ e/h = r_{maxR} + \mu \]

\[ \alpha = r_{maxR} (1 + \mu [e/h - \mu]) \]

\( \alpha = \text{capture efficiency of consumer} \)

\( e = \text{conversion efficiency of consumer} \)

\( h = \text{handling time of consumer} \)

\( \mu = \text{death rate of consumer} \)

\( r_{maxR} = \text{maximum reproductive rate of resource} \)

(after Berezovskaya, Karev, and Arditi 2001)
BKA Parameter Space:

\[ \alpha = \frac{e}{h} - \mu = 0 \]

\[ \alpha = \frac{e}{h} - \mu = \mu \]

\[ \alpha = \mu \]

\[ \alpha = r_{\text{max}R} + \mu \]

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\[ \alpha = r_{\text{max}R} (1 + \frac{\mu}{e/h - \mu}) \]

\[ (0,0) \]

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(after Berezovskaya, Karev, and Arditi 2001)
What is the maximum net reproductive rate of the consumer?

Maximum Consumption Rate = $1/h$

Maximum Reproductive Rate = $e/h$

Max. Net Reproduction = $e/h - \mu$
\[ r_{\text{maxC}} = \left( \frac{e}{h} - \mu \right) \]
BKA Parameter Space:

- $\alpha = \text{capture efficiency of consumer}$
- $e = \text{conversion efficiency of consumer}$
- $h = \text{handling time of consumer}$
- $\mu = \text{death rate of consumer}$
- $r_{maxR} = \text{maximum reproductive rate of resource}$
Data that we do have:

Body Size Ratios for consumer-resource pairs, labeled as:

1. Predator  (n= 15419)
2. Parasitoid  (n= 215)
3. Parasite  (n= 47)
4. Pathogen  (n= 3)

(Source: Brose et al. 2005, Ecology 86:2545)
Net Reproductive Rate is Allometrically Scaled:

\[ r_{\text{max}} (\text{day}^{-1}) \propto \frac{1}{\text{body mass}}^{\frac{1}{4}} \]

(Fenchel 1974)
A Comparison of Definitions:
(net reproductive rate inferred from body size)

<table>
<thead>
<tr>
<th></th>
<th>Our &quot;Predator&quot; ((r_C \leq r_R))</th>
<th>Our &quot;Parasite&quot; ((r_C &gt; r_R))</th>
</tr>
</thead>
<tbody>
<tr>
<td>Predator</td>
<td>78.3%</td>
<td>21.7%</td>
</tr>
<tr>
<td>Parasitoid</td>
<td>38.6%</td>
<td>61.4%</td>
</tr>
<tr>
<td>Parasite</td>
<td>0.0%</td>
<td>100.0%</td>
</tr>
<tr>
<td>Pathogen</td>
<td>0.0%</td>
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</tr>
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</table>
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- \( \alpha \) = capture efficiency of consumer
- \( e \) = conversion efficiency of consumer
- \( h \) = handling time of consumer
- \( \mu \) = death rate of consumer
- \( r_{maxR} \) = maximum reproductive rate of resource

\[
\alpha = r_{maxR} + \mu
\]

\[
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\]

\[
\alpha = r_{R}(1 + \frac{\mu}{r_{maxC}})
\]

- Predators
- Parasites

Colors:
- Red = Consumer Extinction
- Yellow = Coexistence
- Blue = Dual Extinction

(after Berezovskaya, Karev, and Arditi 2001)
Substantiating this distinction between predators and parasites:

• Actual maximum net reproductive rates for consumer resource pairs would yield more direct insights
• We need more data on parasites/pathogens and their hosts
• Key prediction is a limitation on consumption efficiency: this data would allow for falsification of this hypothesis
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Roger Arditi and Dan Stoebel provided insightful comments on earlier versions of this presentation.

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Is this theory robust to functional response form?

Ratio Dependent:

Prey Dependent: