UNIT 5. COMPETING FOR RESOURCES

SOURCES

required: Chapter 5 in Krebs & Davies (1993)

remedial: "Hierarchy" "Attack and Defense"in Halliday 1994; "Fighting" "Friends and Rivals"in the Trials of Life video series

supplement: Chapters 9 & 10 in Blumstein, D.T. and Fernandez-Juricic, E. "A Primer of Conservation Behavior"

PARTS OF THIS LECTURE OUTLINE

1. Exploitation
2. Resource Defense
3. Inter-specific Territoriality

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1. EXPLOITATION ("peaceniks"; no aggression)

1.1. **Simplistic model of competition**: ideal free distribution *(Fretwell 1972 cited in Krebs & Davies 1993:103)*

1.1.1. Assumptions (analogous to check-out lines at supermarket)

1.1.1.1. no limit to competitors- they come in from everywhere

1.1.1.2. individuals free to go where rewards are highest (no territories)

1.1.1.3. everyone has perfect knowledge of the environment

1.1.1.3.1. only two types of habitat: rich and poor (continuous food delivery)

1.1.1.4. limited resources: more competitors=> less food for each

1.1.2. Behavioral decision rules: move toward the highest reward (animals aggregate at the best patches)

1.1.2.1. newcomers go to rich habitat first (choose location with highest rate of return)

1.1.2.2. late comers decide between rich habitat (competitors) & poor habitat (no competitors)

1.1.2.3. when reward rate of one habitat drops below the other=> switching

1.2. **Lab test of Model**- stickleback fish *(Milinski 1979 cited in Krebs & Davies 1993:104)*

1.2.1. 6 fish in aquarium; feed on daphnia (water fleas)

1.2.1.1. rich patch: daphnia dropped in by pipette at one end of aquarium

1.2.1.2. poor patch: daphnia dropped at half the rate of rich patch

1.2.2. Prediction: 4 fish in rich patch and 2 fish in poor patch

1.2.2.1. Clumped distribution of fish matched prediction of the model

1.2.2.2. could also measure equal intake and prey risk predictions

1.3. **Field test of Model**- armored catfish *(Power 1984 cited in Krebs & Davies 1993:105)*

1.3.1. pools along a stream in Panama- food is algae

1.3.1.1. rich patch: sunny pools where algae grows continuously

1.3.1.2. poor patch: shady pools=> algae growth is 6 times lower

1.3.2. Prediction: 6 times more catfish in sunny pools

1.3.2.1. distribution of fish matched prediction

1.3.2.2. assumptions of the model appeared to match these field conditions

1.4. **Take-home message: resource exploitation (no aggression; predict animals go to the "best" patches)**

1.4.1. Animals are clumped where the food is clumped (genotype is a conditional strategy to switch)

1.4.2. Ideal Free Distribution model- predict animal distribution based on the best patches of food

1.4.3. e.g. sticklebacks & daphnia; catfish & algae

Part 1	**Study Questions for Chat & Quiz 5 "Exploitation"**
1.1.1	What are 5 assumptions of the ideal free distribution model of resource exploitation?
1.1.2	What behavioral decision rules are explicitly defined in the ideal free distribution model?
1.2	How did Milinski test the Ideal Free Distribution model under laboratory conditions (TIP: e.g. sticklebacks)
1.3	How did Power test the Ideal Free Distribution Model under field conditions? (TIP: armored catfish)
1.4	What is the Exploitation Hypothesis, in terms of explaining how animals compete for resources?

2. RESOURCE DEFENSE: variation in territorial tactics within a species

2.1. **Add aggressive behavior to the Ideal Free Distribution Model**
- *2.1.1.* hypothesis from studies of red grouse *(Watson 1967 cited in Krebs & Davies 1993:106)*
- 2.1.2. Settlers in rich habitat exclude newcomers=> poor habitat
- 2.1.3. When poor habitat is full, newcomers=> floaters (no territory)

2.2. **Field test:** great tits in Wytham Woods *(Krebs 1971 cited in Krebs & Davies 1993:106)*
- 2.2.1. rich patches = woods filled with territories (older birds)
- 2.2.2. poor patches = hedgerows; lower reproductive success (youngsters)
- 2.2.3. when tit dies in rich patch, vacancy filled by tit from poor patch

2.3. **Economic Defendability Model**
- 2.3.1. Costs and benefits of territoriality *(Brown 1964 cited in Krebs & Davies 1993:110)*
  - 2.3.1.1. prediction: switch to non-territorial when costs > benefits
  - 2.3.1.2. tested: behavior of jays at picnic tables matched predictions
- *2.3.2.* pied wagtail shorebirds on river bank, Oxford *(Davies & Houston 1981 cited in Krebs & Davies 1993:116)*
  - 2.3.2.1. few competitors: 1 bird patrols territory at 40-min intervals
  - 2.3.2.2. many competitors: 2 birds patrol; each @ 20-min; more efficient defense
  - 2.3.2.3. rate of food delivery varied by day; model predicted switches well (75%)

2.4. **Nectar feeding birds-** territoriality matches cost/benefit model
- *2.4.1.* golden winged sunbirds feed on nectar; East Africa *(Gill & Wolf 1975 cited in Krebs & Davies 1993:111)*
  - 2.4.1.1. rich days: 3 microliters/day => territorial
  - 2.4.1.2. poor days: 2 microliters/day => non-territorial
- 2.4.2. rufous hummingbird & paintbrush flowers (Calif.) *(Carpenter et al. 1983 cited in Krebs & Davies 1993:113)*
  - 2.4.2.1. adjust size of territory to balance costs/benefits = weight gain

2.5. Take-home message- resource defence (defense of space between individuals of the same species)
- 2.5.1. territorial exclusion from resource-rich patch, e.g. great tits
- 2.5.2. Economic defendability, e.g. shorebirds, nectar-feeding birds

Part 2	**Study Questions for Chat & Quiz 5 "Resource Defense"**
2.1	What did Watson hypothesize was the function of territoriality in red Grouse?
2.2	How was the Resource Defense Hypothesis tested under field conditions? (TIP: e.g. great tits)
2.3	How did Davies and Houston test the Economic Defendability Hypothesis?
2.4	How was the Economic Defendability Hypothesis tested in nectar feeding birds? (TIP: hummingbirds or sunbirds)
2.5	What are similarities and differences between the Territorial Exclusion and Economic Defendability Hypotheses of resource competition?

3. INTER-SPECIFIC TERRITORIALITY (BETWEEN DIFFERENT SPECIES)

3.1. **Individuals of different species that use similar resources** *(Reed1981 cited in Krebs & Davies 1993:117)*
- 3.1.1. great tits vs. chaffinches
- 3.1.2. both feed on insects and seeds (depends on seasonal availability)
- 3.1.3. different songs and appearance
- 3.1.4. usually ignore each other in a diverse woodlot

3.2. Alternative hypotheses
- 3.2.1. H1: inability to distinguish other species (no adaptive benefit)
- 3.2.2. H2: animosity fixed in the genes (coevolution of the two species)
- 3.2.3. H3: conditional: depends on habitat availability (genotype is a conditional strategy to switch tactics)

3.3. **Field test of conditional hypothesis (H3)** *(Reed 1981 cited in Krebs & Davies 1993:118)*
- 3.3.1. large mainland woodlot- structurally diverse
- 3.3.2. birds do not respond to playback of territorial song
- 3.3.3. small island woods- less diversity in structure
  - 3.3.3.1. each species responds to playback of the other's song
  - 3.3.3.2. counter-approach and aggressive singing
  - 3.3.3.3. removal of chaffinches=> tits took over the territory
- 3.3.4. interpretation: when forced to co-habit, chaffinches exclude tits

3.4. Take home message: inter-specific territoriality (defense of space between two different species)
- 3.4.1. Alternative hypothese: mis-identification; fixed; conditional
- 3.4.2. e.g. chaffinches vs. great tits; conditional on habitat suitability

Part 3	**Study Questions for Chat & Quiz 5 "Inter-specific Territoriality"**
3.1	What is an example of interspecific territoriality? (TIP: e.g. chaffinches & great tits)
3.2	What are three alternative hypotheses about the function of interspecific territoriality?
3.3	How was the conditional hypothesis of interspecific territoriality tested? (TIP: e.g. chaffinches & great tits)
3.4	Why were alternative hypotheses about interspecific territoriality rejected in a species of your choice? (TIP: e.g. inability to distinguish, fixed fighting strategy)

4. SUMMARY

4.1. Exploitation (no defense of space; predicts the animals go to the "better" patches)
- 4.1.1. No aggression; it's a matter of which genotypes better "gobble up the resources"
- 4.1.2. Ideal Free Distribution model- individuals move to richer patches of resources
- 4.1.3. e.g. sticklebacks & daphnia; catfish & algae

4.2. Resource Defense: Intra-specific Territoriality (defense of space within the same species)
- 4.2.1. territorial exclusion from resource-rich patch, e.g. great tits
- 4.2.2. Economic defendability, e.g. shorebirds, nectar-feeding birds
- 4.2.3. Influences genotypes within the gene pool of ONE species

4.3. Inter-specific Territoriality (defense of space between two different species)
- 4.3.1. Alternative hypotheses: H1-mis-identification of signals; H2-genetically fixed; H3-conditional learning
  - 4.3.1.1. H1- maladaptive, no selection on genotypes
  - 4.3.1.2. H2- stepwise co-evolution of territorial behavior in TWO species
  - 4.3.1.3. H3- genotype for conditional strategy switches between territorial & non-territorial tactics
- 4.3.2. e.g. chaffinches vs. great tits; mainland compared to island

Summary	**Study Questions for Chat & Quiz 5 "Competition for Resources"**
4.1	What are 3 take-home messages about how animals compete for resources?
4.2	In competition theory, what is the distinction among resource exploitation, resource defense, and inter-specific territoriality?