

UNIT 10. ALTERNATIVE BREEDING STRATEGIES

SOURCES (for powerpoint format: <http://wfsc.tamu.edu/jpackard/behavior/wfsc622/powerpoints.zip>)

required: Chapter 10 in Krebs & Davies (1993:244-264);

remedial: "Mating & Birth" in Halliday 1994; "Arriving" in the Trials of Life video series

supplement: Chapter 11 in Blumstein, D.T. and Fernandez-Juricic, E. "A Primer of Conservation Behavior"

PARTS OF THIS LECTURE OUTLINE

1. Callers and Sneakers: Alternative Strategies
2. Problems: Testing Hypotheses
3. Sex Changes: Alternative Tactics

1. CALLERS AND SNEAKERS: ALTERNATIVE STRATEGIES (*Krebs and Davies 1993:260 Table 10.2*)

1.1. Changing environment (*Krebs and Davies 1993:245-246*)

1. alternative strategies in sticklebacks: Red-throats & Dull-throats
2. relative payoffs depend on the environment:
 - a. predator-rich location
 - b. predator-free location
3. **Population 1: predator-free deep water environment**
 - a. benefits: Red-throat more attractive to females;
 - b. no cost to Red-throat genotype when no predators are present
 - c. **more Red-throats than** Dull-throats in this population
4. **Population 2: predator-rich shallow water environment**
 - a. costs: Red-throats more conspicuous to predators
 - b. **more Dull-throats** than Red-throats in this population

1.2. Making the best of a bad job: Callers & Satellites (*Krebs and Davies 1993:246-248*)

1. natterjack toads: females choose large over small males
 - a. payoff is highest for large males: 60% of males got 80% of copulations
2. behavior of small males depends on presence of larger males
 - a. Satellite tactics: sit near Caller=> get 50% of females
 - b. test: remove Caller=> small toads switch from Satellite to Caller tactic
3. conditional strategy: small toads get larger with age; tactics shift

1.3 Evolutionary equilibrium of polymorphism (ESS= 2 fixed strategies)

1. coho salmon: Hooknose & Jack strategies (*Krebs and Davies 1993:250-251 Fig. 10.4, 10.5*)
 - a. Hooknose mature at 3 yr=> bigger & better fighters (6% return to stream)
 - b. Jacks mature at 2 yr=> smaller & better sneakers (13% return from ocean)
 - c. both genotypes persist in the population (fitness payoffs equal)
2. bluegill sunfish: Parental & Cuckolder strategies (*Krebs and Davies 1993:252*)
 - a. Parental: mature at 7 yr=>large, build nest, defend territory, care for young
 - b. Cuckolder: mature at 2 yr=> smallest sneak copulations=> larger mimic females
 - c. both genotypes persist in the population (fitness payoffs equal)

1.4 Take-home message: alternative strategies as proportions of genotypes

- a. proportions shift in changing environment; balance in environments with equal payoffs
- b. e.g. sticklebacks, natterjack toads, coho salmon, bluegill sunfish

Part 1	Study Questions for Chat & Quiz 10 "Alternative Breeding Strategies"
1.1	Describe a study showing persistence of alternative breeding strategies (fixed) related to variation in habitat? (TIP: e.g. sticklebacks)
1.2	Explain an example of a conditional strategy, where alternative breeding tactics are related to development? (TIP: e.g. natterjack toads)
1.3	Explain an example of alternative breeding strategies resulting from polymorphism in age at maturity? (TIP: e.g. coho salmon or sunfish)
1.4	Under what environmental conditions would you expect to see co-evolution of alternative breeding strategies? (TIP: relate to variation in space, time and frequency of tactics in a population)

2. PROBLEMS: TESTING HYPOTHESES

2.1. Cause of behavioral polymorphism: strategy or tactic?

1. strategies: different genotypes=> behavioral differences are heritable
 - a. shifting balance of 2 ESS: coho salmon (Hooknose:Jack), bluegill sunfish (Parental:Cuckold)
 - b. fixed ESS: Red-throat stickleback in predator-free environment
2. tactics: same genotype=> different behaviors are conditional on payoffs
 - a. e.g. individual natterjack toads switch from Satellite to Caller with relative size
 - b. conditional strategy is heritable (includes tactics & decision rules for switching)
 - c. TIP: use "tactics" when you are not sure if behavioral differences are heritable

2.2. Relative pay-offs of each strategy: shifting balance?

1. difficulty of defining alternative strategies when the variation is along a continuum
 - a. e.g. bluegill sunfish (is a 3-incher a Cuckold or young Parental?)
2. difficulty testing ESS theory based on real-world predictions of payoffs
 - a. problem of false positive: accept null hypothesis when there is a difference
 - b. may fail to reject the null due to high variance and/or small sample size
 - c. theory assumes stable environment; the system you test may be in change

2.3. Equal payoffs: alternative hypotheses (fixed, mixed, conditional)

1. H1: genetic polymorphism (shifting balance of 2 fixed ESS)
 - a. test: determine heritability + each individual only plays one tactic
 - b. manipulate environment: differential reproduction in different environments
2. H2: several tactics played in fixed proportion (mixed ESS)
 - a. test: tactics not heritable + all individuals play both tactics
 - b. manipulate environment: no change in proportion of tactics + change in payoffs
3. H3: conditional tactics based on behavioral assessment
 - a. test: tactics not heritable + all individuals play both tactics
 - b. manipulate environment: all individuals shift to tactic with highest payoff

2.4. Take-home message: testing hypotheses of balanced polymorphisms (mixed ESS)

1. difficulties: distinguishing among fixed, mixed and conditional strategies
2. tests: VHDP (Variation + Heritability + Differential fitness + Proportion of genotypes)

Part 2	Study Questions for Chat & Quiz 10 "Alternative Breeding Strategies"
2.1	Explain the distinction between behavioral strategy and tactics, illustrating the concepts with appropriate examples of alternative breeding? (TIP: e.g. coho, natterjack toads; relate to heritability)
2.2	What are some of the difficulties of testing whether alternative breeding tactics are fixed or conditional? (TIP: e.g. sunfish)
2.3.1	What are 3 alternative hypotheses about the co-evolution of alternative breeding tactics? (TIP: fixed, mixed, conditional)
2.3.2	What data would you collect to distinguish among 3 hypotheses about alternative breeding tactics? (TIP: fixed, mixed, conditional)

3. SEX CHANGES: ALTERNATIVE TACTICS OF HERMAPHRODITISM

3.1. Changing from Female to Male Tactic (protogynous) (*Krebs and Davies 1993:260-262*)

1. e.g. blue-headed wrasse fish on coral reefs in Atlantic and Caribbean
 - a. small dull fish with Female Tactic => attracted to bright males and release eggs
 - b. small bright fish with Male Tactic=> Sneakers and/or Chasers release sperm large females switch to Male Tactic when opportunity arises (Male removed)
 - c. large Male Tactic: brightly colored, defend breeding site, spawn 40 times a day
2. sex change depends on tactics played by others on site (intense male rivalry)
 - a. large reef=> large population=>higher proportion of primary males (Sneakers)
 - b. small reef=> small population=>females choose larger territorial males

3.2. Male to Female tactical changes (protandrous)

1. e.g. anemonefish (clownfish) on coral reefs in Indian Ocean (*Krebs and Davies 1993:262 Fig. 10.11*)
 - a. anemones are small => food patches big enough for only two
 - i. smallest fish uses Male tactic;
 - ii. larger fish uses Female tactic
 - iii. remove larger fish=> replace with smaller=> Male switches to Female tactic
2. sex change is conditional on behavioral assessment of relative size
 - a. no male rivalry (group size limited by resources)
 - b. larger females lay more eggs (advantage to small fish to inseminate larger)

3.3. Sex change vs. sneaking

1. why don't mammals change sex, e.g. elephant seals?
 - a. physiological constraints (differ between fish & mammals)
 - i. fish: external fertilization, simple sex organs, cold-blooded, indeterminate growth
 - ii. mammals: internal fertilization, pregnancy & lactation, critical stages of development
2. behavioral constraints (similar between fish & mammals)
 - a. advantage of experience
 - i. allocate energy to growth, metabolism, reproduction
 - ii. those that bred later had higher payoffs, given intense sexual competition

3.4. Take-home message: sex change strategies

1. payoffs for each tactic depend on other "players in the game"
2. within constraints
 - a. sexual competition=> large males (wrasse)
 - b. no competition=>large females (anemone clownfish)

Part 3	Study Questions for Chat & Quiz 10 "Alternative Breeding Strategies"
3.1	Explain an example of a conditional strategy (protogynous), where individuals change from female to male tactics? (TIP: e.g. blue-headed wrasse)
3.2	Explain protandrous hermaphroditism, as a conditional strategy where individuals change from male to female tactics? (TIP: e.g. anemone clownfish)
3.3	Why are conditional strategies of sex change observed in fish but not in mammals? (TIP: mention physiological and behavioral factors)
3.4	How has variation in sexual competition influenced evolution of alternative sex change strategies? (e.g. wrasse vs. anemone clownfish)

4. SUMMARY

4.1 Callers and Sneakers: Alternative Strategies

1. proportions shift in changing environment
2. balance in environments with equal payoffs
3. e.g. sticklebacks, natterjack toads, coho salmon, bluegill sunfish

4.2 Problems: Testing Hypotheses

1. difficulties: distinguishing among fixed, mixed and conditional strategies
2. tests needed for each part of the Natural Selection process: VHDP (Variation + Heritability + Differential fitness + Proportion of genotypes)

4.3 Sex Changes: Alternative Tactics

1. payoffs for each tactic depend on other "players in the game"
2. within constraints:
 - a. sexual competition=> large males (wrasse)
 - b. no competition=> large females (anemone clownfish)

Summary	Study Questions for Chat & Quiz 10 "Alternative Breeding Strategies"
4.1	What are the take-home messages for this unit on alternative breeding strategies? (TIP: see summary)
4.2	From a comparative perspective, what factors influenced the evolutionary divergence of alternative reproductive strategies? (TIP: refer to fixed, mixed, conditional)

TIPS: In the previous unit, we examined the hypotheses surrounding the co-evolution of "male" and "female" strategies. In this unit, we learned about models for the co-evolution of "cuckold" and "parental" strategies. We also examined the conditional strategies where each individual may change tactics within a lifetime, depending on how environmental conditions change (i.e. sex change in fish). These variations on the "standard design" illustrate how understanding the process of natural selection may be more powerful for making sense of the diversity of life, rather than trying to design discrete categories for mating systems that defy classification.