Mate choice when males are in patches: optimal strategies and good rules of thumb

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1) Introduction

- Models with food distributed in patches have been prominent right from the start of foraging theory.
- Models of mate choice also have a long pedigree in behavioural ecology (e.g. Janetos 1980).
- But **a patch structure has almost never been incorporated into models of mate choice**, even though males often are patchily distributed.

Figure caption. An obvious application is leks (● = ruff leks), but equally think of a female dragonfly visiting males on the ponds (●) or a female tit inspecting males on these patches of woodland.

2) Assumptions of our model

- Male quality varies: females gain from choosing a better male.
- But risky to take too long (e.g. predation, random end of season).
- Females learn male qualities by inspecting sequentially.
- Females can return to a previously inspected male.
- **Males occur in patches (e.g. of 1 to 20 males, mean = 4).**
- **Movement between males within a patch faster (safer) than between patches (× 10).**
- Females know how many males in current patch, but not in others.

Eyes glazing over? Concentrate on (1) and (3)!

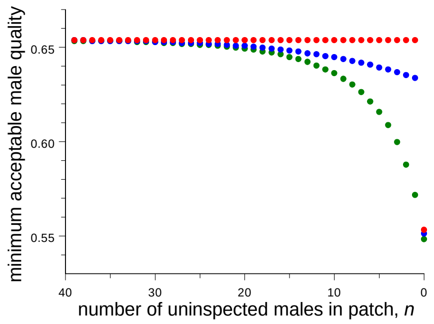
3) Simplest version: no risk to returning to male within same patch

State variables
r = quality of best male so far inspected.
n = number of males left to inspect on current patch.

Optimal policy: the TWO-THRESHOLD STRATEGY
Optimal strategy is to apply just two threshold values (if *r* > threshold, then accept best male, otherwise continue):
high threshold when males left to inspect on current patch; lower threshold once inspected all males on patch.

Resultant behaviour
- May accept male without searching whole patch.
- May return to a male only when all males on patch inspected.
- Never moves to new patch before inspecting all males on last patch.
- Never returns to patch once left (assuming local supply of new patches is infinite).

How the optimal thresholds depend on the number of males in the patch yet to be inspected and on the cost of returning to a male inspected earlier:
- ● the two-threshold strategy, optimal when there are no costs of returning;
- ● when returning has half the cost of inspecting a new male;
- ● when returning impossible.



4) Other versions

4.1) **Some risk to returning to previously inspected male on same patch**
- Now acceptance threshold more gradually declines as numbers of males on patch left to inspect declines.
- Still never return to males till end of patch.
- Even if returns not possible at all, female performance only slightly worse.

4.2) **Takes longer to find the last uninspected males on patch**
- Again acceptance threshold gradually declines.
- May return to a male before inspecting all males on patch.
- May leave patch before inspecting all males (to leave or continue depends on *n*, not *r*).

4.3) **Males of like quality aggregated; females must learn patch quality**
- Decision now not only dependent on best male in patch and number left to inspect in patch, but also mean quality on patch and number already inspected on patch.
- Still big drop in acceptance threshold when examine last male in patch.
- May leave a patch before examining all males.

4.4) **Mean male quality varies between years; females must learn year quality**
- As with (4.3), decision depends on 4 state variables (Bayesian).
- May return to previously visited patch.

5) Rules of thumb

- We assessed various rules of thumb in patchy and non-patchy environments, with and without quality variation between patches or between years.
- **The simple two-threshold strategy performed best overall, and exceedingly well.**
  i.e. use a constant threshold for acceptance, except lower it if you would have to travel further to the next male.
- A further simplification of this rule also worked very well:
  always inspect all males in a patch, then apply a single threshold to decide whether to select best (*cf*. Bertorelle *et al*. 1997)
- Other rules from the literature performed less well. The best-of-*N* rule outperforms threshold rules only in non-patchy environments with between-year quality variation. The cutoff rule (inspect *N* males, then accept next male that is better than all of them) performs poorly.