

Predator- prey coevolution



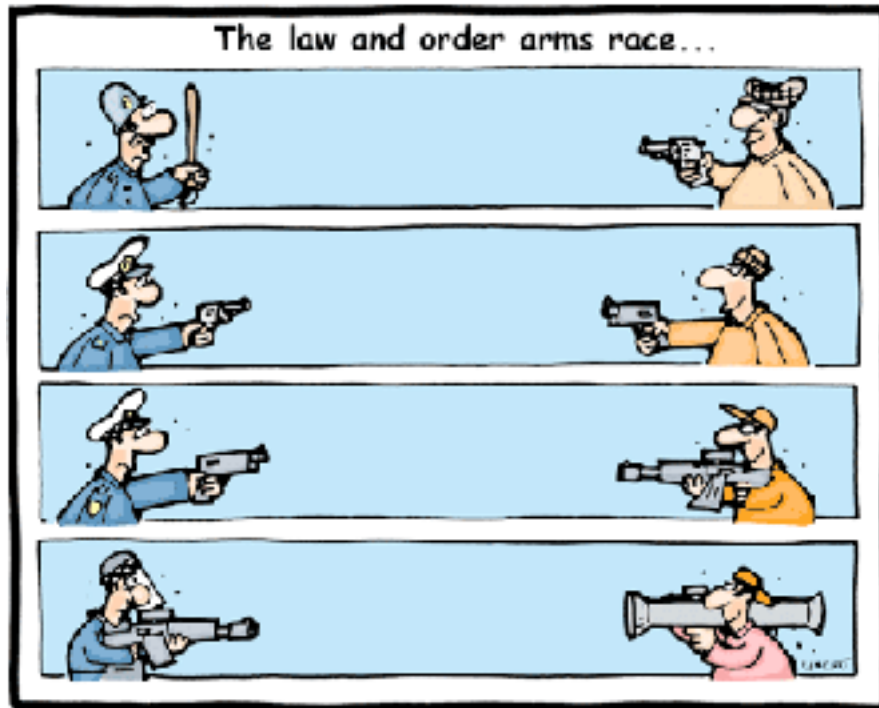
Predator-prey coevolution

- Coevolution
 - Reciprocal influence of two interacting species on each other (evolution of traits/behaviors in two species in response to each other)
 - Mutualistic coevolution = plants vs pollinators
 - Antagonistic coevolution = predators vs prey



Predator-prey coevolution

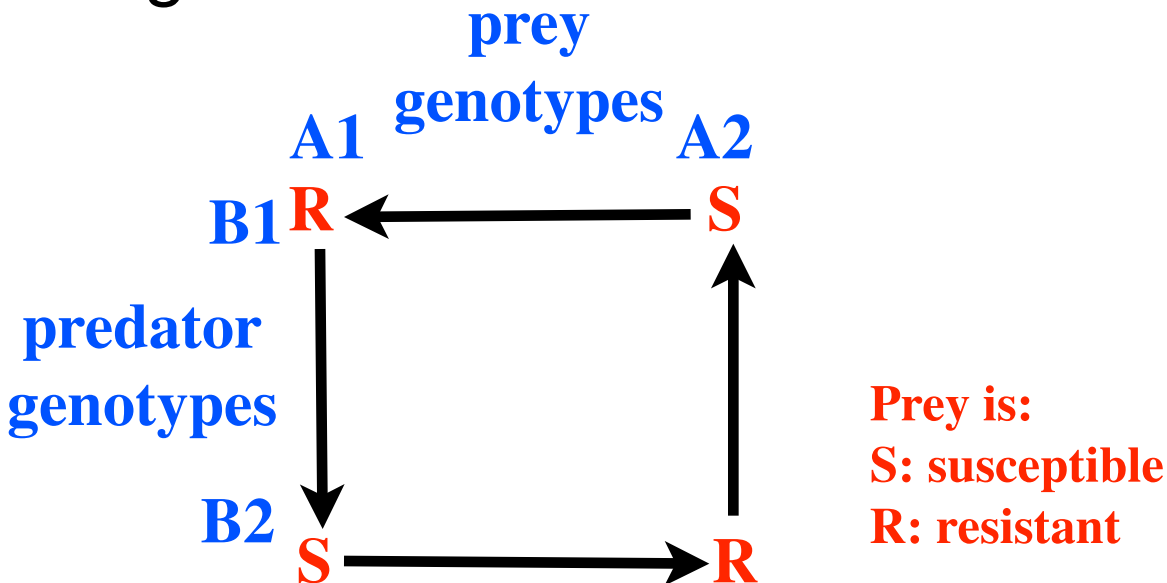
- “Arms race” between predator and prey
 - Predators select for antipredator behavior
 - Antipredator behavior leads to anti-antipredator behavior
 - So on and so forth



The Red Queen

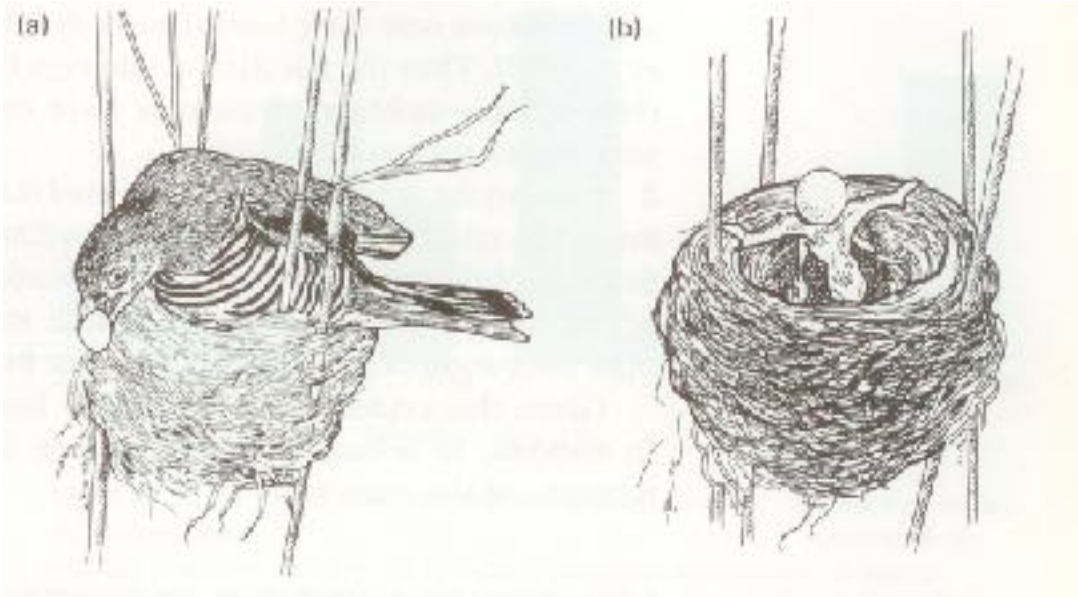
"It takes all the running you can do,
to keep in the same place."

- Constant cycling of adaptation and counter adaptation
- Non-equilibrium state at any given time



Cuckoos: models of parasite predator-prey coevolution

- Obligate brood parasites
- Eggs laid in other birds nest
 - Nestling hatches first
 - Ejects other eggs
 - Raised by surrogate parents





BBC



Brood parasitism: Evolutionary history

- Evolved independently in multiple lineages
 - cuckoos, honeyguides, finches, cowbirds, ducks
- Different strategies in different lineages
 - Eject egg or young
 - Parasite nestlings has hooked bill to kill host nestlings
 - Outcompete nestlings with vigorous begging



Brood parasitism: Evolutionary history

- Facultative brood parasitism common in many species
 - Supplement RS by laying eggs in other same-species nests while still raising own brood
 - Producing only eggs is cheaper than raising young
 - Probable precursor to obligate brood parasitism



Host defense against cuckoos

- Avoid parasitism
 - Chase away/attack cuckoos
 - Abandon nest if detect cuckoo near nest
 - Some species found to desert clutch when cuckoo adds egg before clutch initiation, or after incubation has begun



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 - Some species found to desert clutch when cuckoo adds egg before clutch initiation, or after incubation has begun
 - However, in other species: when experimenters add eggs after incubation begins, egg does not cause desertion
 - » why: in many host sp., adult must see cuckoo to respond to egg



Cuckoo response

- Vigilant hosts selects for sneaky female cuckoos
 - Female cuckoos can lay an egg within 10 seconds!



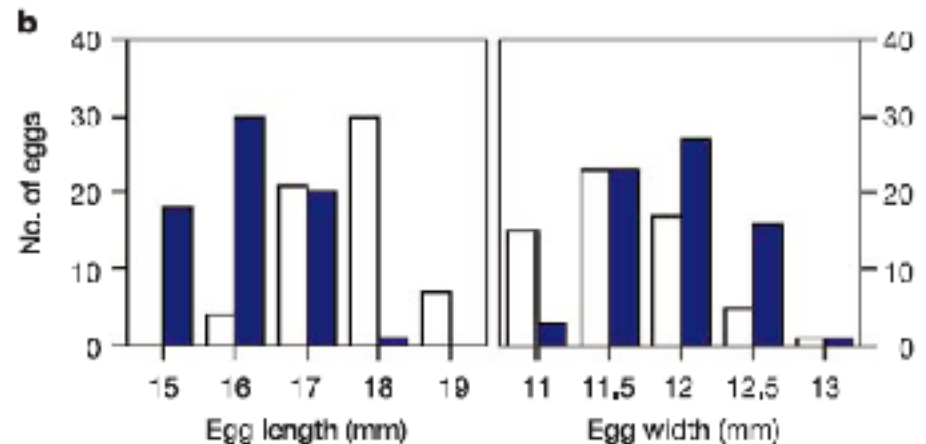
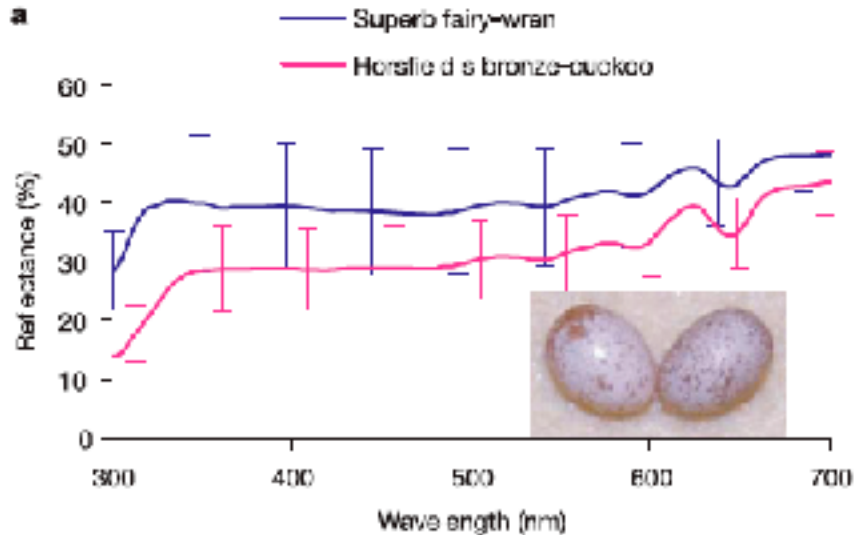
Host defense against cuckoos

- Next line of defense: reject foreign eggs
 - Memorize own clutch, reject eggs that are different
 - Rejection based on color, size, or pattern (egg rejection occurs in only in some host species)



Cuckoo response

- Egg rejection by hosts selects for better egg mimicry by cuckoos



Host defense against cuckoos

- Hosts (some sp.) evolve more variable eggs and learn their own individual pattern
 - Individuals learn “their” pattern first clutch and use template in egg rejection
 - Egg patterns of cuckoo host species more variable between individuals than in non-hosts species



Host defense against cuckoos

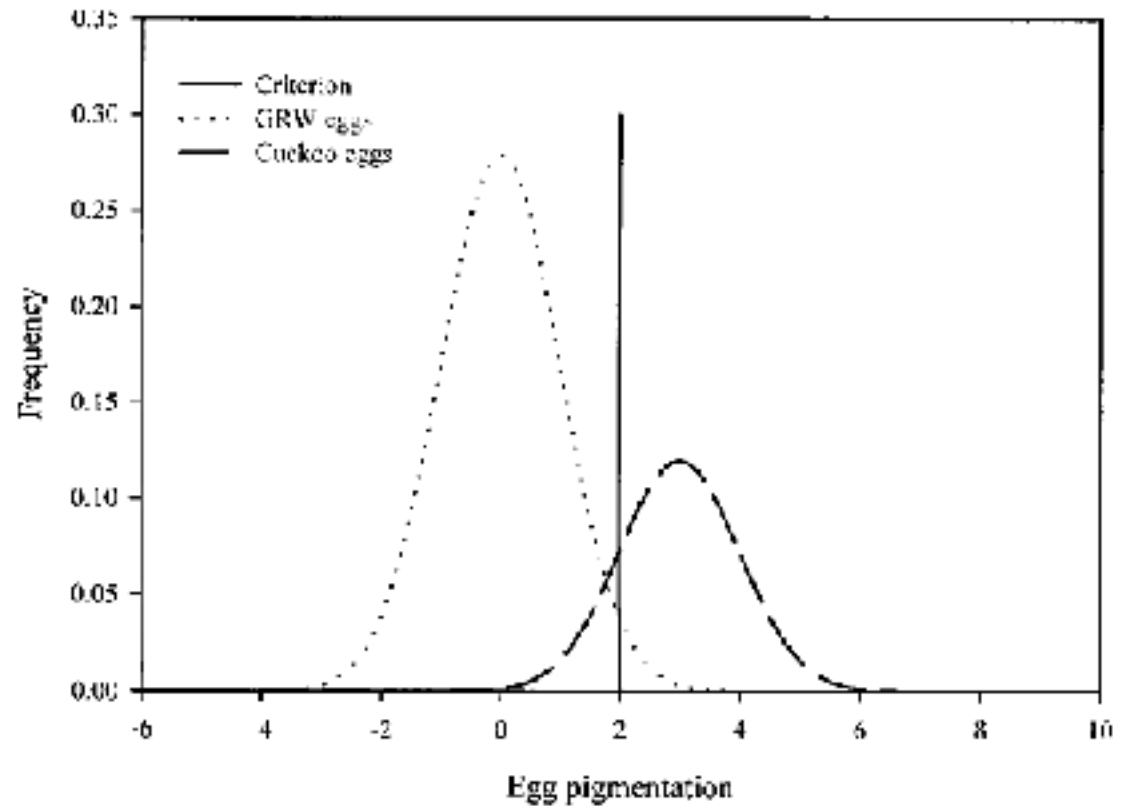
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**Discriminating can be dangerous
because mistakes (rejecting own egg)
would be costly**



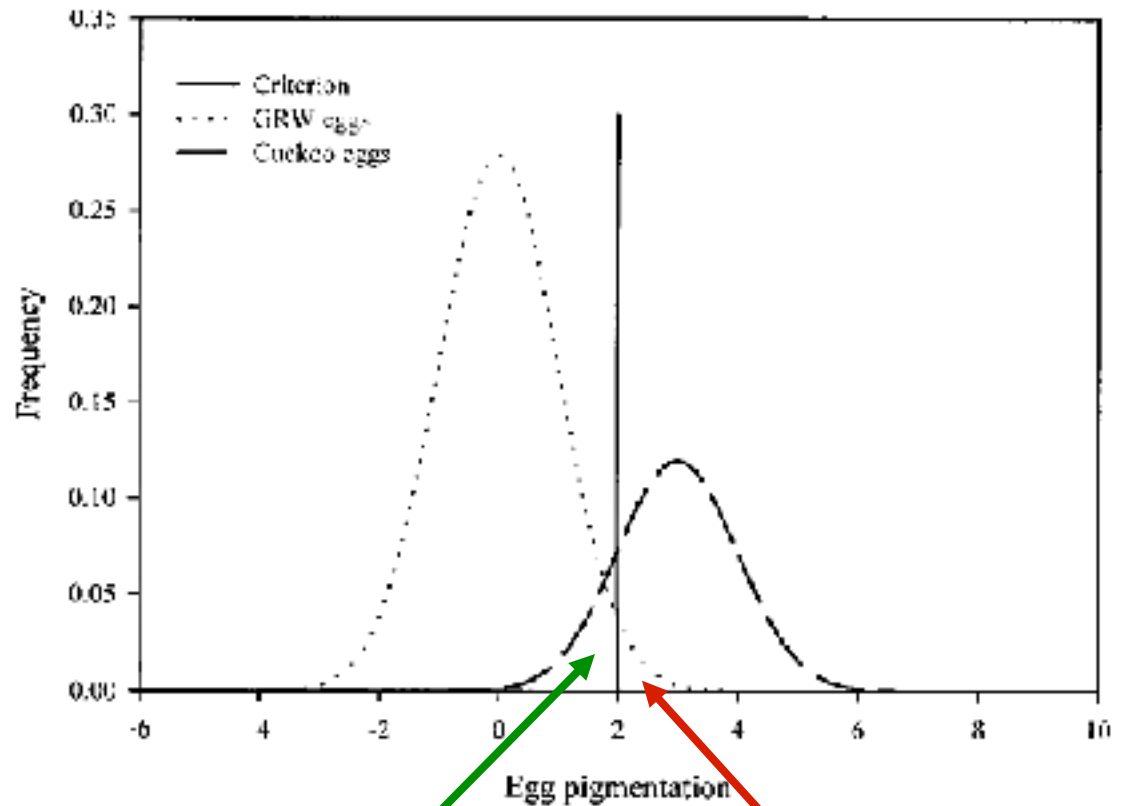
Discrimination threshold

- Model for egg discrimination threshold



Discrimination threshold

- Model for egg discrimination threshold
 - Host acceptance of eggs to left, rejection of eggs to right
 - Optimal place for threshold depends on 3 factors



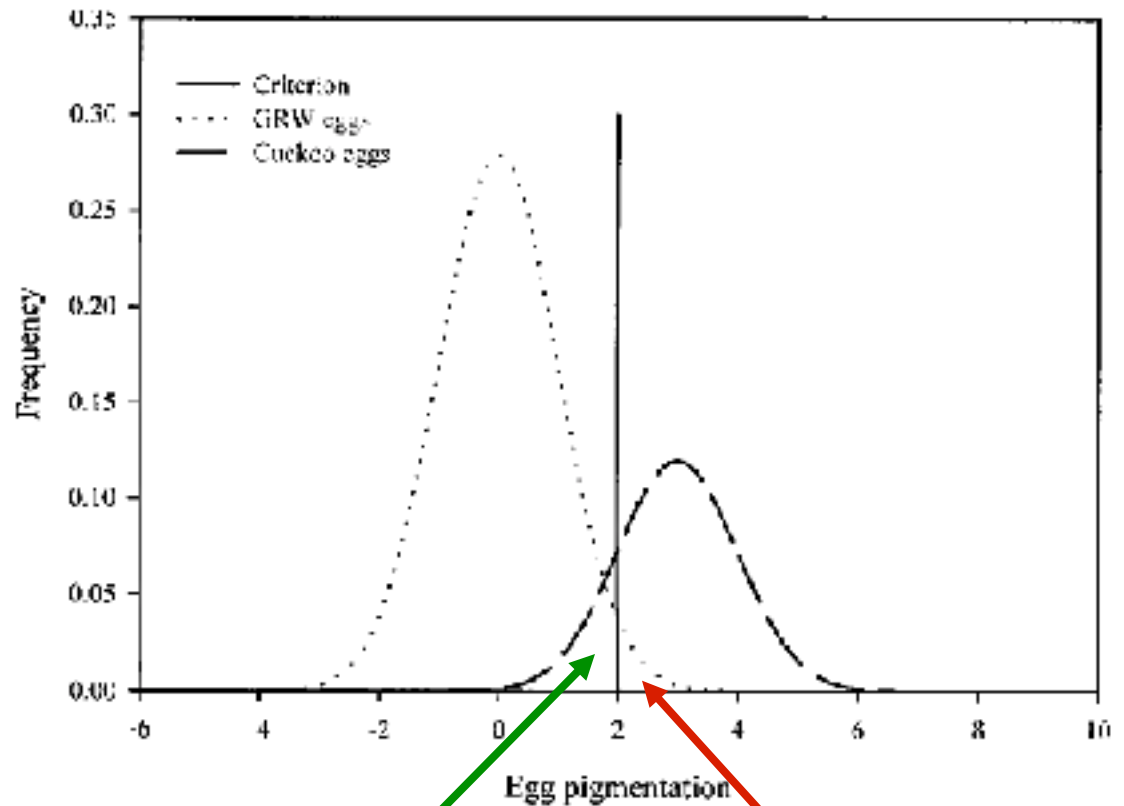
Acceptance errors **Rejection errors** 18

Discrimination threshold

- Model for egg discrimination threshold
 - Host acceptance of eggs to left, rejection of eggs to right
 - Optimal place for threshold depends on 3 factors

How will the threshold shift when alter:

- 1) Greater frequency of encounters:
- 2) Greater costs of rejection errors:
- 3) Greater costs of acceptance errors:



Acceptance errors

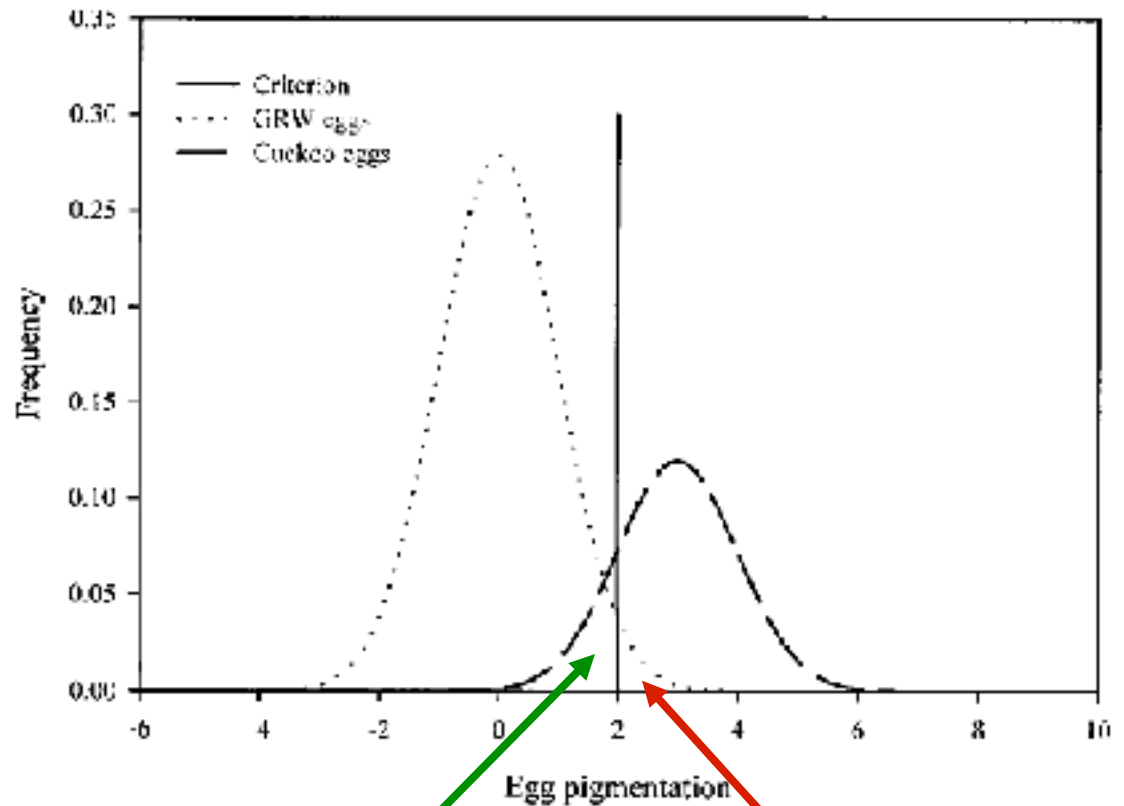
Rejection errors

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Acceptance errors

Rejection errors

Host defense against cuckoos



Host defense against cuckoos

- Next line of defense: reject cuckoo nestlings
 - Seems like rejection should happen given extreme differences in phenotype of parasitic chick
 - But nestling discrimination is **VERY** rare: the vast majority of hosts raise cuckoo nestlings



Why is it so rare for hosts to discriminate nestlings

High cost of mis-imprinting on cuckoo nestling as own species

- Costly if imprint on parasitic nestling: will reject own young in future (will make rejection errors)



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High cost of mis-imprinting on cuckoo nestling as own species

- Costly if imprint on parasitic nestling: will reject own young in future (will make rejection errors)
- Not same risk for eggs because not likely to mis-imprint:
 - 1) host female can imprint immediately after she lays first egg (lay-and-look), and
 - 2) host female has many eggs in clutch to imprint on, so can imprint on the majority-type

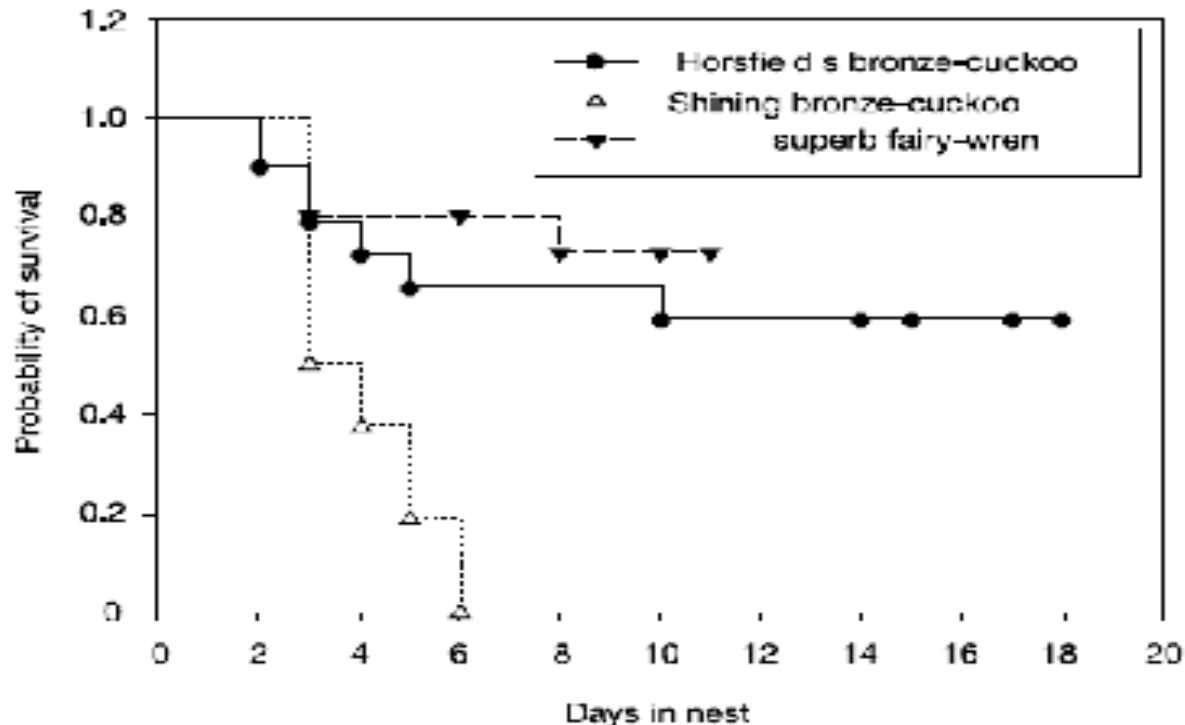


Host defense against cuckoos

- Nestling discrimination is VERY rare: most hosts raise cuckoo nestlings
 - An exception: Fairy-wren females often abandon shining-cuckoo parasite, but rarely abandon horsfield's-cuckoo parasite, or their own nestling



fairy wren



Host defense against cuckoos

- Why has discrimination of shining cuckoo evolved, and how has horsfield's cuckoo escaped discrimination?
 - Exp: remove eggs and put one nestling in each nest (vary type between HBC, SBC, SFW)
 - Findings: rejected their own nestling and SBC



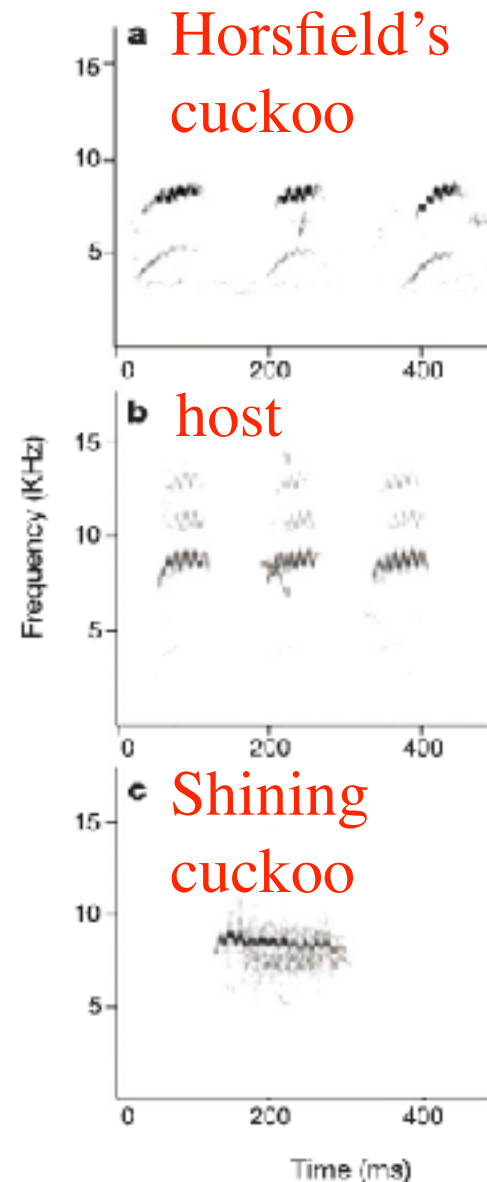
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 - Findings: rejected their own nestling and SBC
 - when have only one chick, fairy-wrens discriminate:
 - with one chick, there is less value to a reproductive attempt b/c 1) there is only one offspring, 2) fairy-wrens live in tropics with long breeding season - and can re-nest over and over
 - SO LESS COSTS TO REJECTION ERRORS
- (note: cuckoos always create a one-chick nest)



Cuckoo response

- Why are Horsfield's cuckoo nestlings still accepted?
 - Horsfield's cuckoo vocally mimics nest of many FW chicks begging!
 - Evidence that cuckoo is responding to selection pressure to mimic host chicks....



Why do hosts always accept parasitic nestlings

- Evolutionary equilibrium hypothesis:
 - Rejection of nestlings is not selected for because there is a high risk&cost of potential rejection errors
 - Thus, risk of rejecting own nestlings for lifetime can be more costly than occasionally accepting a parasitic nestling

