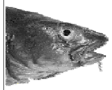
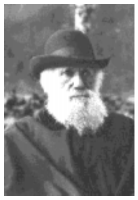
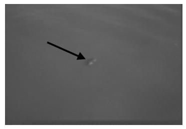
Group & Kin Selection



V. C. Wynne-Edwards (1962)

- Group selection explanations for behavior
  - Population control
  - “Good of the Species”
    - Cheaters would always prosper
      - Cooperation and individual reproductive restraint could not evolve by individual level selection
        - Selfish populations must have higher extinction rates.

G. C. Williams (1966)

- Argued that group adaptations did not exist.
  - Individuals more numerous than populations and with higher turnover rate
    - Selfish gene could replace altruistic gene at much higher rate than altruistic gene could increase through population extinction.
- All of Wynne-Edwards’ examples explainable by selection at the level of the individual.

M.J. Wade (1977)
David Sloan-Wilson (1983)

- Demonstrated that group selection could overcome individual selection if strong enough.

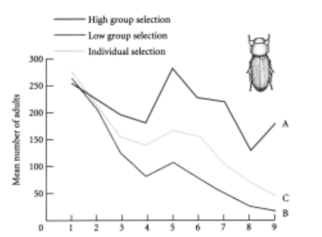


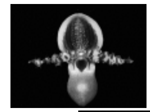
Fig 12.15B Futuyma, After Wade 1977

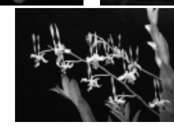
Requirements for Group Selection

- Differences in birth and death rates among entities (groups in this case).
- Selection on group-level traits that are emergent and heritable.
- The rate of replacement of more fit groups is much higher than the rate of replacement at the level of the individual.
- *Any entity at any level of the biological hierarchy that reproduces itself and passes on emergent properties to descendant entities can evolve by natural selection.*
  - Genes, populations, species, clades.

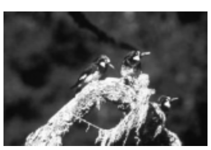
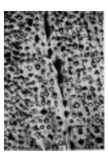
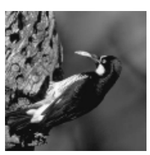
Species or Taxon Selection

- Some clades are more prone to speciate and/or less likely to go extinct than others
  - Differential survival and reproduction of species and higher taxa.



Kin Selection


Altruism

- Acting in the interest of others at a cost to oneself.
  - How can altruism evolve?
  - Four Mechanisms
    - Manipulation
    - Individual Advantage
    - Reciprocation
    - Kin Selection

Manipulation

- Manipulating other's behavior to gain fitness advantage.

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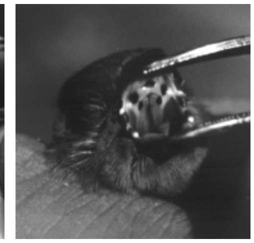
Brood Parasitism in Birds

Black-faced Firefinch Indigobird *V. larvaticola*

Black-faced Firefinch *L. larvata*



After Sorenson 2003

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Host and Parasitic Cuckoo Eggs

Dunnock

Pied Wagtail

Robin

Reed Warbler

Meadow Pipit

Great Reed Warbler

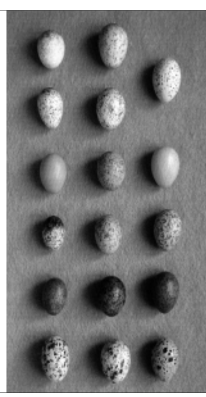

Photo from Mike Sorenson

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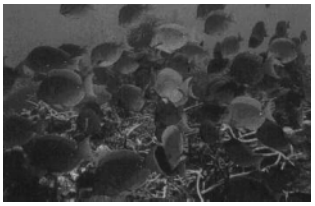
Individual Advantage

- Individual may cooperate with another because it receives a direct benefit
  - Herding and Schooling as antipredator behavior



Reciprocation

- Individuals may act altruistically with expectation that such behavior will be reciprocated.

Kin Selection

- Inclusive fitness
- JBS Haldane
  - "I would gladly give my life for two brothers or eight cousins."
- WD Hamilton and Hamilton's Rule. Altruistic behaviors should evolve when:

rb > c

Where **r** = degree of relatedness, **b** = benefit to the donor's relatives, and **c** = cost to donor.

Kin Recognition and Behavior

- Ability to recognize kin influences the evolution of behavior.

Cannibalism in *Scaphiopus bombiens*

Photo from D. Pfennig

Egg dumping in Acorn Woodpeckers

Photo from W. Koenig

Eusociality

- Eusociality - division of reproductive labor, cooperative care of young, and overlapping generations so that offspring assist their parents.
  - All Isoptera (termites)
  - Evolved independently in at least 10 lineages of Hymenoptera
  - A few other insects
  - One mammal - the naked mole rat

Naked Mole Rats

Eusociality

- Three prominent hypotheses for evolution of Eusociality
  - Kin Selection
  - Parental Manipulation
  - Mutualism (Worker Manipulation?)

Eusociality in insects

- Kin Selection
  - In haplo-diploid Hymenoptera
    - Females diploid, Males haploid
    - Females more closely related to sisters (r = 0.75) than to her own offspring (r = 0.50).
      - In colonies with a single queen (with single mating), females maximize fitness by rearing reproductive sisters.
  - Not adequate explanation for diploid Termites.
    - Several hypotheses available
      - Inbreeding / outbreeding, endosymbionts, etc..

Evolution of Eusociality

- Parental Manipulation
  - Queens suppress reproduction of workers
    - Chemical cues
    - Physical inhibition
    - Support comes from multiple queen colonies, multiply mating queens, and slave making ants in which slaves help rear unrelated offspring of the queen.

Evolution of Eusociality

- Mutualism (Worker Reproduction)
  - Workers may be cryptic reproductives and may enjoy greater fitness by helping in a nest rather than trying to found a new colony.
    - Support comes from observations that unmated workers lay haploid (male) eggs in many species.

Testing Hypotheses for Evolution of Eusociality

- Trivers and Hare (1976) proposed a test of Kin Selection and Parental Manipulation by queens.
  - Queen's fitness maximized by equal offspring sex ratio (Parental Manipulation).
    - Queen is equally related to male and female offspring
  - Workers fitness maximized by female biased offspring sex ratio (Kin Selection).
    - Female offspring are more related to sisters than to brothers.

Sex ratio in 49 species of ants supports Kin Selection Hypothesis

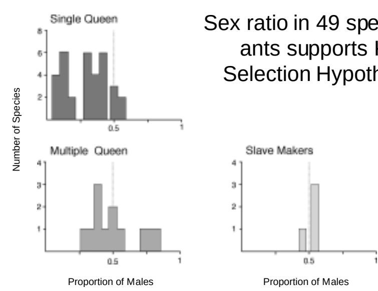


Fig. 20.17 after Seger 1991)