

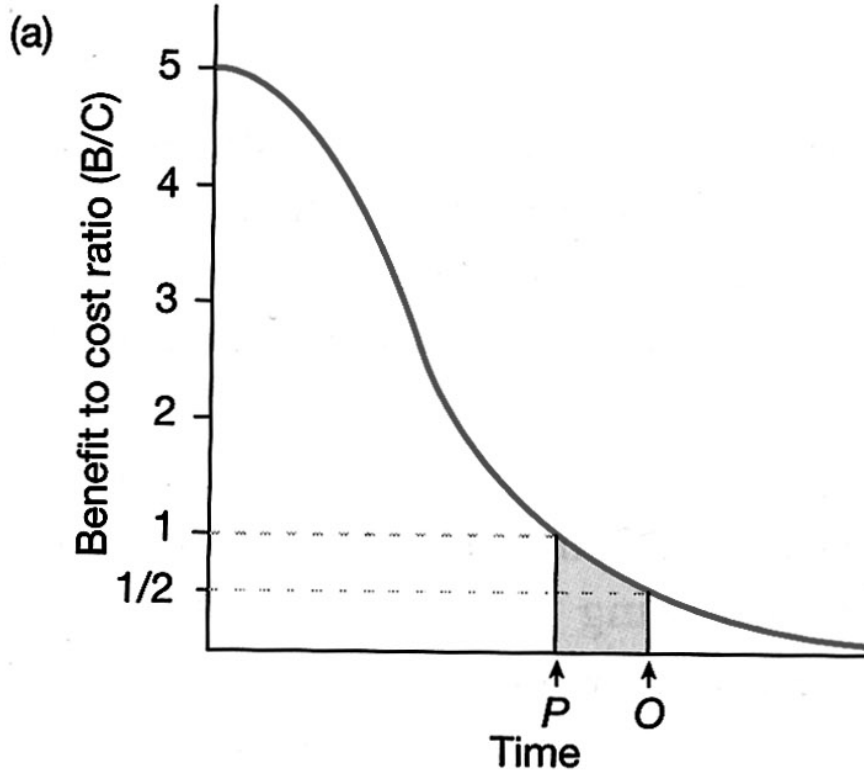
Extensions of kin selection theory

- Parent offspring conflict
- Sibling conflict
- Extraordinary sociality: eusocial species

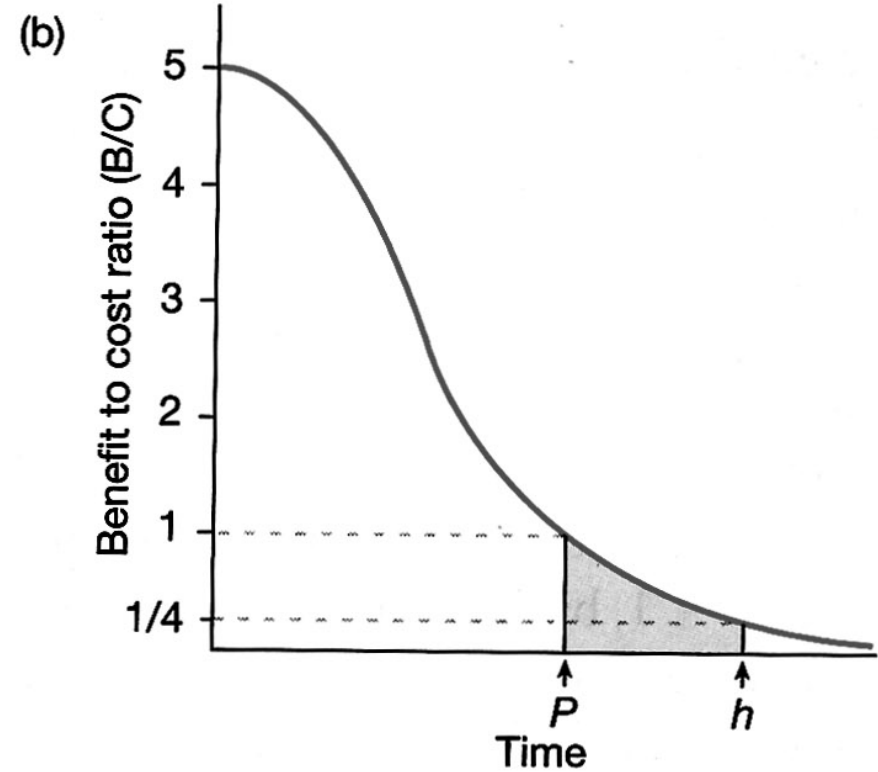
The problem: r to self is 1

- Relatedness to siblings is $1/2$ of r to self
 - True for existing siblings and for potential siblings
- Therefore, we should expect
 - individuals value themselves more than their siblings (sibling rivalry)
 - value themselves more than their parents potential future reproduction (parent-offspring conflict)

Weaning conflict



Siblings



half-siblings

Benefit of investment in current offspring. Cost is decreased production of future offspring.

Siblicide: extreme sibling rivalry

- Killing siblings common in some birds
- Often first eggs incubated and hatched days before the last egg
- So there is a ‘runt’
 - Parents may lay the runt as ‘insurance’
- Killed by older stronger sibling



Extreme helping: Eusociality

- Eusociality
 - Overlapping generations
 - Cooperative brood care
 - Specialized non-reproductive castes
 - E.g., workers or soldiers

Eusociality found in:



- Mammals
 - Naked mole rats (Bathyergidae)
- Snapping shrimp
- Diverse groups of insects

Eusociality in Insects

Order	Family	Subfamily	Eusocial species
Hymenoptera	Anthophoridae (carpenter bees)		In seven genera
	Apidae	Apinae (honeybees)	Six highly eusocial species
		Bombinae (bumble bees)	300 primitively eusocial species
		Euglossinae (orchid bees)	None
		Meliponinae (stingless bees)	200 eusocial species
	Halictidae (sweat bees)		In six genera
	Sphecidae (sphecoid wasps)		In one genus
	Vespidae (paper wasps, yellow jackets)	Polistinae	Over 500 species, all eusocial
		Stenogastrinae	Some primitively eusocial species
		Vespinae	Ca. 80 species, all eusocial
Formicidae (ants)	11 subfamilies	Over 8,800 described species, all eusocial or descended from eusocial species	
	Many other families	None	
Isoptera (termites)	Nine families	All species (over 2,288) are eusocial	
Homoptera (plant bugs)	Pemphigidae	Sterile soldiers found in six genera	
Coleoptera (beetles)	Curculionidae	<i>Austroplatypus incompertus</i>	
Thysanoptera (thrips)	Phlaeothripidae	Subfertile soldiers are found in <i>Oncothrips</i>	

How did eusociality evolve?

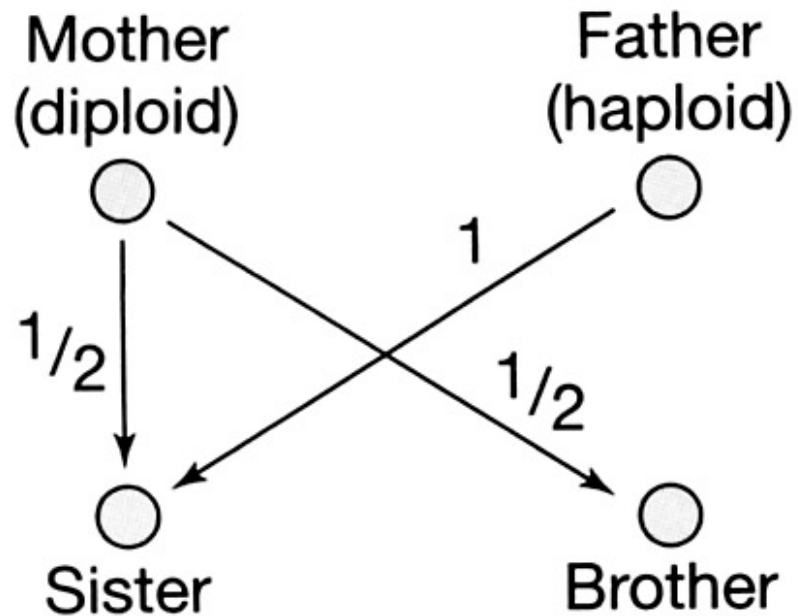
- Two things of major importance
 - High degree of relatedness among individuals
 - Ecological constraints on other options

Mechanisms of high relatedness

- Inbreeding
 - Termites
 - Naked mole rats
- Haplodiploidy
 - Hymenopterans
 - Thrips (Thysanoptera)
- Clones
 - Aphids (Pemphigidae and Hormaphididae)

Haplodiploidy

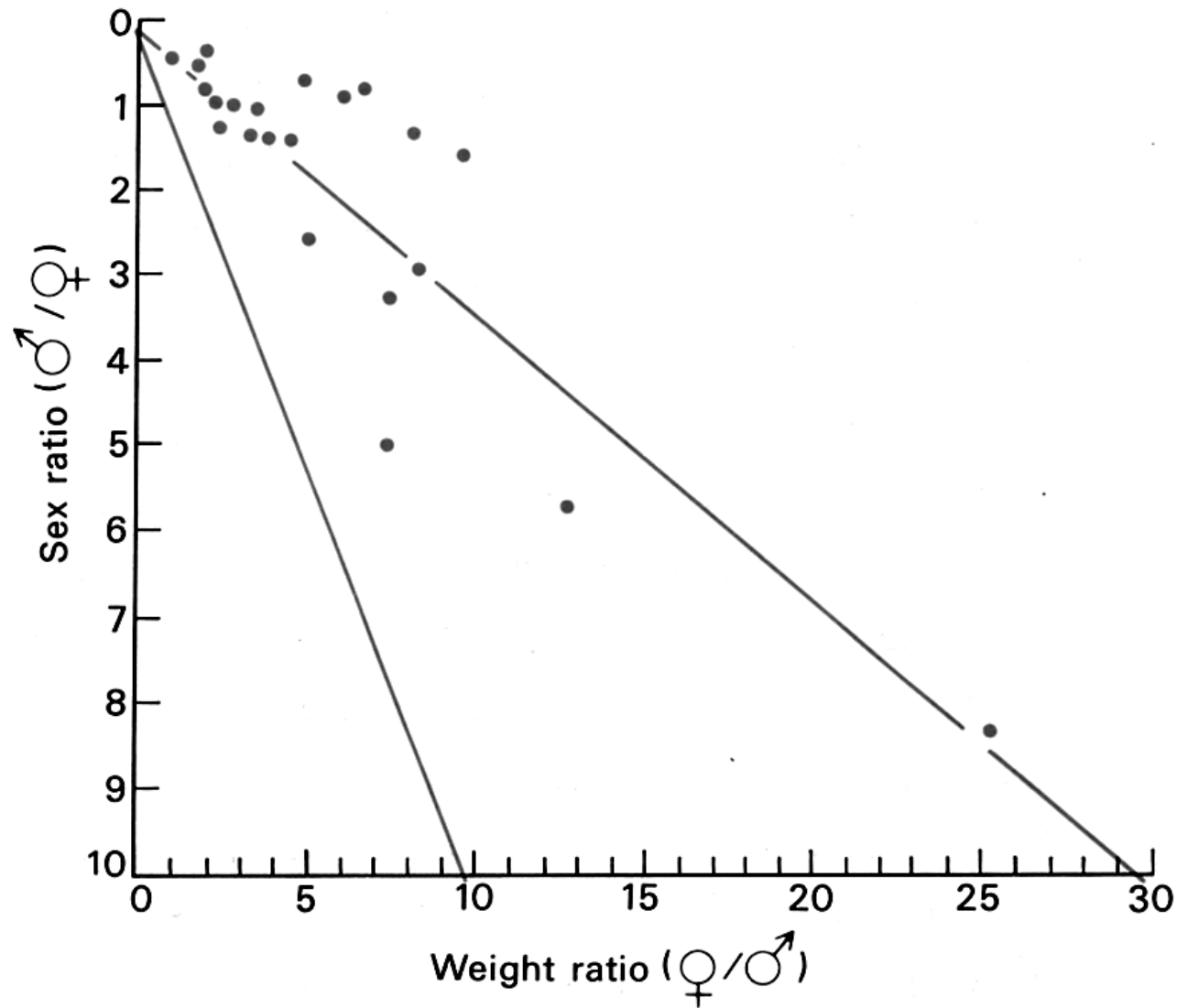
- Females produced from fertilized eggs (diploid)
- Males produced from unfertilized eggs (haploid)
- Females related to:
 - Brother = $1/4$
 - Mother = $1/2$
 - Sister = $3/4$
 - Offspring = $1/2$



Haplodiploidy predictions

- Females prefer to rear (reproductive) sisters ($r = 0.75$) over own offspring ($r = 0.5$)
- Worker females prefer to rear 3 times as many sisters ($r = 0.75$) as brothers ($r = 0.25$)
- Queen females prefer equal numbers of daughters ($r = 0.5$ to queen) and sons ($r = 0.5$ to queen)
- Predicted conflict between queens and workers over sex allocation well documented

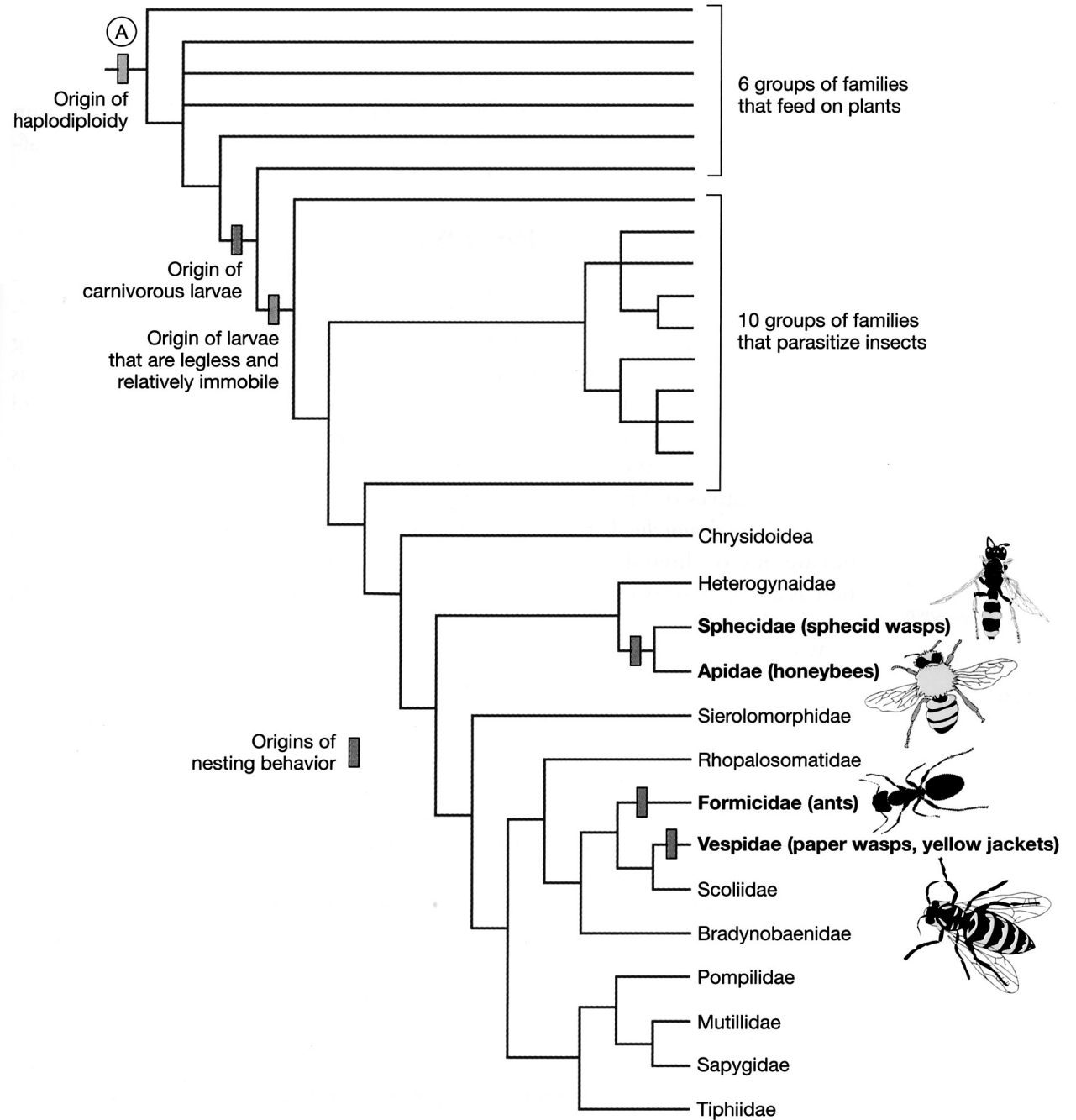
Worker queen conflict: sex allocation



Does haplodiploidy explain eusociality?

- Not by itself.
- Many species have sisters with lower r than 0.75 because of multiple mating by queen or multiple queens (1/2 sisters or unrelated)
- Many haplodiploid hymenoptera are solitary, NOT eusocial

Hymenoptera sociality



Mole rats and termites

- Inbreeding raises relatedness

Average r in mole rat colony members = 0.81



How did eusociality evolve?

- **Two things of major importance**
 - **High degree of relatedness among individuals**
 - = **Br weighted benefit is high**
 - **Ecological constraints on other options**
 - = **C cost is low**