Evolution of age at maturity

Very loosely based on:

Chapter 8 of Fox et al 2001. Evolutionary Ecology: Concepts and Case studies

R_0: lifetime reproduction

$$R_0 = \sum_{\alpha}^{\omega} l_x m_x$$

R_0 is the number of offspring produced by an individual during its lifetime (assuming no density dependence)

α: Age at first reproduction,
ω: Age at last reproduction,
l_x: Probability of surviving from birth to (at least) age x,
m_x: Expected number of offspring at age x,
dx: the length of time between reproductive events, is assumed to be 1.

- l_x is the probablity of surviving to at least age x
- l_x should be a decreasing function of x
- For example, $l_x = s^x$ where s is the probability of surviving a time step (i.e. a year)

Exercise 1

- Calculate R_0 for these two genotypes
- What type of life history tradeoff is represented by these life histories?
- Make a graph that illustrates the life histories of each genotype

Genotype 1:

x	1	2	3	4
l_x	0.5	0.3	0.2	0.1
m_x	0	2	2	2

Genotype 2

x	1	2	3	4
l_x	0.8	0.6	0.4	0.2
m_x	0	0	2	2

Exercise 2

- Calculate R_0 for these two genotypes
- What type of life history tradeoff is represented by these life histories?
- Make a graph that illustrates the life histories of each genotype

Genotype 3:

x	1	2	3	4
l_x	0.5	0.3	0.2	0.1
m_x	0	2	2	2

Genotype 4:

x	1	2	3	4
l_x	0.8	0.6	0.4	0.2
m_x	0	1	1	1

Exercise 3

- Calculate R_0 for these two genotypes
- What type of life history tradeoff is represented by these life histories?
- Make a graph that illustrates the life histories of each genotype

Genotype 5

x	1	2	3	4
l_x	0.5	0.3	0.2	0.1
m_x	0	0	2	2

Genotype 6:

x	1	2	3	4
l_x	0.5	0.3	0.2	0.1
m_x	0	1	1	1

Patterns of mortality and age at first reproduction in natural populations of mammals

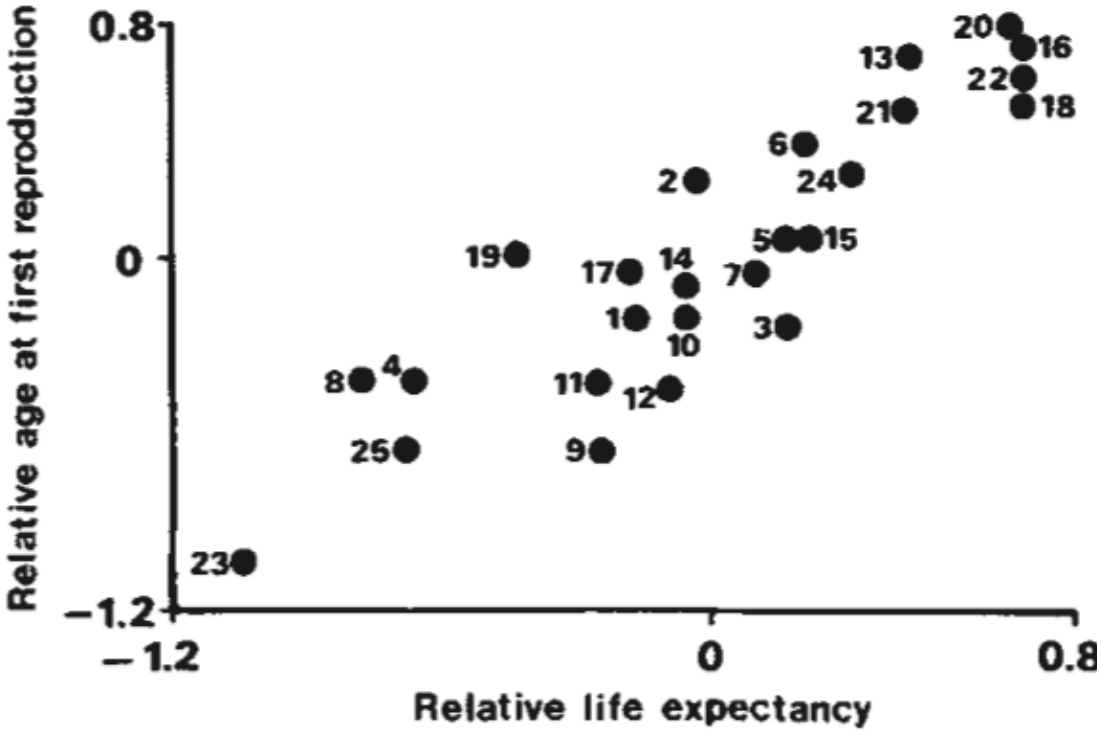


Fig. 1 Relative age at first reproduction plotted against relative life expectancy at birth for natural populations of mammals. Relative values refer to deviations from logarithmic regression lines of age at females' first breeding, or expectation of life at birth, on adult female body size. Numbers refer to different mammalian genera. Artiodactyla: 1, *Syncerus* (buffalo); 2, *Hippopotamus*; 3, *Aepyceros* (impala); 4, *Sus* (pig); 5, *Cervus* (deer); 6, *Ovis* (sheep); 7, *Hemitragus* (tahr); 8, *Phacochoerus* (warthog); 9, *Kobus* (kob); 10, *Connochaetes* (gnu). Carnivora: 11, *Taxidea* (American badger); 12, *Lynx*; 13, *Lutra* (river otter); 14, *Mephitis* (skunk). Lagomorpha: 15, *Sylvilagus* (cottontail rabbit); 16, *Ochotona* (pika). Perissodactyla: 17, *Equus* (zebra). Proboscidea: 18, *Loxodonta* (African elephant). Rodentia: 19, *Castor* (beaver); 20, *Tamias* (chipmunk); 21, *Spermophilus* (ground squirrel); 22, *Sciurus* (grey squirrel); 23, *Clethrionomys* (vole); 24, *Tamiasciurus* (red squirrel); 25, *Peromyscus* (mouse).

Harvey and Zammuto 1985

Evolution of age at first reproduction in *Drosophilia*

Photo credit: André Karwath

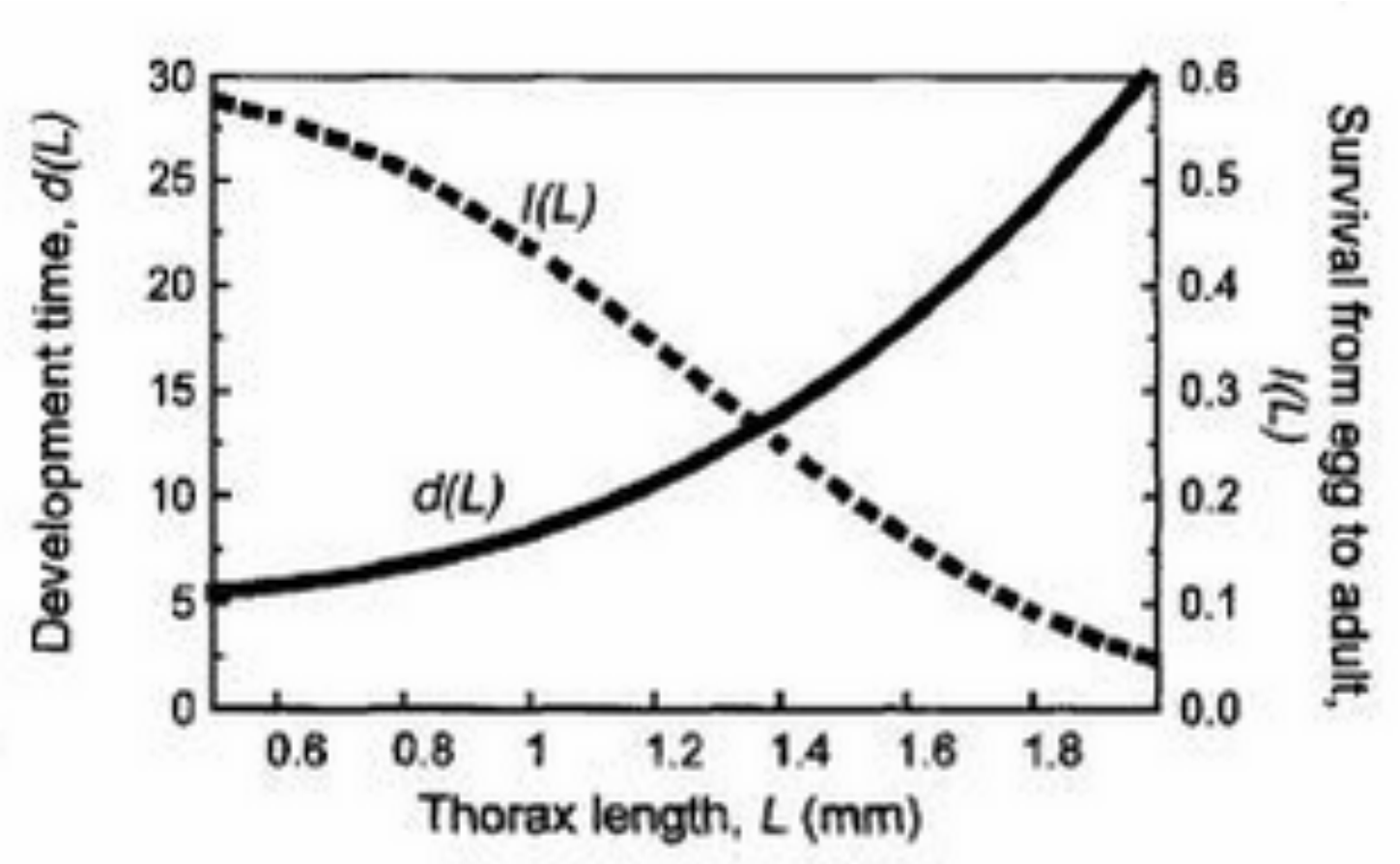
Evolution of age at first reproduction in *Drosophilia*

- Later age at first reproduction (e.g. higher α)
  => higher fecundity (e.g. higher m_x)

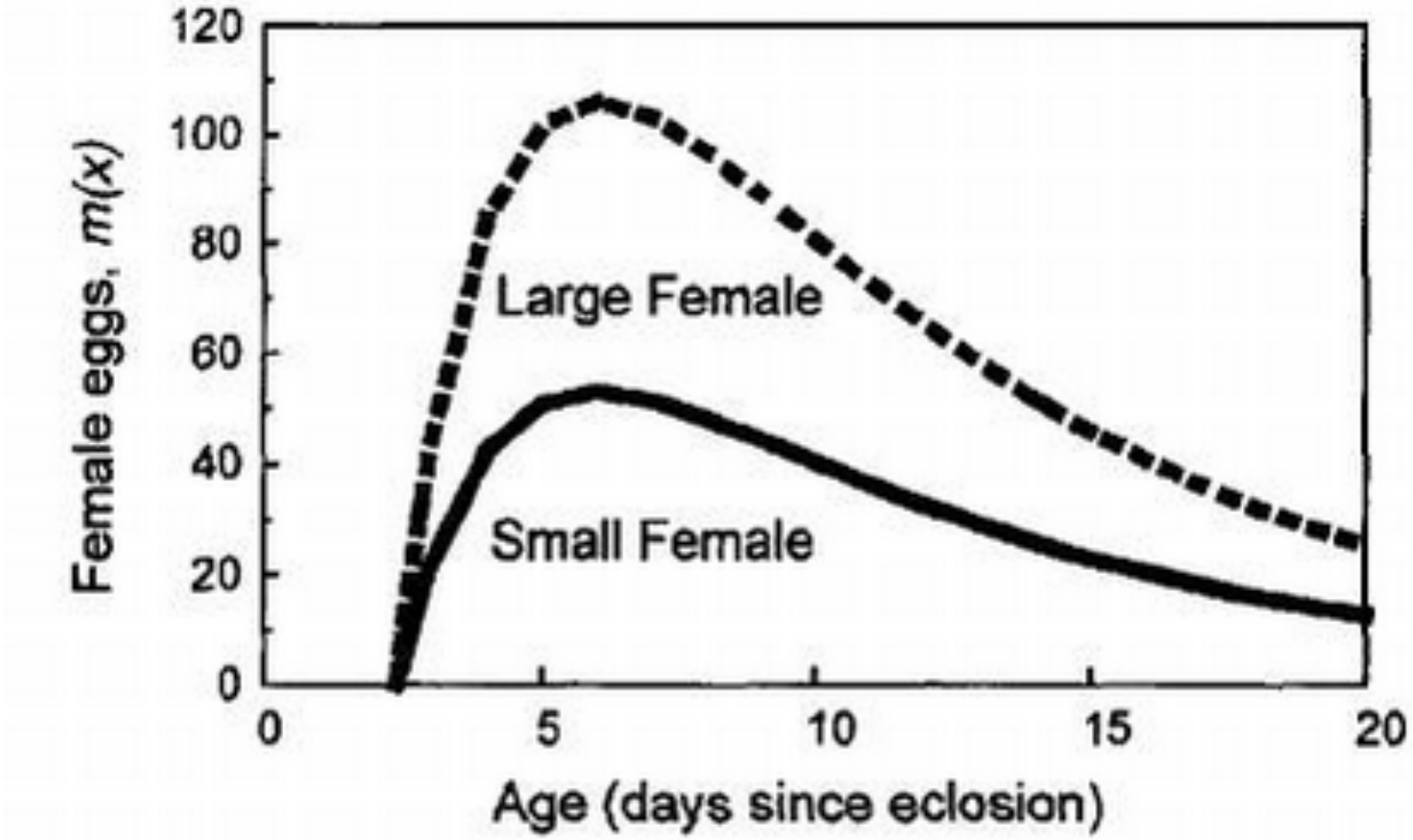
- Later age at first reproduction (e.g. higher α)
  => higher juvenile mortality (e.g. lower l_x)

- This tradeoff emergences because both dependent on body size at maturity

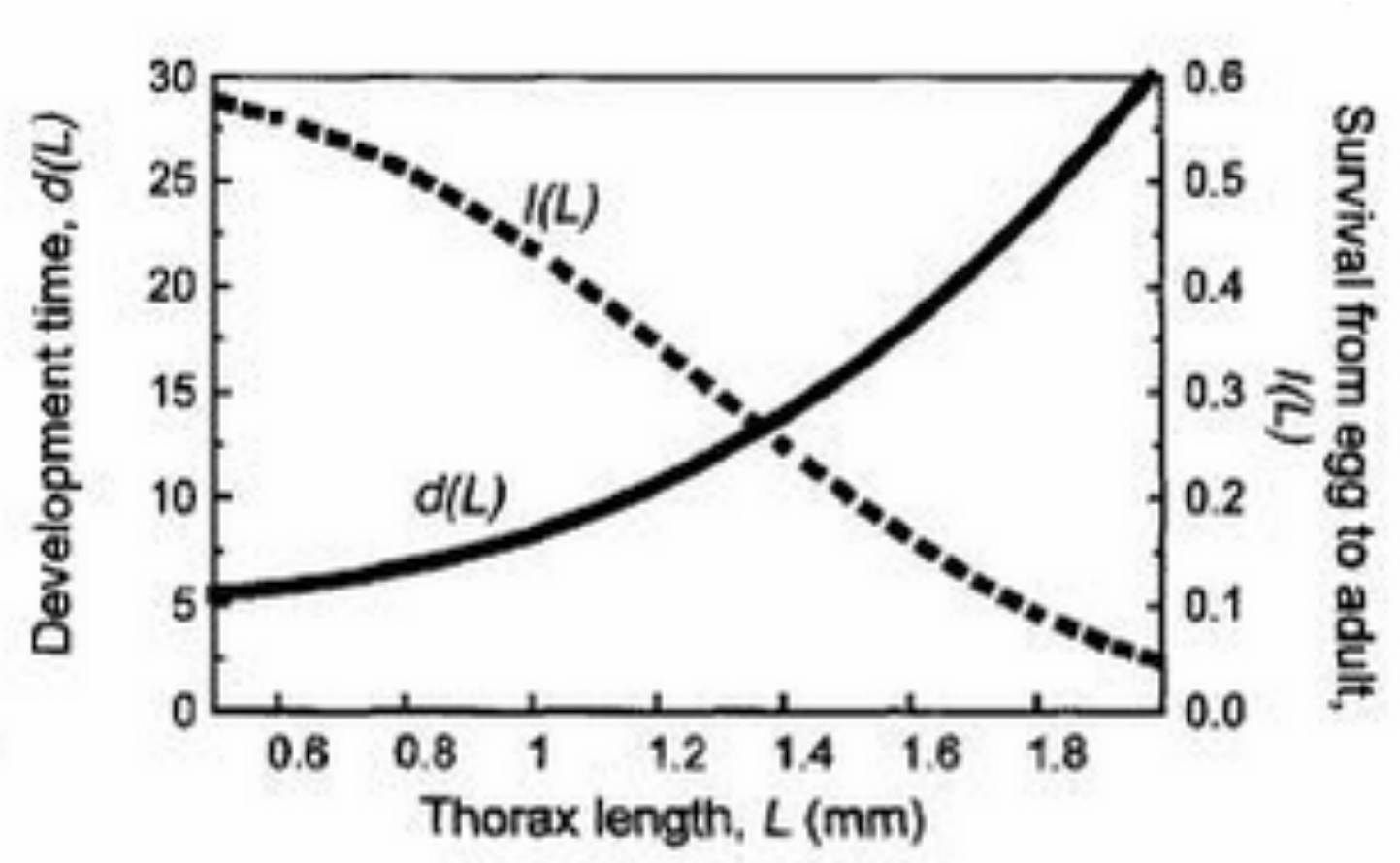
Body size at maturity, *L*



Fecundity


Female eggs, m(x)
120
100
80
60
40
20
0
Large Female
Small Female
0
5
10
15
20
Age (days since eclosion)

Juvenile mortality



Exercise 4

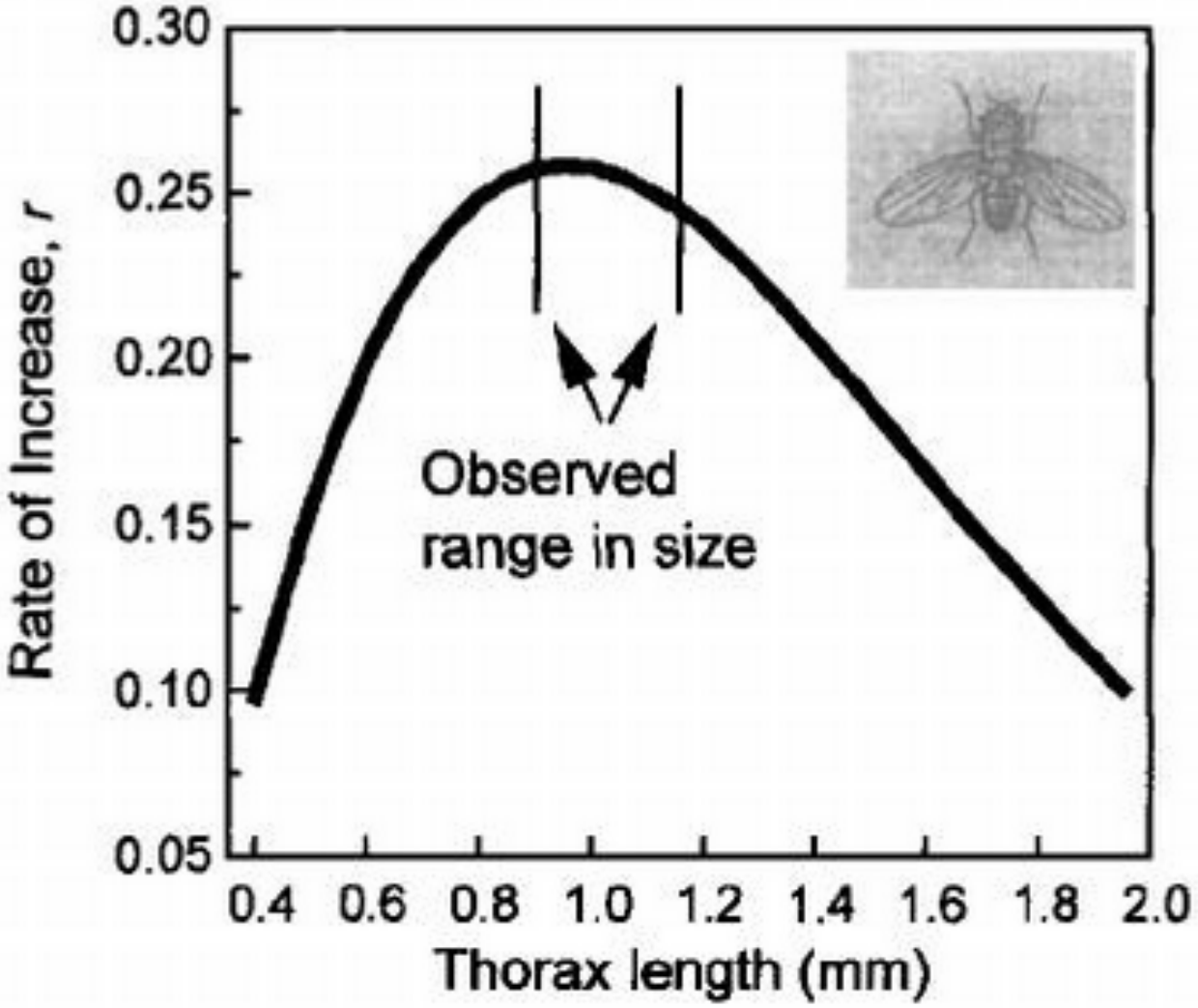
- Complete the table using the graphs on the previous slides
- Assume after reaching maturity, the probability of surviving another 5 days is 0.5
- Calculate R_0 for the large and small genotypes
- What type of life history tradeoff is represented by these life histories?

Small (L = 0.5mm; α =)

x	5	10	15	20
l_x				
m_x				

Large (L = 1.2mm; α =)

x	5	10	15	20
l_x				
m_x				


0.30
0.25
0.20
0.15
0.10
0.05
Rate of Increase, r
Observed
range in size
0.4
0.6
0.8
1.0
1.2
1.4
1.6
1.8
2.0
Thorax length (mm)

1. It sometimes matters whether one maximizes r or R_0 (models 3, 4).

▼ Evolutionary Ecology : Concepts and Case Studies

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